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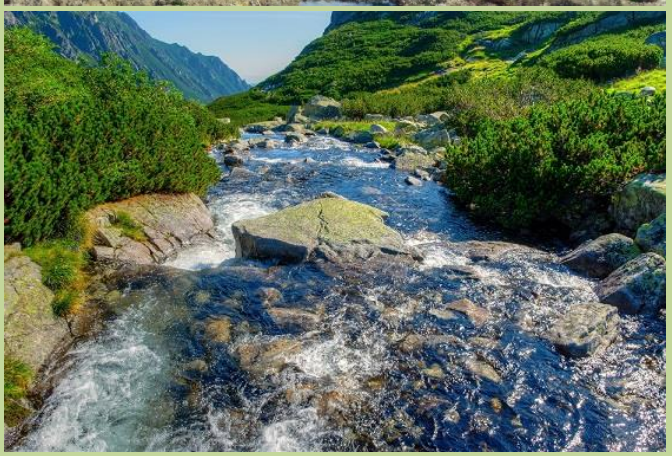

The Health and Social Benefits of Nature and Biodiversity Protection

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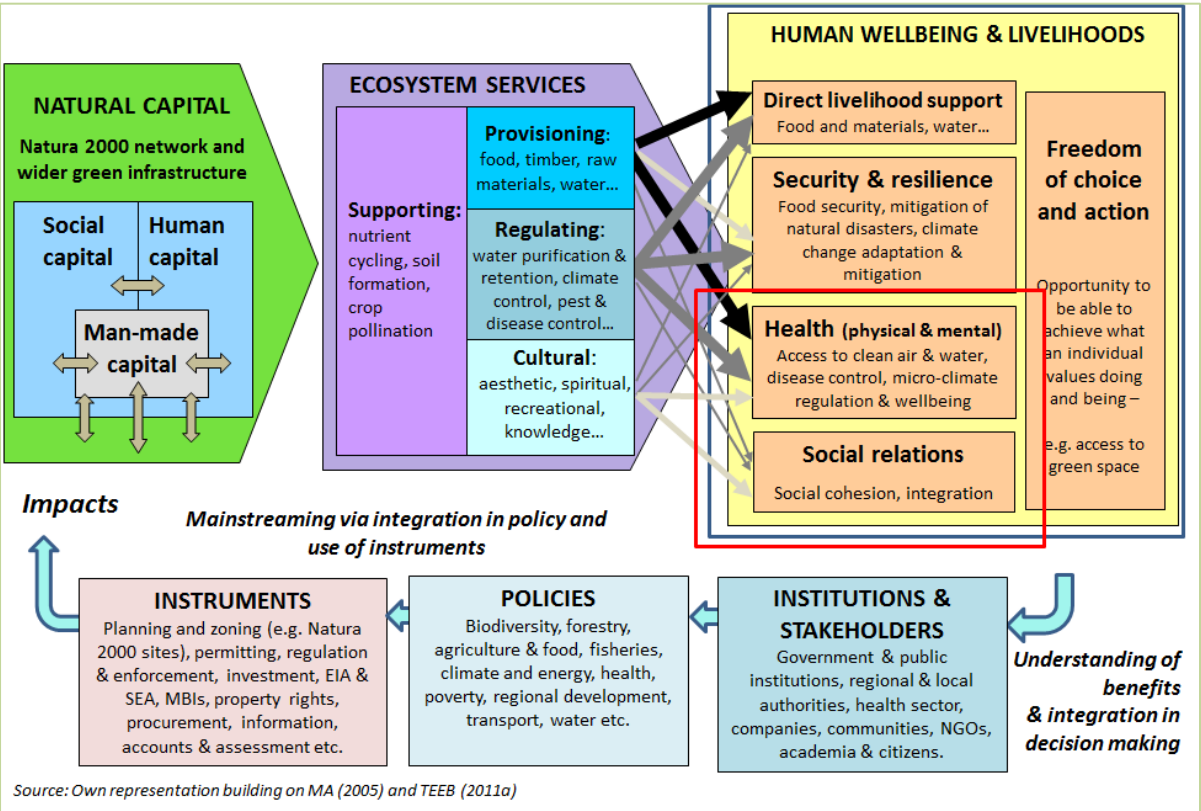
1 Introduction

1.1 Exploring the contribution that nature can make to health and social challenges

Over the past decade, numerous studies have shown the multiple benefits of protected areas, such as the Natura 2000 network, and green infrastructure to the economy and to human well-being. Examples include carbon storage benefits, water supply and purification, flood management, soil retention, recreation and tourism, and the provision of fish and timber.

These assessments have helped communicate the importance of biodiversity protection for the wider public, attract funding for management and restoration and also encourage due engagement with protected areas, green infrastructure and their management to deliver wider benefits for stakeholders, from local authorities, to business (e.g. water companies, tourism & recreation related industries), the public (e.g. schools) and NGOs and clubs (e.g. nature associations, sports) (see Figure 1.1 on the ecosystem services, awareness of the benefits and response).

Figure 1.1: Natural capital, ecosystem services, human wellbeing and livelihoods



Source: Own representation building on MA (2005) and TEEB (2011a)

The Convention on Biological Diversity (CBD), for example, has already done important work to explore the links between biodiversity and health, drawing on studies and cases from across the globe (CBD, 2012; CBD, 2015). Yet while many of the existing studies on protected areas and green infrastructure refer to health benefits and social benefits,

including rural viability, none offers a comprehensive assessment of public health benefits from improved air quality, climate, exercise and healthier lifestyles and/or of social benefits from access to nature and working with nature (see Figure 1.1).

This study aims at filling this gap and exploring the potential health and social benefits associated with the protection and enhancement of biodiversity in the EU – and in particular with the Natura 2000 network and wider green infrastructure (see Chapter 11). It identifies opportunities for further developing and increasing health and social benefits, it identifies possible tools for mapping of social values and health benefits that could be linked to nature environment and also make recommendations on how actions at the EU level could serve to promote the linkages between biodiversity policy and socio-economic policies more effectively. The more general objective is to evaluate the social benefits (potential and actual) associated with EU biodiversity policy. The work focuses on the following nine areas:

Table 1.1: Health and social benefits of nature assessed

Direct and indirect health benefits
Improved air quality & health benefits
Improved climatic conditions – addressing heat stress
Noise reduction benefits
More pleasant & peaceful, less stressful environment
Healthier lifestyles – nature experience
Outdoor recreation and physical activity
Wellbeing – living in attractive location
Promoting social cohesion
Quality of green public spaces, reduced social tension
Opportunities for involvement – volunteers, employment, management

1.2 Methodology and approach

This report reviews and discusses the existing scientific evidence on the health and social benefits of nature for individuals and at community scale, based on a number of different research methods and work from different research disciplines. This review is primarily based on peer-reviewed literature. It considers some further non-peer reviewed literature to complement the findings from academic research.

Furthermore, the report features numerous practical case examples across Europe that illustrate how stakeholders – in different constellations – work together to realise health and social benefits by working with and in nature in urban, suburban or rural settings. The case examples come from all Member States or the European Union. Twenty of these cases are analysed in more detail as examples of good practice in protected areas or working with wider green infrastructure. These cases also show how nature and biodiversity can often benefit from activities that are primarily targeting human health or social concerns.

As realising health and social benefits through nature-based approaches typically requires collaboration across the nature, health and social communities, the study team conducted a detailed stakeholder analysis, including a survey and a series of interviews with experts and initiatives across EU Member States. This analysis provided additional insights into governance aspects of nature-health-social links.

The evidence brought together from a review of the literature and from looking at real-life applications has been presented to and discussed with a wider range of stakeholders with nature, health or social backgrounds working at local, regional, national or international level at a workshop help in the course of this work. The discussions and insights from this workshop have been integrated in this report and have helped shaping conclusions and recommendations to a way forward in order to better make use of nature-based approached for tackling health and social challenges across Europe.

1.3 Structure of the report

The report first presents and discusses the scientific evidence on the benefits of nature across nine thematic areas. This comprises direct health benefits related to air quality (Chapter 2), to mitigating urban heat stress and noise (Chapters 3 and 4), and to the presence of nature in everyday living environments (Chapter 5). In the following course, the focus is on a number of indirect health benefits related to healthier lifestyles and nature experience (Chapter 6), recreation and exercise (Chapter 7) and the role nature of wellbeing and living in attractive location (Chapter 8). Finally, the discussion also addresses several social benefits provided by nature, namely the access to nature including for disadvantaged individuals and groups, as well as wider socio-economic benefits through opportunities for volunteering, skill building and employment (Chapters 9 and 10).

This review of the scientific evidence and practical experience is followed by a dedicated analysis of tools for managing and planning protected areas, especially with a focus on the European Natura 2000 network of protected sites, which can be found in urban, peri-urban and in rural environments, but also covering wider green infrastructure (Chapter 11). This analysis is complemented by a review of governance aspects, including stakeholder engagement and collaboration across the nature, health and social communities (Chapter 12).

Based on the above scientific evidence and the practical experience across Europe, and by considering approaches from other regions of the world, the report draws a number of conclusions and recommendations, including a Road Map for health-social-nature synergies (Chapter 13). Stakeholders working at local, regional, national or international level have a number of options to better realise the multiple benefits of nature for human health and wellbeing and the role of nature of biodiversity for delivering these benefits.

2 Improved Air Quality

2.1 The European air quality challenge

This chapter examines the social and health benefits of nature in improving air quality. As air quality continues to be a significant health concern in many parts of Europe, increasing research and application of the ecosystem services concept in improving air quality, particularly vegetation in urban and peri-urban settings, is as relevant as ever.

The chapter presents evidence of how nature can be used to actively improve air quality or reduce exposure to pollutants and consequently generate social and health benefits. As well as exploring the modes through which vegetation can influence air pollution, it presents cases of Natura 2000 sites and Green Infrastructure (GI) in Europe, as well as further afield, which support these arguments.

Air quality is a key determinant of public health, particularly cardiovascular and respiratory functions. Poor air quality in many parts of Europe is a cause for concern and contributes to a significant health risk.

In order to understand the potential for natural spaces to provide social and public health benefits, it is necessary to recognise the severity of the public health risks that air pollution continues to pose in Europe. The European Environment Agency (2015) estimates that air pollution is responsible for 430,000 premature deaths in Europe. A considerable body of research links air pollution to a number of significant health impacts. Air pollution drives serious impacts on cardiovascular and respiratory systems, including reduced lung function, asthma, chronic bronchitis and premature deaths (COM, 2013c; Amann et al., 2005; Hansell, et al., 2015). The literature focuses on the pollutants that pose the biggest public health threat (see Table 2.1).

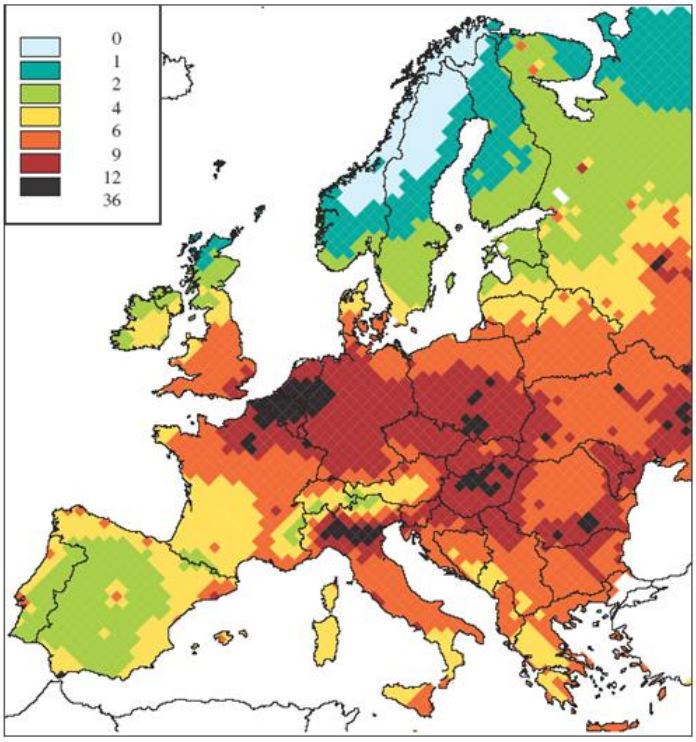
Table 2.1: Important air pollutants, including EU limits and data for exceedance

Pollutant	Source	Health impact	EU limits, 1 year averaging period unless stated **(COM, 2013c)**	European levels, 2012 **(EEA, 2014)**
Particulate matter (PM)	Road vehicles, shipping, power generation, industry, and households, natural sources (sea salt, wind-blown soil, sand)	Can cause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias. Can cause cancer. May lead to atherosclerosis, adverse birth outcomes and childhood respiratory disease. The outcome can be premature death.	PM_{10} 50 µg/m^3 $PM_{2.5}$ 25 µg/m^3	For PM_{10} 21% of sites exceed EU limit
Ground-level ozone (O_3)	A secondary pollutant produced by chemical reactions of NOx and VOCs in sunlight	Can decrease lung function, can aggravate asthma and other lung diseases, can lead to premature mortality	120 µg/m^3 (8 hour mean)	24 % of the O_3 stations
Nitrogen oxides (NO_x)	Road vehicles, shipping, power generation, industry and households	Exposure to NO_2 is associated with increased all-cause cardiovascular and respiratory mortality and respiratory morbidity.	40 µg/m^3	2 % (17 stations) of all urban background stations
Volatile organic compounds (VOC)	The use of solvents in products and industry, road vehicles, household heating and power generation	VOCs are the key component in the formation of ground-level ozone.	n/a	n/a
Sulphur dioxide (SO_2)	Power generation, industry, shipping and households	Aggravates asthma and can reduce lung function and inflame the respiratory tract, can cause headaches, general discomfort and anxiety.	125 µg/m^3 (24 hours)	3 stations in Bulgaria and Poland, other sites generally well below EU limit

COM, 2013; EEA, 2014, p. 31

In some cases, the links between air pollution and morbidity are still not fully understood. Research in these areas is still uncovering how particulates and other airborne material can affect human health. Some aspects, such as long-term exposure to ozone or ultra-fine particles ($PM_{<2.5}$) may be underestimated (WHO, 2013; Jerrett et al., 2009).

Figure 2.1: Loss in average statistical life expectancy (in months) due to identified levels of anthropogenic PM2.5



Source: EEA, 2012b

The EU as a whole continues to lag behind the USA (EPA, 2011) and Japan (Ministry of the Environment, 2015) in its air quality standards, and in many locations it is far from complying with WHO guideline values, which are more stringent than EU legislation (WHO, 2014). It is estimated that over 80 per cent of Europeans are exposed to particulate matter levels above the 2005 WHO Air Quality Guidelines (AQGs). The social and health impacts of poor air quality are not spread uniformly across Europe. There are major variations between and within member states. Figure 2.1 shows that the health impacts of particulate matter are worst in the Benelux area, Eastern Europe and Northern Italy. Many member states continue to breach EU standards on local air quality.

European City Ranking

Two European campaigns "Soot-free for the Climate!" and "Clean Air Life+ Project" have looked at air quality across Europe at the city scale. The projects explore how cities can use local solutions to improve air quality and they rank cities on the basis of their air quality performance, focusing on PM_{10} and NO_2. The aim of the ranking is to stimulate knowledge transfer and best practices between Europe's major cities. The first ranking was carried out in 2012. The second ranking in 2015 looked at 23 European cities. Cities are ranked with a score according to their use of different measures to address air quality. The five best and worst cities are included in the table on the right. None of the cities achieved the top score of A+. Several cities had the lowest possible score.

Source: Freunde der Erde, 2015

Rank	City	2015 Score
1	Zurich, Switzerland	B+
2	Copenhagen, Denmark	B
3	Vienna, Austria	B
4	Stockholm, Sweden	B-
5	Berlin, Germany	C
…		
19	Glasgow, UK	F
20	Madrid, Spain	F
21	Rome, Italy	F
22	Lisbon, Portugal	F
23	Luxembourg	F

At a micro-scale, air quality shows further variations, and the dynamics of air pollution within cities is highly complex (Meyer, 1999). One study looking at The Hague developed a model for urban traffic dispersion. The models included parameters for street width and length, building height, wind velocity and direction, ambient air temperature, background pollution, traffic volume, vehicle type and speed (Wang et al., 2008). In this respect, air quality continues to be a challenging and trans-boundary environmental issue and the impacts it poses to social and public health necessitate an effective response at the European, Member State, and also city and neighbourhood levels.

2.2 Benefits of nature protection and biodiversity to air quality and public health

Scientific and empirical evidence suggests that the role of nature in improving air quality is highly complex and the function of multiple variables. The benefits derived from nature-based solutions to air pollution are potentially significant due to the high burden and costs linked to respiratory and cardiovascular disease.

A number of case studies from European cities, peri-urban spaces and Natura 2000 sites support this argument, as well as demonstrating innovative strategies that are being applied to derive social and public health benefits from nature. The chapter focuses on harmful pollutants, rather than on the contribution of nature to the oxygen and carbon cycles – even though these are significant.

What are the causal links between nature and air quality benefits?

There is a growing evidence base on the relationship between public health, air quality, and nature, however, significant gaps still exist in understanding the potential role which nature-based solutions can play. Table 2.2 presents an overview of the causal links between nature and health benefits and illustrative results from research. Green spaces and vegetation can have a positive impact on air quality through a number of direct and indirect pathways.

Table 2.2: Causal links, hypothesis, measures and evidence – an overview with illustrative examples

What environmental and health pressures could biodiversity help address and what indicators are useful?	What specific benefits could in principle (and actually) be measured? **What quantitative indicators are used?**	What benefits can be measured in monetary terms?	Main beneficiaries of biodiversity measures	What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?
Nature can reduce exposure to pollutants, including $PM_{2.5}$, PM_{10}, O_3, NO_X, SO_2, VOC, toxic metals. Nature can contribute by directly removing pollutants temporarily or permanently, dispersing pollutants by generating airflows, as well as indirectly by providing clean air oases and facilitating behaviour change to reduce pollutants at source.	▪ Avoided premature deaths (mortality) ▪ Avoided hospitalisations and medical treatments (cardiovascular disease, stroke, breathing problems, asthma, lung cancer, impacts on central nervous system, impacts on reproductive system) ▪ Avoided lost days of output (GDP)	▪ Value of loss of life years (VLL) ▪ Avoided hospitalisation costs ▪ Avoided loss of output	▪ Urban and peri-urban populations in general ▪ Population living in areas with low share of green space ▪ Especially elderly population, children, pregnant women, all persons exposed to highly polluted areas, person with predispositions such as breathing problems, cardiovascular disease	Urban and some peri-urban Natura 2000 sites preserve valuable sinks of pollutants, as well as clean air oases. Large urban parks and forests including Natura 2000 sites contribute massively to air quality. Old and large trees also play an important role. City green infrastructure (trees and parks) can help to maximise the potential for air quality improvements, particularly in highly polluted areas. Intelligent GI strategies can be particularly effective Both GI and Natura 2000 should be integrated as part of smart urban systems to address air pollution.
<u>Vegetation can improve air quality in three ways</u> (Pugh, et al., 2012, p. 7692): **- Absorption of gaseous pollutants (O_3, NO_X, SO_2)** **- Dry deposition of PM** **- Dispersion of pollutants by cooling** **<u>Useful indicators</u> for a given location:** - **Current levels of pollutant** - **Rate of removal (t yr^{-1})** - **Percentage reduction %** **<u>Example</u>:** **Reported up to 40% for NO_2 and 60% removal of PM in London (Pugh, et al., 2012)**	<u>Calculating specific benefits:</u> - Comparative studies of different areas - Externality values for value in removing pollutants (e.g. UFORE, i-Tree etc.) <u>Example</u>: Research shows that increasing street tree count could reduce asthma prevalence in Carlisle by up to 29% (Carlisle City Council, 2011)	<u>Monetary benefits can be understood in terms of three factors:</u> - Cost of installation / management - Rate of removal of pollutant (t yr^{-1}) - Model for health/social impacts or externality scalar (e.g. UFORE, i-Tree) <u>Example</u> Barcelona's trees and shrubs have removed 305.6t yr^{-1} of pollution from the air. From an economic point of view, this purification is valued at €1,115,908 a year (Chaparro & Terradas, 2009)	<u>Air pollution as transboundary but benefits of air quality control by vegetation are most effective at high pollutant sites</u> - Urban hotspots such as road junctions benefit most from vegetation (Mitchell & Maher, 2009) - Young children and the elderly are often most susceptible to respiratory disease (Lovasi, et al., 2008)	<u>Natura 2000 and conservation</u> - Nantes, winner of European Green Capital 2013, has a rare city centre Natura 2000 site which helps the city to maintain high air quality levels - Preservation of old and large trees demonstrate high flux of pollutants (FAA, 2014) - Certain species demonstrate higher flux rates (Donovan, et al., 2005) <u>Green infrastructure</u> - In street canyons, green walls and roofs can be more effective than trees (Pugh, et al., 2012)

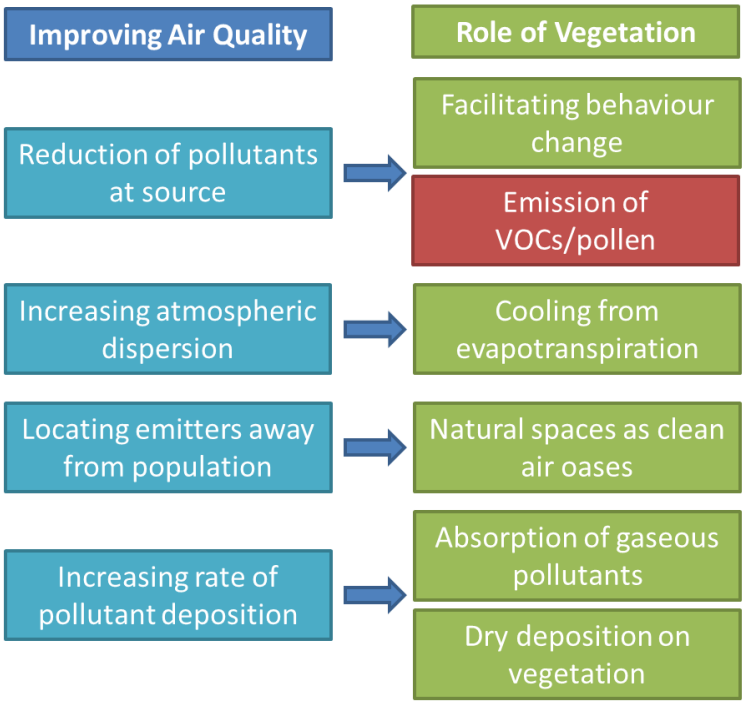
Air quality and natural spaces

Natural spaces have primarily positive direct and indirect impacts on air quality and human health; filtering harmful pollutants, providing oases of clean air, dispersing pollutant concentrations and facilitating behaviour change. More research is needed to establish a more comprehensive understanding of the benefits of nature.

Air pollution can be controlled in four main ways: reducing the emission of pollutants; increasing their dispersions to reduce concentrations; locating emitters away from populated areas; and increasing the rates of pollutant removal (Pugh et al., 2012, p. 7692). The role of vegetation in contributing to these processes through ecosystem services is being increasingly explored (Gomez-Baggethun et al., 2013).

The focus has largely been on the absorption of gaseous pollutants and the deposition of particulates on vegetation, but vegetation can also contribute to dispersing pollutants and contribute negatively through some emissions, such as pollen (as an allergen) and VOCs. Furthermore, large natural spaces such as parks, by virtue of being located away from emitters such as motor vehicles or industrial sites, provide oases of clean air, and these natural spaces can promote behavioural change towards less polluting activities. These six pathways are shown in the schematic below:

Figure 2.2: Pathways by which vegetation affects air quality



Source: Own representation

Direct ecosystem interactions with air quality

Deposition and absorption – ecosystems directly remove air pollution, through absorption or intake of gases (e.g. NO_2, CO, SO_2) through leaves, and through direct deposition of particulate matters (PM) on plant surfaces.

Microclimate regulation – ecosystems provide shade and cooling through evapotranspiration; this affects local temperature, precipitation and air dynamics, which contributes to the generation of clean air-flows, reduces the formation of some harmful pollutants and disperses pollutants, thereby changing their concentrations.

Emissions – many ecosystems emit volatile organic compounds (VOCs) such as terpenes and arenes. While sometimes considered as pollutants, many natural VOCs play a critical role in atmospheric chemistry and air quality regulation. Ecosystems also release pollen, sometimes associated with acute respiratory problems. Burning of vegetation is also associated with significant pollution emissions (CBD, 2015, pp. 10-11).

Indirect ecosystem interactions with air quality

Clean air oases – green spaces, by virtue of not being industrial or transport land uses, often improve the ambient air quality of surrounding urban spaces. This impact can be more evident in larger parks. Citizens can minimise their exposure to pollutants by spending time in urban spaces distant from pollutant sources, including green spaces and protected areas.

Behaviour change – as part of well-designed urban systems, green infrastructure can promote lifestyle choices which reduce air pollutants at source, particularly through cycling or walking, but also through urban farming to reduce food miles and emissions (Pikora et al., 2003; EEA, 2015a; Panter & Ogilvie, 2015; Lee et al., 2015)

Vegetation has a natural capacity to absorb and remove air pollutants. Trees, woodlands and other vegetation can absorb a number of relevant pollutants such as SO_2, NO_X and O_3 (Chaparro & Terradas, 2009; Escobedo & Nowak, 2009; Gomez-Baggethun et al., 2013, p. 181). Some studies have attempted to quantify this effect, for example, a study of 55 cities in the US showed that trees and shrubs removed over 711,000 t yr^{-1} of O_3, PM_{10}, NO_2, SO_2, and CO (Nowak et al., 2006). However, such figures should be put into the perspective of absolute emissions and it should be noted that research into the effectiveness of vegetation in removing pollutants is very complex due to the high number of variables involved. This complexity should not be ignored when considering the absorption and deposition of pollutants linked to vegetation (Pataki et al., 2011).

For gaseous pollutants, the removal capacity varies among species and depends on transpiration rates and surface characteristics of plants. Inside the plants, gaseous pollutants react with water and are transformed (Baldocchi et al., 1987). Generally, higher transpiration rates are associated with greater removal of gaseous pollutants. Vegetation is also capable of fixing particulate matter on the leaves and stems of plants, thus removing it from the atmosphere. The removal capacity largely depends on the surface characteristics of plants. Dense crowns of trees with rough leaves can absorb more particulate matter that plants with coarse and simple leaves (Smith, 1990). Evergreen leaves offer the advantage of absorbing particulate matter on their surface all year. In contrast to gaseous pollutants,

green vegetation serves mainly as a temporary sink for PM, which, depending on the climatic conditions, can be released back to the atmosphere or washed down to the soil during precipitation events (McDonald et al., 2007). There is also some temporal variation in the rate of scrubbing as generally the stomata of a plant are closed at night and do not absorb pollutants, as a result of this further variation occurs across seasons. Similarly, the rate of pollutant removal decreases when deciduous trees shed their leaves in the winter (Gomez-Baggethun et al., 2013, p. 182).

When considering absorption and deposition, the effectiveness of natural spaces in improving air quality is dependent on a large number of variables. For instance, the species of vegetation, local airflows, the role of street canyons, pollutant concentrations, plant positioning etc. will all impact upon the rate at which different pollutants are removed (Pugh et al., 2012).

Considering indirect contributions to air quality regulation would require the incorporation of further variables, including social and local population factors. Researchers have begun to explore how urban greening strategies and the conservation of green space can be managed in order to maximise pollutant deposition and absorption. However, no initiatives were identified which explore how integrated approaches to green infrastructure can contribute to improving air pollution control across the six pathways outlined above.

Location and structure of vegetation

Vegetation can be strategically placed in order to maximise its impact on pollution. Research on the interaction of vegetation with air quality has focused on placing vegetation in polluted areas to maximise the absorption or deposition of pollutants. For example, placing trees at urban hotspots, such as major road junctions and at traffic lights will often yield higher rates of pollutant removal (Mitchell & Maher, 2009). Thus, from a planning perspective, integrating green infrastructure in polluted areas within the urban landscape may be more desirable than maximising the area of large urban parks. However, this ignores indirect benefits for air quality. Urban parks often experience significantly better air quality than other spaces, provide citizens with clean air oases, and may have a stronger impact on promoting behavioural change – for instance by providing a comfortable route to cycle to work (EEA, 2015b).

As well as the location of vegetation, the mode of planting can also impact upon its effectiveness in delivering improvements in air quality. In many cities, green roofs or moss walls are increasingly complimenting traditional applications of green infrastructure, such as trees and shrubs. These new types of green infrastructure often interact directly with grey infrastructure; they bring benefits such as avoiding land use change or even provide a medium for advertising or cultural and artistic value (Climate-KIC, 2014). The effectiveness of different types of vegetation structures in improving air quality will also need to account for these considerations.

Bosco Verticale - Vertical forest in Milan, Italy

In the Porta Nuova district of Milan, the construction of the world's first vertical forest is almost complete. The Bosco Verticale aims to improve urban biodiversity and reduce the Italian city's increasing pollution. The project consists of two large towers which have dense trees and vegetation planted on all of their facades. The two buildings can hold over 400 large and medium sized trees, 11,000 ground cover plants and 5,000 plants – roughly equivalent to 2.5 acres of forest (COM, 2015b).

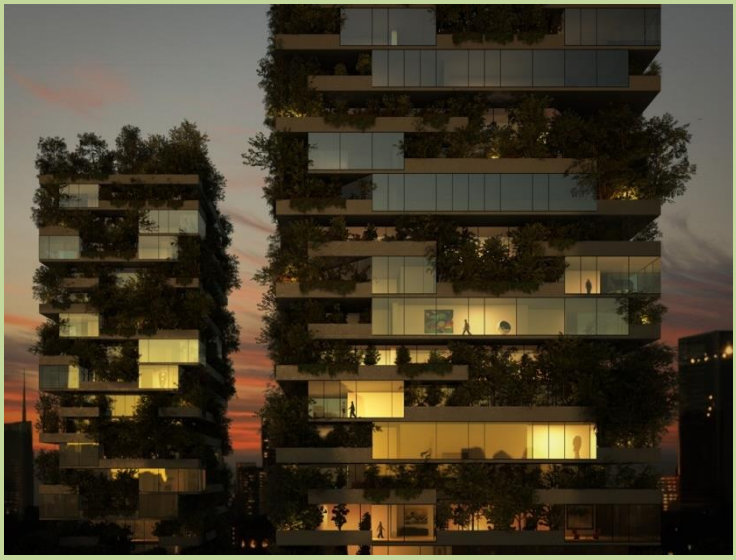


Photo: https://www.ordineingegneri.milano.it/professione/aggiornamento-professionale/eventi-esterni/mostre-ed-eventi-culturali/porta-nuova-visita-al-bosco-verticale

The USDA Forest Service has developed a number of software suites in order to support urban forestry analysis, including UFORE (Urban Forest Effects) and i-Tree. The i-Tree Eco model and Urban Forest Effects (UFORE) have been applied to a number of natural and urban spaces in order to quantify the biophysical and monetary benefits derived from trees in providing ecosystem services. The models can be focused on "air purification", and "air pollution" from biogenic emissions, and have been used to explore studies of vegetation impacts on air quality across the globe (Currie & Bass, 2008). They do not explore more complex pathways to air quality improvements, including indirect benefits and personal exposure.

A report by the Forestry Commission in the UK compiled 23 case studies on the benefits of trees in the built environment. One study measures the value of ecosystem services of trees with the improvement of air quality. By applying the UFORE and i-Tree model in Torbay, they showed the removal of up to 50 tonnes of pollutants each year (Forestry Commission, 2012). A study using the UFORE model in Toronto showed that trees and shrubs removed air contaminants more effectively than green roofs or green walls, with trees being more effective than shrubs (Currie & Bass, 2008, p. 416). The authors argued that this was probably due to the number of functioning leaf units on a tree creating a greater surface area for deposition of particulates. Although they found that adding grassy species to green roofs had a positive impact on contaminant reductions from GI, they concluded that green roofs and walls should complement rather than replace trees (Currie & Bass, 2008, p. 419).

Another study explored how lines of birch trees could influence indoor concentrations of PM in roadside houses (Maher et al., 2013). They show with two empirical methods that indoor concentrations of PM_{10} could be reduced by more than 50%, with tree leaves capturing iron rich ultrafine spherical particles, which pose a particular health hazard. They

concluded that some model-based approaches to assessing the effectiveness of vegetation tend to underestimate results.

Type of vegetation

The ability of plant species to control air pollution is not heterogeneous, and relates to the types of plants used for this purpose. Certain species of plants and trees show a greater propensity to filter pollutants and as such could be planted in greater numbers in order to maximise this utility.

Berlin, Germany – Street trees for clean air

Berlin's streets have over 440,000 trees, and it boosts one of the best air quality records for a city in Europe (EEB, 2011). Berlin was one of the top performing cities in the City Ranking of European cities based on its air quality strategy, ranked 1st in 2011 and 5th in 2015.

The city's Air Quality Plan 2011-2017 (be Berlin, 2014a) laid out an action plan for addressing drivers of air pollution, such as cars and industry. It also covers strategies for macro and micro scale greening. Macro scale covers the maintenance of open spaces and large parks, including the closure and conversion of the former Tempelhof airport into a large public park in 2010 – the Tempelhofer Feld (see in box below). Micro scale greening in the city refers to roof, façade and courtyard greening, as well as street tree planting.

One of the plans within Berlin's Air Quality Plan is Stadtbäume für Berlin (City Trees for Berlin) which aims to plant 10,000 new street trees in the city by 2017 (Senatsverwaltung für Stadtentwicklung und Umwelt, 2015). In Berlin the most common street trees are the linden and oaks. The project recognises that trees can filter pollution in the air and the health of trees can also act as a good indicator of air quality. A single tree provides roughly enough oxygen for ten people each day.

The cost of a street tree in Berlin is €1,200 for planting and the first three years of maintenance. In Stadtbäume für Berlin, the city government promises to pay the rest of the costs from each €500 donated by citizens or private bodies.

One study in Leicester, UK, explored how different species of trees interact with gaseous pollution. Their Urban Tree Air Quality Score (UTAQS) ranked 30 trees on this basis; pine larch and silver birch were the most effective. Some trees if planted in large numbers could

worsen downwind air quality because of the production of VOCs (see box below) (Donovan, et al., 2005).

A study in London focused on the deposition of particulate matter on different species of plant. Shackleton et al. (2010; TfL, 2012, p. 24) examined a living wall, shrub beds and planted towers at different high pollution sites in London. Their results showed that leaves that are waxy, hairy, or deep veined were the most effective at trapping particulate matter. Smooth and supple leaves on the other hand were the least effective.

Green infrastructure in cities

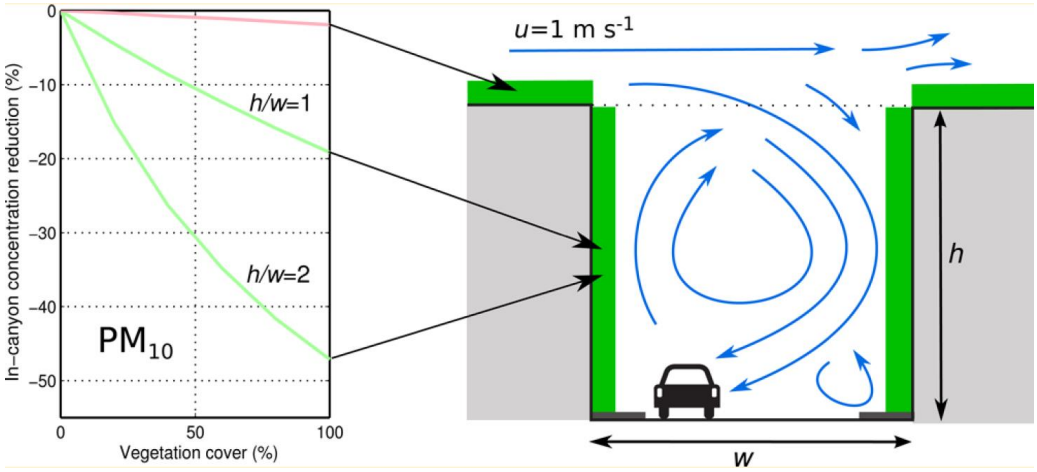
Cities across Europe are becoming increasingly active in developing air quality strategies, some of which integrate nature-based solutions. In addition to constructing new green infrastructure, they also have responsibility for preserving existing natural spaces. Large, and often ancient trees, are often noted for their benefits, but can equally be targets for removal to make space for redevelopment (Currie & Bass, 2008). Some cities have regulations to prevent larger trees from being felled. For instance in Stuttgart, Germany, all trees growing in the urban core with a trunk circumference of 80cm at a height of 1m are protected by law (Baden-Württemberg, 2012). An important consideration is that natural spaces take a long time to develop, so some benefits are not immediate, trees for instance may take several decades to reach maturity. Furthermore, as well as greening cities, the effectiveness of existing natural spaces can be maximised through good maintenance of what is already in place (Smith, 2012; Jim & Chen, 2003). Consequently, the protection and sustainability of natural spaces is a key element in benefitting from nature.

This attempt to explore how well certain species of plants interact with pollutants could prove to be an important tool for planners aiming for health benefits. Most research has focused on examining how well plants perform at both removing gaseous pollutants and the deposition of particulate matter. However, wider considerations may be just as important in developing sustainable cities with clean air and healthy citizens. For instance, which species are native and resistant to disease (Smith, 2011), or what green infrastructure design persuades citizens to choose soft mobility over driving (Pikora, et al., 2003).

The interaction of vegetation and air pollution is further complicated when one considers the role of airflows, particularly around existing urban morphologies. Planting vegetation can interact with microclimates and infrastructure to alter airflows, which can be important in both controlling and dispersing pollutant concentrations (Wang et al., 2008). However, in some cases, vegetation can reduce this dispersion effect (Pugh et al., 2012).

Street canyons present a specific urban morphology in which the row of buildings along a street, can work to increase local concentration of pollutants as the exchange between air within the canyon and outside is limited. The effectiveness of vegetation in cleaning air in street canyons is highly dynamic. Encouraging airflows between the street canyon and the outer layer can be favourable to improve street-level air quality. Local conditions, microclimates, and thermal dynamics vary from site to site. The extent to which vegetation can contribute to the dispersal of pollutants in highly polluted canyons is dependent on multiple variables (Buccolieri et al., 2009; Pugh et al., 2012; Gromke & Bodo, 2009).

Figure 2.3: Encouraging air flows in street canyons



Source: Pugh et al., 2012

In the case of street canyons, planting trees can act to reduce the mixing of air with the canyon and the air above the buildings. In cases of high emissions, trees lining street canyons can actually reduce air mixing and limit the ability of vegetation to increase air quality and generate health benefits. Hence, in these cases green walls may deliver preferable results, with the potential to reduce concentrations of NO_2 by up to 40% and particulate matter by up to 60% (Pugh et al., 2012).

Baik et al. (2012) explored the thermal impacts of green roofs and how this could impact on airflows and consequently air quality in urban street canyons. Using a computational fluid dynamics (CFD) model, they showed that the cool air produced by evapotranspiration on green roofs would flow into the street canyon. This increases the flow of air within the street canyon, thereby increasing pollutant dispersion, and improving air quality at street level. They then supported these results with a field study in a real urban morphology in Seoul, Korea, again showing improvements in road level air quality in relation to canyon cooling. Interestingly this study shows that GI can play a thermodynamic role in improving air quality as well as directly filtering pollutants (Baik et al., 2012).

Air quality oases

Achieving ambient air quality targets is a priority for Europe, however local and personal approaches to air pollution can help to reduce exposure for individuals. Understanding local spatial and temporal variations in air quality can help individuals to reduce their exposure to harmful pollutants significantly. For instance, crossing the road (Tomlin, et al., 2009) or choosing a new bike route (Cole-Hunter et al., 2013), or taking a route with a tree lined street can dramatically reduce micro-level pollutant levels (Al-Dabbousa & Kumar, 2014). Similarly, natural spaces, particularly large public parks in contrast to pollution hot spots provide important air quality oases in busy cities.

Atmosys, an air quality mapping project, shows that the almost all of the metropolitan area in Brussels exceeds WHO limits (Hope, 2014). Yet a higher resolution reveals that natural spaces, particularly the large Sonian Forest, a Natura 2000 site, have less than half the levels of pollutants such as NO_2 and PM (EEA, 2009; IBGE, 2012). Likewise, in Croatia, the Medvednica natural park, another Natura 2000 site, offers the citizens of Zagreb a break from pollution in close proximity to the city. In Barcelona, the Collserola Natural Park, a Natura 2000 site, acts as the biggest sink for pollutants in the city (Chaparro & Terradas, 2009). As Barcelona has a relatively low level of city vegetation, the Collserola Park provides an important haven for the local population.

A protected area to escape the city and enhance tourism: Zagreb, Croatia

Medvednica Nature Park is a protected area located on the Medvednica mountain, which is located in the north-west of Croatia and is part of the capital, Zagreb. Annually it attracts around one million visitors, and since Croatia's accession to the European Union it has become a part of the Natura 2000 network. Medvednica is accessible to everyone and provides leisure opportunities such as hiking, skiing, cycling and educational programmes. Furthermore, it offers tourism facilities and has diverse cultural heritage, such as medieval cities, castles and chapels. Additionally, the Park is rich in biodiversity, as it is the habitat of many different protected and endangered species of flora and fauna. Medvednica Nature Park also welcomes numerous traditional manifestations/events, to which nearly 30,000 people participated in 2015.

This offers a further perspective on how nature-based solutions can contribute to air quality that is not explored in the literature. Rather than focus on the contribution of vegetation to improving ambient air quality, urban planners can start to think about how to maximise citizen access to pockets or corridors of clean air – and reduce personal exposure to pollutants.

2.3 The role of supporting instruments and governance

Successful applications of green approaches to air quality are dependent on a number of policies and governance tools involving a range of actors and stakeholders at different levels.

The persistence of air pollution related health impacts in Europe represent both an economic burden and a public health crisis, necessitating novel approaches to delivering air quality improvements. Nature-based approaches have potential to deliver improved air quality outcomes in Europe.

Legislation, targets and monitoring

Top-down legislation with clear targets for reducing pollutants at source through monitoring programmes must continue to provide an overarching framework for addressing air pollution. These may be legislated by international bodies, like those in place from the EU or WHO, but may also have local level actors involved in monitoring and data collection. As stated, many parts of Europe suffer from high levels of air pollution and continue to fail to meet European, let alone international standards. The health impacts of this, as discussed previously, are far reaching.

At the EU level, legislation to address human health and air quality started as early as 1970 with European standards on car exhausts (COM, 2005). Most recently in 2013, the European Commission launched its Clean Air Package, providing objectives up until 2030, including National Emission Ceilings Directive (COM, 2013b) and a new directive to reduce pollution from combustion installations (COM, 2013b). Air pollution legislation does not consider how nature-based solutions, as part of integrated and intelligent urban systems, can contribute to reaching air quality targets and reducing health impacts and costs. The Clean Air for Europe (CAFE) Steering Group have published a review of air quality in the EU, as well as quantifying and valuing its health impacts (Amann et al., 2005). In addition, increased hospital admissions and medication consumption, and lost working days contribute to significant public health expenditure (COM, 2013d).

Strategies and plans (cities, regions, protected areas)

Recognising the links between nature, air quality and public health, a number of actors have started to include these considerations in their planning strategies. Some national and city scale strategies for health, air quality and green infrastructure respectively have begun to consider the benefits of nature. In some cases, these have translated into highly complex interventions and investments to manage green infrastructure and areas of conservation. Having said this, the practice of using nature explicitly for improving air quality is uncommon. Many urban greening strategies fail to integrate potential health benefits into their objectives, or indeed ex-ante or ex-post assessments (Gomez-Baggethun et al., 2013); consequently, there are opportunities for health and social benefits that are not being fully taken advantage of, or accounted for in the valuation of green space.

Stuttgart, Barcelona, Nantes, Rome and London are just some of the European cities that include vegetation as a control for air quality in their city plans. In 2013, Nantes became the European Green Capital, partly on the basis of its good air quality record and being well

within European levels for all pollutants. In its application for the Green Capital award, Nantes placed a big emphasis on the integration of "housing, green spaces and soft traffic". It features one of the few city centre Natura 2000 sites - Petite-Amazonie (City of Nantes, 2013).

Some city plans successfully integrate considerations for air quality and nature. In rare cases, such as Stuttgart, this involves the application of dedicated planning software, a website and teams of specialists, such as climatologists and programmers.

Stadtklima and Nature Conservation for Clean Air, Stuttgart, Germany

The City of Stuttgart has implemented GIS mapping, zoning legislation, and investment in green infrastructure (GI), including green walls and roofs, to improve urban microclimates, as well as facilitate clean air exchange and exposure to harmful pollutants. To date, Stuttgart is the only German city with a dedicated climatology department. The particular geography of the city makes it susceptible to warm temperatures and air pollution. It is located in a basin, with low wind speeds, a mild climate and high levels of traffic and industrial activity (EEA, 2012c). Property developments on the city's surrounding slopes also prevent air from moving through the city, reducing air quality. The Municipality of Stuttgart adopted a strategy to use vegetation to alter the cities microclimate, change airflows and improve the city's air quality. In 2008, new laws prevented developments on slopes surrounding the city. In addition, a 'climate atlas' was developed which mapped urban climatic elements, such as local climate, the distribution of air temperature, airflows and air pollution concentrations for the city. Based on this, areas of the city were placed into 8 different categories depending on their role in the cities (Baden-Württemberg, 2012). For each category of space, planning measures were recommended.

Alongside conventional policies, a number of GI focused strategies have been implemented to improve the air quality. As well as increasing the amount of GI, construction projects of more than 60 ha were prevented in 2010 in order to preserve ventilation corridors (WWF, 2012).

The primary benefit of Stuttgart's integrated approach to air exchange in the city is to reduce exposure to air pollution and heat stress in the region. Stuttgart's approach for addressing air pollution, alongside decisive transport policies such as banning vehicles with high emissions and HGVs from the city's Umweltzone ("environment zone"), is complimented with GI innovations. Particularly notable is the 2016 project to construct a three meter high and 100 meter long moss wall on Cannstatter Straße, expected to cost €400,000 (Milankovic, 2015). A new program for 2016 and 2017 "New Green: More trees and plants in the city" will be financed with €1,800,000.

The city publishes climate and air quality data on its dedicated StadtKlima site (www.stadtklima-stuttgart.de). Thanks to policies to address the source of pollution, complemented with nature-based solutions, the air pollution concentrations have markedly. Since 2011, the annual EU PM_{10} limit value has been met. The hourly limit value for NOx reduced from more than 800 exceedances to about 60 nowadays. Nevertheless, there is still room for improvement as the measurement stations still fail to meet the EU targets along main roads.

Cities with a good understanding of local climate, air quality dynamics, and land uses can generate more sophisticated approaches to promoting health benefits from nature. In the case of air quality, this goes beyond simply planting more trees, and involves balancing multiple considerations; this could include behavioural economics, local climatology and pollutant mapping.

Successful urban and landscape planners should understand how natural spaces, grey infrastructure, people, local climates and air pollutants interact, and can be designed to reduce human exposure to pollutants. Poor air quality in even some of the world's wealthiest cities suggests that there has been a lack of innovation and that comprehensive responses remain rare.

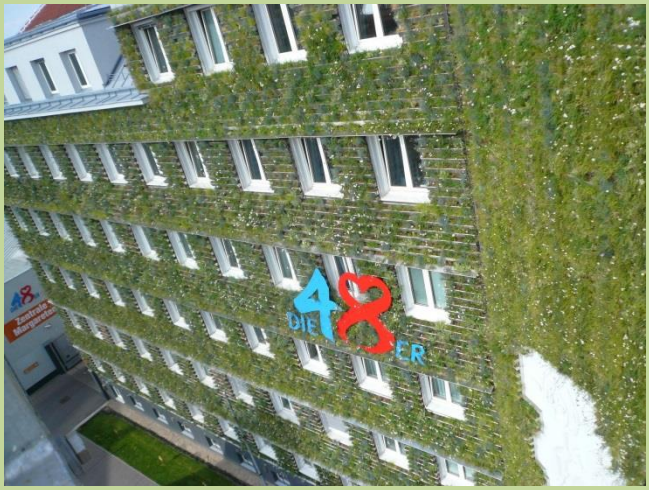
The use of city networks of GI or green corridors to promote airflows is particularly notable. Since 2012, London's action plan for an All London Green Grid has laid out plans to "enhance London's strategic network of green and open natural and cultural spaces" and to increase the usage of these spaces (Mayor of London, 2012). It has incorporated the ongoing LUCID (Local Urban Climate Model and the Intelligent Development of Cities) project, which is developing state-of-the-art software for calculating local climate and air quality in the city (Mayor of London, 2012, p. 137). The All London Green Grid acknowledges that GI and vegetation can filter pollution, but it does not consider the role of other pathways to improve air quality (Mayor of London, 2012, p. 70).

Similarly to London, Vienna, Ljubljana and Barcelona make reference to the importance of green networks in their city plans. Ljubljana's Environmental Protection Programme (Mestno občino Ljubljana , 2014) presents its spatial plan for a network of green space or "green system", connecting parks in the city with corridors and circular connections to the greener rural spaces outside the city in order to generate airflows of clean air. One of the aims of Barcelona City Council is to develop a number of "Urban Green Corridors" through its Green Infrastructure and Biodiversity Plan 2020. These corridors will include strips with high concentrations of vegetation to be used exclusively by pedestrians and cyclists (Ajuntament de Barcelona, 2010).

Little information is available on how existing large-scale soft mobility focused green infrastructure projects, such as the Promenade planté (Paris), The High Line (New York City) or the Greenway (East-London), provide air quality benefits. These could be imagined in terms of behaviour change, firstly, increasing the use of zero- or low-emission transport options, and secondly, in terms of individuals changing their routes to work.

Pilot project – green walls and the reduction of particular matter, Vienna, Austria

Although Vienna has been ranked as the city with the highest life quality (Mercer, 2015) air pollution, particularly particulate matter, remains a challenge (VCÖ, 2015). In order to tackle the problem the municipality of Vienna supports the installation of green walls financially (by up to €2,500) and with information such as manuals (Wien.at, 2012A; Wien.at, 2012B) . The efforts of the municipality were supported with research by the University of Natural Resources and Applied Life Sciences (BOKU, 2013). The manuals provide citizens with information on the structural-physical requirements of buildings as well as on the plant requirements and management.



Generally, green walls have multiple benefits, not only improving air quality but also providing noise and heat insulation. In order to investigate these multiple positive effects further, BOKU started a pilot project (BOKU, 2013; Wien.at, 2012c) monitoring the green face of a building in Vienna (see photo). BOKU cooperates amongst others with PROGreen City, which is a project dedicating its research to the relationship between plants and particulate matter.

Source: https://www.wien.gv.at/rk/msg/2010/09/12001.html

Research

As well as physical networks, virtual networks and research programmes between stakeholders could help to support best practices and knowledge exchange on how to apply GI and natural spaces in order to improve air quality. This will often involve a combination of local governments, public bodies, universities, research institutes and private actors, such as landscape planners, engineers and architects.

For instance, the URBES project aims to bridge the knowledge gap regarding the relationship between biodiversity and ecosystem services, which contribute to human well-being. The overall aim of the project is to inform city planners on how to best support the natural environment and human needs. It is a partnership of academic institutions and international organisations. It consists of 16 partners from Spain, Sweden, the Netherlands, Germany, Belgium, Austria and Finland (Elmqvist, 2014). Air quality control is identified within the URBES network as an area in which ecosystem services could be better utilised (Elmqvist, 2014). The strategy quantitatively assesses different types of GI in terms of the contribution they make to a number of functions, including habitat quality; biological quality; environmental quality; sensory quality and cultural interest. Within the category 'environmental quality', there is an indicator for air quality. It allocates different types of GI a score based on the air quality performance (Barcelona, 2013).

The OpenNESS project provided a meta-analysis of ecosystem service based "air quality regulation", covering 50 peer-review studies (Soba et al., 2015). The review concluded that most of the evidence on direct contributions of vegetation used modelled data that scaled up small-scale laboratory or field experiments. It also highlighted that, in absolute terms, when comparing the total emissions for a city and the direct emissions removal by trees, the contribution of vegetation was relatively small.

The work and collaboration of research institutes in developing novel ways to assess how natural spaces interact with air pollution is important. Evaluation tools and models such as i-Tree and UFORE mentioned above show how the complexity of the benefits of nature is expanding. However, such approaches may not be available to small cities, which have considerably less resources than larger ones. Hence, simple and cost-effective approaches, such a bio-monitoring described below, may also need to be considered.

Bio-monitoring of air quality in Ghent, Belgium

For many environmental issues, detecting and monitoring is often the first step towards mitigation. Measuring air quality can allow planners to make strategies to avoid human impacts. However, technology-based approaches to monitoring air pollution are often costly and can consequently only be applied to a limited number of sites. Bio-indication describes the use of chemical and physical organisms to detect changes in the environment, potentially providing an alternative to otherwise costly technologies (CBD, 2015, p. 11).

A team in Ghent explored the use of two species of linden tree, one hairy leafed and the other smooth leafed, to measure air quality in their city (Zadeh et al., 2013). They chose several trees at two sites; the first an industrial area with poor air quality and the second a greener area with semi-natural habitats.

Using government-monitoring stations as controls, they showed that chlorophyll content was significantly lower at the polluted site. The study used reflectance analysis on tree leaves as a proxy for chlorophyll content. Their results were most visible from hairy leafed linden trees. The study argued that low chlorophyll content was the likely cause of high reflectance, and resulted from the hairy leaves' ability to trap pollutants, increasing their suitability as a bio-indicator. The study concluded that plants could provide an alternative method for observing air pollution, with certain species being more suitable than others.

On a personal level, citizens may also take action to reduce their exposure to pollutants. By living in areas with more vegetation; choosing walkways which are more wooded; avoiding busy roads; or exercising in public parks; individuals can greatly reduce their exposure to pollutants (Davies & Whyatt, 2009; Dadvand et al., 2012). Large natural parks, including Natura 2000 sites, provide clean air oases to this end. Novel technology can inform citizens with real time mapping of pathways of lowest pollutant levels cities. Such applications could also support planners, for instance by greening the busiest routes for a school or large business (Microsoft, 2015; Breezometer, 2015; Smith, 2012). Fine grain data on air quality is increasingly available to citizens allowing them to make choices, including prioritising recreation in natural spaces or clean air oases, which reduce the health impacts upon them, even though average ambient air quality itself may not have improved. Assessments that consider the benefits of green infrastructure for air quality tend to focus on ambient, or city-

level air quality, and consequently ignore how green space can influence personal exposure levels.

Pressure, Local action and Conservation

Air quality concerns and the benefits of nature may at times conflict with other interests, particularly in urban spaces where stakes and the value of land are high. Likewise, valuations of green infrastructure generally fail to comprehensively account for the contribution of green spaces to air quality. Furthermore, many decision makers and citizens are unaware of the impact which air quality has on their health, and choose to prioritise other services. Pressure on states or regions which fail to improve air quality, or conserve valuable natural spaces can stem from a range of governance perspectives. For example, judicial bodies may also have to play a role in placing pressure on states that fail to comply with legally binding targets. In November 2014, a landmark case against the UK at the European Court of Justice (ECJ) increased pressure on national governments to comply with the Air Quality Directive[1]. In the UK, London, Leeds and Birmingham are not expected to stop infringements until after 2030. The European Commission has infringement actions against a number of member states for different pollutants under the European air quality directives.

Table 2.2: Member States which the European Commission are taking legal action against for air quality infringements at the European Court of Justice.

Pollutant	Member State	Directive
PM_{10}	Belgium, Bulgaria, the Czech Republic, Germany, Greece, Spain, France, Hungary, Italy, Latvia, Portugal, Poland, Romania, Sweden, Slovakia, and Slovenia	Directive 2008/50/EC
NO_2	United Kingdom, Portugal, Italy, Spain, Germany and France	Directive 2008/50/EC

Source: EC, 2015

At a local level, action may be necessary to preserve specific natural spaces. In Malta, following court action, an NGO, Flimkien Ghal Ambjent Ahjar (FAA), and MEPA (Malta Environment & Planning Authority), prevented the uprooting of seventy-year-old ficus trees at It-Tokk Park in Gozo. The Victoria local council in Malta wanted to remove the trees and replace them with shrubs in planters. FAA argued that the trees played an important role in improving air quality in Victoria, reducing the rate of asthma, heart disease and dementia, as well as forming an important feature in the historic square (FAA, 2014).

In Berlin, Germany, the former Tempelhof Airport makes an interesting case for citizen engagement in the conversion and preservation of natural space with impacts on local air quality and public health and well-being.

[1] Judgment in Case C-404/13 The Queen, on the application of ClientEarth v The Secretary of State for the Environment, Food and Rural Affairs (2014).

Citizen engagement to promote clean air and conservation, Berlin, Germany

Berlin Tempelhof has been the subject of two successive referendums. The first on 27th April 2008 was an attempt to prevent the closure of the airport. Although a majority of voters voted to keep the airport open, voter turnout, 36%, was insufficient for the referendum to be successful.

The campaign to proceed with its closure called upon the noise and air pollution which local residents suffered from. The campaign "Flugfreies Tempelhof" (flight free Tempelhof) had the support of a number of political and environmental actors (Kurpjuweit, 2008; Der Tagesspriegel, 2008).

The Airport has been closed since November 2008 and in May 2010 it was opened as a 300ha public park, with investments from the city of €60 million to 2017. This plan included 80 percent of its space being conserved as a grassland habitat for a number of redlisted birds, including the skylark, the red backed shrike, tawny pipit and the wheatear (be Berlin, 2014b). Berlin also has the highest density of goshawks in the world (Liptrot, 2015).

In 2011, however the government presented plans for 25% of the Tempelhofer Feld to go to property development. The plans received widespread opposition from the citizens of Berlin. A petition entitled, 100% Tempelhofer Feld initiative, gathered 185,000 signatures forcing the city to hold a further referendum, albeit this time, to save the public park from developers. 64.3% of voters rejected the development proposal, consequently preserving the site as a public park for recreation (Fahey, 2015).

The result of this long series of public participation in local governance illustrates how citizens helped to transform a pollutant source into an important local resource, providing opportunities for social interaction, clean air and nature conservation in the city.

Investment

Generating funding to support nature-based solutions also requires the work of a number of stakeholders and actors.

At the EU level, an increasing amount of funding is available for nature-based solutions, particularly green infrastructure projects. 5% of the Cohesion Fund is earmarked for GI projects and further funding support is available from Life, Horizon 2020, and innovative new tools like the Natural Capital Financing Facility (NCFF) (Vella, 2015). Furthermore, the European Green Capital Award and the new Green Leaf Award, give opportunities to cities and small towns to actively gain European support. In the case of Nantes, the city was able to pursue its ambitions for improving the well-being of its citizens and ensuring good air quality by capitalising on its existing natural spaces as well as developing a comprehensive GI strategy.

In many cases, funds mobilise further public and private investments. This can be seen in both London's Clean Air Fund (see below), where the Greater London Authority (GLA) matches investments by London Boroughs, as well as the aforementioned City Trees for Berlin project which uses a comparable fund matching instruments, but also attempts to mobilise citizen investments.

Some large GI projects, such as the Bosco Verticale in Milan, mobilise chiefly private finance. In the case of this project, this included investments from large property developers and private equity houses including Hines, Qatar Holding LLC and TIAA CREF (Residenze Porta Nuova, 2015). In the City of London, the City Corporation and the British Council for Offices created a briefing note to encourage private developers to consider the benefits of Green Roofs in the design and construction of commercial properties (BCO, 2008).

London – Funding for innovative ways to tackle PM

Air pollution is predicted to cause 10,000 premature deaths annually in London, with parts of the city regularly exceeding EU air quality limits (Shackleton, et al., 2010; Walton et al., 2015). In 2010, the Greater London Authority (GLA) produced an air quality report which argued that increasing green space in the capital could deliver local reductions in particulates (GLA, 2010). Since the report has been published, the GLA has been investing in small projects across the capital to deliver improvements in local air quality.

The first fund, The Clean Air Fund (CAF) made GBP 5m available to Transport for London (TfL), London's transport authority, to invest in improvements in air quality. From the CAF, GBP 1m was allocated specifically for GI at PM_{10} priority locations. As well as more traditional approaches of tree and shrub planting, TfL chose to explore and invest in green walls and green screens to improve air quality. TfL carried out a review of two trial green walls constructed at Edgware Road tube station (TfL, 2012). Over a 3-month period, a green wall at Edgware Road station captured 515 grams of PM_{10}.

In 2013, the GLA launched the Mayor's £6 million Air Quality Fund. The fund matches investments by London Boroughs into schemes and projects designed to improve air quality until 2016. The first project to be completed as part of the Air Quality Fund was a new green wall, which was constructed at The Warren School in the London Borough of Barking and Dagenham. The school is located at a pollution hotspot along a busy road. Students helped to design the wall and influenced how plants should be arranged on its green panels to create a "bespoke living wall" (TfL, 2014). The wall is 54 m^2 and is made up of a variety of plants designed to trap NO_2 and PM_{10}.

The GLA expect that the fund will provide over £20 million in investments until 2023 (GLA, 2013).

Photo (Shales, 2014)

Quantifying the Health and Social Benefits of Nature: Air Quality

The health impacts of poor air quality are substantial. Air pollution and associated disease is one of the largest causes of premature mortality in Europe. The burden on health services and the wider economy warrant an appropriate policy response. The literature reviewed in this chapter suggests that nature based solutions should be used to support at source policies on pollutants. There is a lack of comprehensive research into the likely positive contribution of nature to air quality across a number of pathways. Indicatively, the exclusion of indirect and active approaches to reducing personal exposure to pollutants may suggest that the benefits of nature are being underestimated.

Methods: This task focused on the existing research on the valuation of the health and social benefits of nature and biodiversity protection in terms of improving air quality, with the aim to substantiate and illustrate the benefits of nature for Europe, which were outlined in this chapter. Quantifying benefits can help to communicate them to a wider audience. A review of the literature suggests, that although there is evidence on the role of nature in suspending and absorbing gaseous pollutants, very little has been said about how nature can facilitate the development of low emissions cities or how green spaces offer clean air oases that reduce personal exposure. The exclusion of these more nuanced aspects of the benefits of nature means that data on the real contribution of nature to urban air quality is lacking. An exploratory assessment of the potential contribution of nature to air quality has been made here. This will build on the research outlined in this chapter, and build an exploratory methodology to support future research and suggest the policy implications.

Step 1: Key variables and causal links

- Assess the data from the literature
- Develop the evidence base on the contribution of nature to improved air quality, i.e. where does Natura 2000 or green infrastructure offer benefits? Identify dependent variables and relationships.
- Review the EU-wide scale of health costs associated with air pollution. Identify independent variables.

Step 2: Cases and developing a comprehensive method

- Develop an exploratory methodology
- Explore how a more complete picture of the contribution of nature to air quality can be established.
- Potential tools for an assessment of nature-based solutions to air quality in London.

Step 3: Policy and research implications

- Conclusions – in the context of the robustness of the evidence, what can be said about the contribution of nature to improved air quality?
- Developing policy – how can further work in this area support sustainable policy making, drawing on the multiple benefits of nature?

Step 1: Key variables and causal links

Air pollution (guidelines and exposure): The EU and WHO provide guidelines on air quality limits for a range of pollutants. The less stringent EU guidelines have been adopted into national law across the EU-28. Currently, 21% of stations exceed EU guidelines in the EU-28 and 90% of urban populations are exposed to harmful levels (COM, 2013d).

Health (Burden of disease morbidity and mortality, DALYs): In the WHO Europe Region, air pollution was responsible for 600,000 premature deaths in 2012 (WHO, 2015). The EEA (2015a) estimate that air pollution is responsible for 430,000 premature deaths annually in the EU-28.

Absorption of gaseous pollutants and dry deposition (flux of pollutants t yr-1): Vegetation can improve air quality through the absorption and dry deposition of pollutants, although the contribution of this service relative to pollution levels is difficult to ascertain. Numerous studies have attempted to define the key variables and quantify the size of the benefit for air pollution in a given area (Soba et al., 2015). Assessments generally cover one or more of the following aspects; vegetation characteristics (e.g. vegetation species, BVOC emissions, leaf area index, canopy cover, habitat area); climate (e.g. air flows, canyon studies, temperature, wind speed); human aspects (e.g. pollutant concentration thresholds; intervention). Methodologies applied vary between modelling approaches and empirical studies, with results providing a value of deposition velocity (t yr-1) or pollutant reduction (%). Some studies establish market values of air purification through gaseous absorption or dry deposition. A few examples of such studies are given in the table below:

Study	Location/method	Quantitative benefit	Economic benefit
Nowak et al., 2006	USA – Model of meteorological and pollution concentration data (for O_3, PM_{10}, NO_2, SO_2, CO) for 55 US cities in 1994.	Total for 55 cities: 711,000 t yr^{-1}	US$3.8 billion in 1994
Nowak, 1994	Chicago (Cook and DuPage counties) – Using 1991 data, the study assessed the rate of pollutant removal for O_3, PM_{10}, NO_2, SO_2, CO. Chicago has 11% tree cover.	Removal: O_3 – 191 tonnes; PM_{10} – 212 t yr^{-1}; NO_2 – 89 t yr^{-1}; SO_2 – 84 t yr^{-1}; CO –15 t yr^{-1} Hourly rate of improvement in air quality (%): O_3 – 0.3; PM_{10} – 0.4;NO_2 – 0.2; SO_2 – 0.3; CO – 0.002	Annual Value: US$1 million for Chicago US$9.2 million across Cook and DuPage County
Currie & Bass, 2008	Toronto – Applied the UFORE (Urban Forest Effects) model to investigate the impact of green roofs and green walls on air pollution in urban Toronto. Used 7 scenarios, Scenario 1 represented existing vegetation.	Midtown Toronto Scenario 1:O_3 – 10.86 t yr^{-1}; PM_{10} – 8.26 t yr^{-1}; NO_2 – 5.41 t yr^{-1}; SO_2 – 2.00 t yr^{-1}	Midtown Toronto per annum Scenario 1 total pollution removal value: US$149,916
Yang et al., 2008	Chicago – Quantified the level of air pollution removal by green roofs in Chicago using a dry deposition model. Included current coverage and potential if all roofs were covered.	Current removal: 1.675 t of pollutants removed by 19.8 ha of green roofs. Annual removal of 85kg ha^{-1} yr^{-1} Potential removal: 2046.89 t yr^{-1} if all roofs covered	Cost of pollution removal (installation costs UCS$/air pollutants removed t) US$1.68 million t^{-1}
Chaparro &	Barcelona – Examined ecological services of urban forest in Barcelona.	Air pollution removal by Barcelona forest (2008): O_3 –	Associated value of

Terradas, 2009	Application of UFORE model to estimate services from existing forest in Barcelona.	72.6 t; PM_{10} – 166 t NO_2 – 54.6 t;SO_2 – 6.8 t	ecological service O_3 – €336,941 PM_{10} – €514,280 NO_2 – €253,290 SO_2 – €7,703
Manes et al., 2012	Rome – Quantified the effects of urban tree diversity on the removal of ozone in the City of Rome.	The total ozone uptake by urban trees was: 311.1 megagrams (Mg) in 2003 306.9 megagrams (Mg) in 2004 Change in annual uptake of Ozone for tree types across 2 years: 25% less for evergreen broadleaves; 4.5% more deciduous broadleaves; 23% more for conifers	Value of ecosystem service ozone removal: Costs of externalities: US$2 million per year Costs of reduced mortality: US$3 million

Clean Air Oases (personal exposure - the lifetime average daily dose): Conservation and protected areas, as well as large parks, have lower air pollution concentrations than alternative land uses. This is due to the absence of pollutant sources and the shielding which forest stands can provide (Nowak & Heisler, 2010). The use of these spaces in preference to other urban spaces could lower exposure to pollutants – no studies were identified which explore this benefit. Certain types of green infrastructure, such as pedestrianised green corridors, increase the availability of clean air oases.

Microclimate regulation and air exchange (pollutant concentrations - µg/m3): Evapotranspiration and shading linked to vegetation can generate air exchange, which can increase or decrease the concentration of pollutants in a given area. Some studies have attempted to explore how microclimates influence dry deposition (Pugh et al., 2012). In Stuttgart, city wide GIS is used to map climate and air quality, as well as guide city planning (www.stadtklima-stuttgart.de).

Smart cities and behaviour change (absolute emissions, e.g. National Emissions Ceiling): Green infrastructure can facilitate behavioural change to change mobility patterns and lower pollution. Developing urban systems that satisfy the needs of citizens and have low environmental impacts, is a relatively new area of research – but such integrated approaches are increasingly seen to be important in developing sustainable cities (Terrapin Bright Green LLC, 2012; EEA, 2015a). Green infrastructure provides a powerful tool to design cities, which, for example, encourage people to cycle to work, or produce food collaboratively through urban gardening, can contribute significantly to reducing air pollutants at source (EEA, 2015a; EC, 2012).

Jobs and growth (output losses and health care costs % of GDP): The economic bill of air pollution in the WHO Europe Region is roughly 10% of GDP, or ~€1.4 trillion per year (WHO, 2015). A review of air quality in Europe, as well as a quantification of health impacts conducted by The Clean Air for Europe (CAFE) Steering Group, estimated that the total public health costs in the EU associated with particulate matter and ozone would be between €189 billion and €609 billion by 2020 (COM, 2005, p. 39). Health care spending on respiratory disease in the EU averages €95 per capita each year,

€47.3 billion, or 6% of the total healthcare budgets of the member states (HEAL & HCWH, 2010). The Aphekom study across 25 European cities estimated that complying with WHO air quality guidelines for $PM_{2.5}$, PM_{10}, and ozone, would bring annual benefits in excess of €30 billion (Chanel, 2011).

Step 2: Cases - Developing tools for a comprehensive evaluation

A number of studies have explored how vegetation contributes to citywide air quality improvement, and based on this have estimated the size of the benefit in monetary terms (REFS). Generally, these studies draw on mechanistic models, and focus on the removal of pollutants only – no studies identified evaluate the benefits of nature in terms of indirect impacts on pollution.

As part of this study we attempted to assess how green infrastructure can contribute to meeting air quality targets in London. Unable to overcome data limitations without considerable assumptions, this assessment was turned into an exploratory methodology:

Considerations for a methodology to explore a nature-based strategy for improving air quality in a selected case, e.g. Greater London:

1. Establishing a baseline for air pollution in London relative to EU/WHO legislation/guidelines.
    - Which pollutants to observe (i.e. NO_x, $PM_{2.5}$, $PM_{10,}$ etc.)
    - Which limit values to use (i.e. Directive 2009/50/EC or WHO Air Quality Guidelines)
    - Observance period (i.e. annual average, 24 hours, rush hour)
    - Geographical coverage (i.e. citywide average, or single monitoring stations, such as poorly performing stations – Oxford Street, Putney High Street, etc.)
    - Data sources (i.e. London Air Quality Network, DEFRA, independent studies)
2. Estimate health and social impacts of air pollutants in London.
    - Impacts to observe (i.e. studies on mortality, cardiac hospitalisations, respiratory hospitalisations, medical and rehabilitation costs, VOLY, VSL, loss of productive work e.g. Aphekom Project)
    - Population (i.e. entire Greater London, one London Borough, single street)
    - Monetisation (i.e. expenditure as % of GDP, NHS expenditure, avoided annual output losses as % of GDP)
3. What contribution does nature make to air quality in London?
    - Gaseous absorption/deposition (i.e. in a given area for a given pollutant, what is the rate of flux tyr^{-1}?)
    - Climate (i.e. establish how GI can support the dispersal of pollutants and reduce pollutant concentrations µg/m3 e.g. GIS StadtKlima Stuttgart)
    - Indirect reduction at source (i.e. establish how GI/biodiversity contributes positively/negatively to pollutant sources i.e. supporting soft mobility, reducing food miles, increasing building efficiency e.g. absolute emissions for a given area)
    - Indirectly personal exposure (i.e. establish how GI/biodiversity influence routes to work, locations for leisure activities e.g. assess personal exposure independent of AAQ, lifetime average daily dose)
4. Methods
    - Modelling approaches (e.g. UFORE, i-Tree Eco Model, CiTTyCAT model)
    - Empirical intervention or comparative studies (i.e. longitudinal before and after a greening strategy, cross-sectional comparison of green and non-green districts)
    - Self-reported observations (i.e. subjective health & well-being, behavioural change)
    - Big data (i.e. GIS data on pedestrian or cyclists routes with overlays of pollutant data, data from smart phone apps)
5. Policy
    - Policy development (i.e. stakeholder engagement, R&D, funding etc.)
    - Policy implementation (green strategy - e.g. Greater London National Park City)
    - Policy evaluation (i.e. ex-post/ex-ante, delta public health expenditure, cost-benefit analysis with BAU and alternative measures e.g. London Ultra Low Emissions Zone)

Step 3: Policy and research implications

Considering that the costs of air pollution in Europe are in excess of €1 trillion, successful application of nature-based solutions could pay significant dividends (WHO, 2015). A method for estimating the benefits of nature at the city level is outlined in the example for London above. Future research in this area could work towards a comprehensive assessment of the contribution of nature to air quality, including a quantification of benefits in monetary and non-monetary terms. No comprehensive assessments of the role of nature in improving urban air quality were identified in this study. Whilst research exists which considers nature and air quality, as well as monetising benefits, there is a clear focus on absorption and deposition. Wider, more nuanced, impacts of nature must be taken into account and have the potential to be significant.

In terms of policy, many cities already benefit from nature's contribution to air quality, although may not be assessing the benefits. Efforts to implement green corridors, or large greened pedestrianised zones, and re-establishing disused canal ways, provide good examples. Better evaluation of how these types of programmes contribute to reducing exposure to pollutants across a range of pathways and placing a value on this benefit will support wider policy development in this area.

Policy should increasingly move towards smart city strategies, which integrate how the design of urban spaces influences day-to-day behaviour, including emissions and exposure to pollutants. The presence of nature has a considerable impact on society, as established throughout this study, so ignoring nature's role in improving air quality or focusing simply on absorption or deposition would be misleading.

2.4 Conclusions

The scale of the air quality crisis in Europe warrants an urgent and appropriate response from decision makers, which should include nature-based solutions in addition to at-source policies.

The evidence presented here demonstrates a number of pathways through which nature can contribute to minimising public exposure to harmful pollutants, which drive vast health impacts and economic burden. Largely these pathways have a positive impact on air quality.

Although there is a growing literature base exploring the pathways between the presence of GI and air quality, there is a lack of comprehensive understanding of the true contribution of nature-based solutions. Evidence and assessments of benefits are undermined with limitations, such as a high number of variables involved, a focus on pollution removal, and research methods that are mostly based on modelling (with multiple assumptions). Meta-analysis on work in this area has usefully identified many of the shortcomings in the existing research.

Despite this, there is potential for nature and GI to contribute to improving air quality. Existing literature has mostly ignored some additional, potentially significant pathways – namely the contribution of green spaces as clean air oases, and the impact of green space on citizen behaviour and the indirect benefits these can both have on exposure to pollutants – the ultimate determinant of health impacts. This chapter provided a number of examples of where green infrastructure has already been applied and shown to contribute positively.

The degree of benefit is dependent on a number of variables, namely; concentrations of pollutants; proximity to pollutants; city morphology; spatial organisation; local climate and air flows; and the type of vegetation. The interaction of these variables needs to be better understood in order that they can be included in strategies to improve European air quality.

The health of natural spaces is another important driver of air filtering, suggesting the need for management and conservation. A number of large conservation areas and parks continue to be the biggest sinks for pollutants in many cities; they also display lower pollutant levels to other urban spaces. Similarly, large trees can be one of the best sinks or shields for pollutants but may take many decades to develop, and hence warrant conservation.

Notably, the preservation of existing natural spaces, biodiversity and mature vegetation, emphasises the importance of the Natura 2000 network. Air quality oases offer necessary respite from pollution in Europe's cities, providing opportunities to minimise personal exposure to pollutants (CBD, 2015, p. 32). In addition, air quality also necessitates the development of informed GI strategies, which maximise on air quality benefits, particularly in highly polluted urban areas.

Wider GI, including novel approaches such as green roofs and green walls, can offer opportunities to decision makers to make additional contributions to local and regional air quality. Networked and carefully planned GI projects, such as green corridors, have already been shown to interact with other environmental variables such as climate to support air exchange. The extent to which this kind of project can indirectly influence city mobility, amongst other factors, has not been researched in detail. Having said that, this chapter has reviewed some of the member states and their cities which have demonstrated an understanding of the links between nature and air quality and have tangibly included this in their governance actions.

Successful application of nature-based solutions is often dependent on complex governance networks involving multi-disciplinary teams, as well as investments from public and private funds. At the same time, some very simple and bottom-up approaches also play an important role – including grass-roots campaigning to preserve or re-establish green space. The role of research and innovation in supporting these areas is clear. A number of research networks are already putting resources into understanding the links better, using new methods and models to further understanding.

At all levels, from EU air quality legislation, to neighbourhood-level activities, and the choices which individuals make in their day-to-day lives, there is a clear need for better understanding of how different governance levels interact, and how city planners and engineers can develop smart urban systems which promote clean air in Europe's cities.

The overall health benefits to Europe in terms of respiratory and cardiovascular disease, as well as the associated economic burden, are incredibly difficult to assess. Yet the sheer size of the health risks from air pollution indicates the role of nature can contribute significantly. When the benefits reviewed in this chapter are complimented by those from the other eight themes, the importance and potential of nature is incontrovertible.

3 Improved Microclimatic Conditions – Mitigating Heat Stress

3.1 Heat stress as a public health challenge

There exists a long tradition of using nature to provide cooling and thermal comfort benefits to urban, peri-urban and rural populations. In densely built and populated cities, temperatures are typically markedly higher than in the city surroundings. Climate change projections indicate a rise in average and extreme temperatures across Europe, with important implications for public health.

Rising temperatures and extremes in the form of heat waves have a vast array of adverse effects on human health, including "heat stress". Heat stress occurs when the body is unable to regulate its normal temperature; the body attempts to cool itself by sweating. Left untreated, heat stress progresses to heat exhaustion (excessive sweating) then to heat stroke (red skin and sweating has ceased), to hyperthermia and ultimately, mortality (Kovats et al. 1999). Heat stress, is a risk for many people, including children and elderly people and those who work in hot environments. In the context of climate change, with rising average and extreme temperatures and the increasing prevalence of heat waves, the risks are relevant to an increasing number of people.

This chapter focusses on the role of nature for mitigating heat stress through different forms of green infrastructure, including protected areas, in urban, peri-urban and rural settings. It analyses the opportunities that nature offers for realising health benefits and discusses a number of supporting instruments that can be helpful for realising these benefits.

Urban heat island effect

The high thermal capacity of buildings combined with a high concentration of buildings in urban areas results in urban heat islands (UHI) (Watkins et al. 2007). Urban heat islands can be observed in cities all over the world, while the heat differential between the built-up urban area and suburban areas differs with the degree of green coverage in urban centres (Peng et al. 2012, Campbell-Lendrum and Corvalan, 2007; Corvalan et al., 2006; Zoulia et al., 2009). Furthermore, built-up urban areas retain heat for longer periods, creating unique challenges during heat waves. Given that buildings typically are permanent structures in the urban environment, their impact on health and the environment is lasting (Younger et al. 2008). Therefore, as building construction continues, consideration of the materials used and their impact on health and the environment is important. Furthermore, there is the added complexity of climate change contributing to prolonged periods of high temperature. Individuals with pre-existing health conditions, such as cardiovascular and respiratory diseases, are also at greater risk (McMichael, et.al 2010; Hallegatte et al., 2011; Armstrong, 2012; Baccini, 2008; Basagna et al., 2011; Astrom et al., 2013).

In Europe, UHIs can increase urban temperatures by up to 12 degrees compared to non-urban areas (Depietri, Renaud, and Kallis, 2011). The 2003 heat wave in Europe caused up to 70,000 deaths over four months, many of which could have been prevented (EEA, 2012d).

Analysis of the 2003 heat wave in Paris investigated the factors contributing to the high mortality rate. In a comparative study of Paris and the suburb of Marne de Val, Laaidi et al. (2012) found that successively high temperatures at night coupled with high daytime temperatures were a factor in the mortality rates of adults over the age of 65. In their study of Manchester, where average temperatures could rise by 1.4 – 5.8 degrees by 2100, Skelhorn et al. (2014) highlight that urban areas in the UK can be up to 7 degrees warmer than surrounding rural areas.

Urban heat islands, extreme temperatures and human health

Extreme temperatures, rising temperatures, and extreme weather events have a vast array of adverse effects on human health. High summer temperatures in 2003, which caused up to 70,000 deaths over four months, showed that extreme temperatures are a real threat to Europe (EEA 2012). Risks to health in cities from heat stress are expected to increase in the future. In most parts of Europe, climate projections suggest that average and extreme temperatures are likely to increase, likewise daily and extreme precipitation are also likely to increase (IPCC 2007). The causal pathways between negative climate impact and adverse health outcome are numerous and complex. Some impacts follow a direct relationship, while others follow a less clear indirect path.

As regards the direct impacts on human health, there exists limits to how much heat the human body can be exposed to (Campbell-Lendrum and Corvalan, 2007; Kovats and Akthar, 2008; McMichael et. al., 2010). The human body is capable of regulating and maintaining its internal temperature of 37°C through various processes, namely sweating in order to cool the body. If the body's natural cooling mechanisms fail, the outcomes are heat exhaustion, then heat stroke and ultimately death, if left untreated (Hajat et. al., 2010). In the context of urban populations and research on heat waves and health, the most vulnerable populations are the elderly and young children (Campbell-Lendrum and Corvalan, 2007; Kovats and Akthar, 2008; Glasper, 2011).

Heat is also an occupational hazard, especially for outside workers (Kovats and Akthar, 2008; Baccini, 2008; Basagna et al., 2011; Dear, 2005; Glasper, 2011). For this population there is evidence of decreased productivity, as workers have to stop working, in order to cope with the heat (Kovats and Akthar, 2008).

Studies on Heat Waves and Vulnerable Groups

United Kingdom

In a study of the 2009 heat wave in the UK and the government's response, Glasper (2011) highlights two key vulnerable groups:

- The elderly over the age of 75, women living alone in particular;
- People with long-term conditions, such as mental Illness, Parkinson's disease or chronic respiratory diseases, or those taking medication that compromises the body's ability to regulate its temperature

France

Vandentorren et al. (2006) found that of the 315 cases involving those over the age of 65 who were admitted to hospital during the heatwave in August 2003, 254 deaths were related to a pre-existing causes exasperated by the heat, (35 % were heat specific, 37% were cardiovascular related, 7.5% cancer, 6.3% respiratory, and 4.3% neurological diseases). The study also highlighted that while building temperature played a role in death, additional behavioural factors also played a role, namely not dressing for the weather and sleeping in the upper floor where heat is trapped where the room is likely to be hotter if it is exposed to light for a long period of time (Vandentorren, et al., 2006). Additionally, lack of hydration was also a behavioural factor that contributed to death, an issue revealed in a study by Kettaneh et al., (2009). Social factors, namely the lack of engagement in community activities were also identified as contributing factors (Vandentorren et al., 2006). Interestingly, Vandentorren et al. (2006), assessed the age of the buildings in which victims died and it was found that buildings built prior to 1975 and those without or with limited access to comfort amenities such as private bathrooms played a role.

The Netherlands

In the Netherlands, Kunst and Britstra (2013) assessed the implementation of heat plans in long-term care institutions in Amsterdam. Their study has found weaknesses in the implementation of the National Heat Plan developed in the wake of the 2003 and 2006 heatwaves. Their interest in the actions of long-term care facilities emerged from data that showed that the elderly living in these facilities faced a higher risk of mortality, not just in the Netherlands (relative risk 1.5 versus 1.09 for those living in facilities), but also in France where mortality increased by 100% in retirement homes, and in Italy where mortality increased by 50%. Kunst and Britstra (2013) recommend that more needs to be done to cool buildings and train employees.

As well as the direct physiological impacts of heat on the human body, it also has indirect impacts on human health. Research has shown that during heat waves air quality is degraded and the concentration of pollutants increases (Campbell-Lendrum and Corvalan, 2007; Harlan and Ruddell, 2011; Corburn, 2009). It is estimated that up to 12 per cent of air pollution problems in cities are attributable to heat island effects due to the temperature-dependent formation of many pollutants, including volatile organic compounds (VOCs) and ozone, and the dynamics of particulate dispersal (Forest Research, 2010).

This has consequences for individuals suffering from respiratory disease (Filleul et al., 2006). A study by Lacour et al. (2006) investigated the relationship between ozone concentration and temperature. The key finding from their study was that ozone concentration and temperature were strongly correlated Ozone production specifically was associated with hot, dry weather; while “high ozone concentration was associated with high temperature, low relative humidity and prolonged sunshine” (Lacour et al., 2006).

Impact of climate change

Climate projections suggest that the prevalence of heat waves will increase in the future, thus the risks of heat stress will rise (IPCC, 2014). In most parts of Europe, climate projections suggest that average and extreme temperatures are likely to increase, likewise daily and extreme precipitation are also likely to increase (IPCC 2007).

Current climate change projections predict an increase of global average temperatures of up to 1.7°Cin the low-emissions scenario and up to 4.8°C for the highest emission scenario (IPCC 2013). For Europe, the increase in average temperatures is expected to be higher that the global average (Ciscar et al. 2014). The expected rise in temperatures, including extreme high temperatures will therefore exacerbate the heat stress caused by existing urban heat islands (Kershaw et al. 2010). An EEA study (EEA et al., 2008) projected almost 86,000 additional deaths per year in 2071–2100 in the EU-27 Member States compared to the 1961–1990 EU-25 average, using a severe scenario for temperature increases. Most of these deaths are expected to be in urban areas where the risks of heat stress, both climatic and non-climatic, manifest themselves (CBD, 2015).

€2.5 billion to €10.4 billion per annum by the end of the 21st century. The risks of heat stress are also unequally distributed according to geographic and social factors. Age, gender and income are often determinants of vulnerability. For example, during the 2003 heatwave in France, mortality rates from heat stress were twofold higher in the most deprived cantons (Rey et al., 2009).

3.2 Benefits of nature to climatic conditions and public health

There exists a long tradition of using green spaces to provide cooling benefits. On a hot summer day, an urban park with a dense canopy will typically be several degrees cooler than its surrounding built environment. Infrastructures such as green recreational areas allow for weekend escapes from densely developed cities. Large, interconnected, undeveloped areas of land generate cool air that can help moderate temperatures in city centres and mitigate heat. In light of climate change, with expected rising average and extreme temperatures, the cooling and thermal comfort benefits of nature are gaining in importance (Jim, 2011). This section discusses how nature provides cooling benefits and which variables are important in order to maximise these benefits.

How does nature help cooling cities?

Nature can help to reduce the risks associated with heat stress by providing cooling through shade and the evapotranspiration (Ennos, 2012). The magnitude of cooling is dependent on the configuration, type, size, health and density of vegetation (Zupancic, Westmacott, and Bulthuis, 2015). Seasonal and temporal variations may also influence the cooling capacity of vegetation (Renaud and Rebetez, 2009).

Protected areas, green open spaces such as parks and fields, and various forms of green urban infrastructure (green roofs, green walls, and green belts) can help mitigate the UHI effect, the expected rise in average temperature and the impact of heat waves. Two processes are at work. First, green infrastructure provides shade and reduces the absorption and retention of heat by surfaces in the built environment. Choosing lighter colours and materials that retain less heat can further enhance this effect in the built environment. Second, the plants and trees that make up green infrastructure cool their environment through evapotranspiration (Ennos 2012). This effect can be observed directly close to the green infrastructure itself but also in the vicinity. Ideally, such measures are combined with

activities to manage storm water and increase the permeability of soils, which allows for increased cooling through evaporation. Blue infrastructure, namely bodies of water such as rivers, are also shown to contribute to reducing the heat island effect, including air temperatures at night (Hathway & Sharples, 2012).

Zipperer et al. (1997) estimate that increasing tree cover by 25% can reduce afternoon air temperatures by 5 to 10°C. In town centres and high-density residential areas, green roofs have been shown to provide an effective means to reduce surface temperatures and enhance the thermal efficiency of buildings (Carter and Butler, 2008; Handley and Carter, 2006; Goode, 2006). A meta-analysis of empirical data on the effects of urban greening on temperature shows that, on average, an urban park could be 1°C cooler than a non-green site (Bowler et al., 2010).

The heat mitigation effect depends on a number of factors. For maximum temperature, the difference is higher in deciduous and mixed forests compared to coniferous forests. For minimum temperature, in contrast, the discrepancy is higher in coniferous forests (Renaud and Rebetez 2009). Similarly, during heat wave days, the increase in sensible heat flux is initially much larger over forests than over grasslands (Teuling et al. 2010). In the long term, however, grasslands become the main heat source because elevated evaporative cooling accelerates soil moisture depletion (Teuling et al. 2010).

Gaitani et al. (2011) studied a municipality programme and its impacts on UHI in Athens, Greece. Their findings suggest that bioclimatic rehabilitation design can provide up to a 2°Cdecrease in temperature during the summer. Meier and Scherer (2011) investigated the various types of vegetation in the urban environment and their capacity to cool. Their findings suggest that the canopy cover of trees determines their ability to cool. However, there are a range of factors that also contribute, such as the shade from surrounding buildings. Deciduous trees have a greater capacity to cool, in comparison to coniferous trees. Even small urban patches of green infrastructure can contribute markedly to local cooling. For example, a study of a 0.24 ha urban park in Lisbon recorded temperatures that were up to 6.9^{o}C cooler than surrounding areas on the hottest days (Oliveira et al. 2011).

Bowler et al. (2010) studied the impacts of urban greening projects in a range of cities with diverse vegetation. The results of the studies confirmed that greening had a net positive effect in reducing temperatures in urban centres by a minimum of 1°C. As part of a study by Zoulia, Santamouris and Dimoudi (2009), the temperature differences in a national park in Athens, Greece were investigated along various routes and at different times throughout the day. Their findings suggest that the density and type of vegetation play a role in the extent of the decrease in temperature in the surrounding area.

Large parks and protected areas make significant contributions to cooling and provide oases on hot days (Bowler, et al., 2010). The cooling effect of parks may extend to the wider surrounding area (Green Infrastructure North West, 2011). For example, a long-term study of three parks in Gothenburg, Sweden, showed that the cooling effect could reach as far as 1 km from the park boundary, for the largest park considered (156 ha) (Upmanis et al 1998). In US cities, such as Los Angeles, municipal health and emergency services keep parks open for longer during heat waves. They are advertised to the public as “cooling centres”

alongside air-conditioned public spaces, recognising that they may be cooler than people's homes.

A study in Manchester, UK showed that a 10 % increase in green areas would keep the maximum temperatures by 2080 at nearly the same level as the 1961–1990 baseline conditions and mitigate an expected temperature rise of 4°C (Gill et al., 2007).

Traditional green infrastructure elements (parks, trees, green spaces)

Historically, green infrastructure has focused on parks of various sizes and street trees, and these continue to be important features of the urban environment that provide valuable health benefits. Several studies have examined the benefits of trees in contrast with alternative forms of green infrastructure (green roofs, green walls, bio swales) and have largely found trees to be more effective in providing shade and cooling (Teuling, et al., 2010; Bowler, et al., 2010). Furthermore, larger green spaces have been shown to demonstrate greater cooling benefits (Bowler, et al., 2010).

Cities and regions continue to promote and build on existing green infrastructure. Tree planting campaigns represent a good example of this. Cities such as Berlin and Manchester have strategies to increase the density of street trees; with both cities including increased shade as a motivation for their strategy. Through the Stadtbäume für Berlin (City Trees for Berlin) campaign, Berlin is aiming to plant 10,000 new trees by 2017 (Senatsverwaltung für Stadtenwicklung und Umwelt, 2015). The city authorities argue that broadleaf trees have around 30,000 leaves, and 80 to 100 year old beech or oak trees can have between 120,000 and 800,000 leaves, and consequently provide a considerable amount of shade on hot days. For this reason, mature trees can provide a stronger cooling effect than younger ones, and there is a temporal lag before some new green infrastructure can provide maximum benefits. It is not surprising that there is often a positive correlation between neighbourhoods with a higher density of public parks or large street trees and local property prices (Sander, et al., 2010).

Manchester, UK – Red Rose Forest promoting street trees

Although Manchester has a relatively mild climate, the aforementioned study of the effects of green infrastructure on summer high temperatures demonstrated surface temperature differences of up to 15°C between town centres and woodlands (Gill, et al., 2007). The city of Manchester has adopted green infrastructure thinking into its ongoing climate change action plan, Manchester: A Certain Future (MACF) (Manchester City Council, 2009; Manchester City Council, 2014), as well as its up-and-coming green infrastructure strategy (Manchester City Council, 2015). These documents explicitly refer to mitigating urban heat islands and contributing to climate change adaptation, as an ecosystem service offered by natural spaces.

The Red Rose Forest initiative is a community-orientated organisation in the Greater Manchester area that has been one of the key stakeholders and implementers of green infrastructure in the city (Red Rose Forest, 2014a). Building on the UK Government's Big Tree Plant, which has completed its aim set out 2010 to plant 1 million trees in the UK by early 2015, with 74% in urban areas and 5,000 street trees (Forestry Commission, 2015), Red Rose Forest continue to promote tree planting in Greater Manchester, citing the benefit of reducing summer temperatures through shading. Some of

their projects include a competition providing grants of up to GBP20,000 for local street greening ideas, tree audits of Manchester, and a tree planting campaign using funding from a local waste management company (Red Rose Forest, 2015). The initiative has also published a guide for urban street tree planting (Red Rose Forest, 2014b).

Green roofs and green walls

Green roofs and green walls provide valuable additions to urban green infrastructure and can help to improve climatic conditions in cities. The advantages of these approaches are that they do not compete in the same way with other land uses in urban spaces where competition for commercial space is high.

Some countries and cities have implemented legislation enforcing the use of green infrastructure. For instance, France recently passed a law that new buildings in commercial zones must include partial cover with either green roofs or solar panels. Since 2008, Copenhagen became one of the first cities to have a mandatory green roof policy for municipal buildings (City of Copenhagen - Klimatilpasning, 2012). Other cities with legislation to implement or finance green roofs in Europe include London, Stuttgart, Düsseldorf, Berlin, Munich, and Basel (City of Copenhagen - Klimatilpasning, 2012, pp. 48-51).

In Manchester, Red Rose Forest (see above) support the implementation of both "big green roofs", including a 750m^2 roof at the Manchester Metropolitan University (MMU, 2011), and "small green roofs", which promotes bottom-up green roofs on small buildings, for instance on garden sheds (Red Rose Forest, 2006). They argue that even small roofs act as hotpots for biodiversity, provide insulation and absorb radiation.

Climate adaptation study and implementation using green infrastructure, Ghent, Belgium

Ghent in Belgium is striving to be a climate-proof city by 2030. The city authorities have carried out a detailed analysis of heat stress and UHI dynamics for the city, including climate projections (VITO, 2012). City temperatures in Ghent itself are generally 3°C warmer than the surroundings, increasing to 8°C on hot days. In contrast, city parks are at least 1.5 degrees cooler than the surrounding city. The initial heat stress study was used to inform climate adaptation policy for the short, medium (2014-2018) and long term (to 2030), including the Climate Plan 2030 Ghent (Stad Gent, 2014).

Combined green and blue infrastructure

Whilst green infrastructure is often only associated with vegetation, it also includes water infrastructure. Indeed, vegetation and water are inexorably linked, as are the climate benefits related to green infrastructure, e.g. the cooling function of evapotranspiration. This has also been acknowledged in policy documents. For example, the European Commission's communication on green infrastructure includes blue infrastructure in its definition (COM, 2013a).

Increasingly, green infrastructure strategies are being explored which integrate both green and blue infrastructure in relation to climate change. The Blue Green Dream research project, supported by Climate-KIC, is working to enhance the synergy of urban blue and green systems and provide effective, multifunctional blue-green solutions to support urban adaptation to future climatic changes. This has included 10 demonstration sites in the UK, Netherlands, France and Germany (Blue Green Dream, 2015).

Lyon, France – The Rhône River, rain water and coping with heat waves

The city of Lyon has had to tackle multiple challenges in relation to climate change. The 2003 heat wave increased mortality in the city by 80%, above the national average for a French city (Vandentorren, et al., 2004). Green and blue infrastructure, including the Rhône River, which runs through the city, has been at the heart of the solution. Increasingly, the city is making the links between the benefits of green and blue infrastructure, conservation and practical urban spaces.

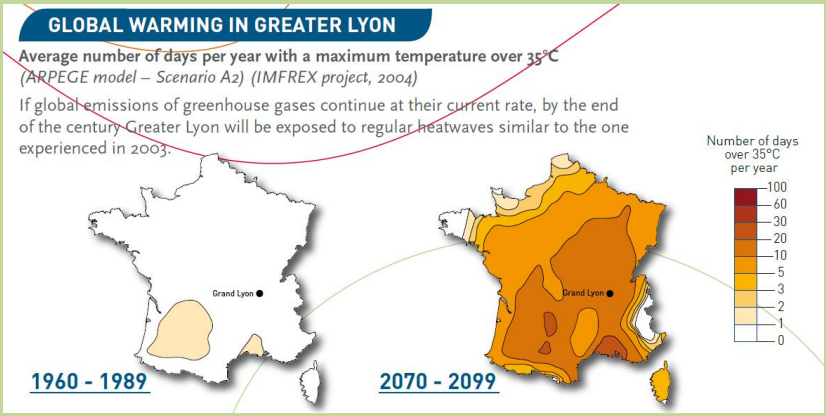


Photo: http://www.ale-lyon.org/download/Plan_climat_Grand_Lyon/plaquette_PCT_GL_UK.pdf

In the 20th century, a focus on grey infrastructural solutions to flooding in the city left both a disconnect between the citizens and their river and a number of issues in relation to future risks for the city. Several green infrastructure projects in the city, with the support of investments in research and design have introduced a shift from grey to green infrastructure in city planning.

For instance, a study at Confluence, an eco-district in the city where the rivers Rhône and the Saône meet that is undergoing development, has contrasted the use of green roofs in newer buildings with artificial surfaces such as asphalt in older buildings. The analysis showed that natural surfaces helped reduce energy consumption for buildings (Bouyer, et al., 2009). The redevelopment of Lyon Confluence is now going into its 2nd phase. It aims to better integrate green and blue spaces, and hydrological and thermal impacts – for instance through sustainable urban drainage, rainwater-harvesting systems and green roofs (Lyon Confluence, 2012). The project aims to provide housing for 25,000 people and 14,000 new jobs by 2030.

The city's development is increasingly guided by strategies such as the Climate Plan (Grand Lyon, 2007b) and the Water Strategy (Grand Lyon, 2007a). The strategies stress that, whilst flooding has been a priority of the past, increasing water scarcity and summer heat waves will affect the city. The Greater Lyon Initiative includes a shade indicator, calculating annually the area of shade provided by trees, roughly 3.5 million m^2 for public spaces. Such a quantitative indicator allows clear targets to be developed in the future (Grand Lyon, 2007b, p. 6).

Finally, in 2007, the city reopened public access to the banks of the city's river (Grand Lyon, 2014). The €42 million redevelopment programme, Berges du Rhône, replaces a bitumen car park with 5km

of pathway and green spaces, as well as providing soft flood protection, opportunities for recreation, and connecting two urban parks and the Natura 2000 site Grand Parc de Miribel-Jonage in the north of the city.

Well-being through climate Change Adaptation: Copenhagen, Denmark

Copenhagen's Climate Adaptation Plan (City of Copenhagen, 2011) identifies a number of risks that the city will face in coming years. Risks from flooding in the city are particularly acute, with €800 million of damage caused in July 2011. Other risks such as high summer temperatures and amplified air pollution are significant. In a heat wave in 2006, surface temperatures reached 47^{o}C (City of Copenhagen, 2011). These risks have acted as drivers for the city to invest in green infrastructure, which provide multiple benefits for its citizens. A law, which forces the implementation of green roofs introduced in 2010, has helped to slow surface run off, reduce heat stress, and improve air quality, but also provide new public spaces. Furthermore, the city's ongoing Cloudburst Management Plan (City of Copenhagen, 2012), will construct cloudburst parks, creeks and boulevards, to hold water in extreme events, on normal days these provide usable green spaces. In addition, successfully reducing storm water runoff in Copenhagen has also improved harbour water quality, which now complies with bathing regulations.

Table 3.1: Causal links, hypothesis, measures and evidence – an overview

What environmental and health pressures could biodiversity help address and what indicators are useful?	What specific benefits could be measured in principle (and practice)? What quantitative indicators are used?	What benefits can be measured in monetary terms?	Who are the main beneficiaries?	What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?
Average and peak city air temperatures (the heat island effect) can be reduced through a higher proportion of green and blue areas in cities. This can reduce the probability of heat-stress and other health impacts.	Avoided premature deaths from heat stress (number of hospitalisation/treatment cases days of lost output).	From heat stress: value of loss of life years (VLL); Avoided loss of output; Avoided hospitalisation costs;	Generally: Population in cities characterised by UHI Specifically: Elderly population	Urban and some peri-urban Natura 2000 sites can create cooler micro-climates; City green infrastructure (trees and parks) can help cooling.
What does the data say: A 10 % increase in green areas by would keep the maximum surface temperatures at nearly the same level as the 1961–1990 baseline conditions and hence mitigate the expected temperature rise of 4°C (Gill et al., 2007); Shade from trees has been shown to be important for lowering temperatures; however, temperatures have also been shown to be lower in unshaded green sites or above short vegetation (Bowler, et al., 2012); Increasing the canopy cover may reduce air temperature by 1-3 degrees. Green roofs or planting on roofs, may also decrease UHI and decrease storm run-off, (O'Neill et al., 2009); Density and type of vegetation play a role in reducing temperature during heat waves (Meier and Scherer, 2011, and Skelhorn et al., 2014). Meier and Scherer reviewed 18 different species of trees, and measured the temperature surrounding the trees. Their results suggest that it is the canopy/coverage of the trees that play a role in their ability to cool. However, deciduous trees have a greater cooling capacity for than coniferous trees.	Tree canopy cover and tree species influence rates of evapotranspiration Additionally location of trees also determines rates of evapotranspiration and amount that the temperature decreases. Trees in the shadows of buildings have lower temperatures, whereas those exposed to sun have higher temperatures.			Green spaces, from small grassy plots to clusters of trees, cool the surrounding environment; Gaitani, et al., (2011), Zoulia et al., 2009; Meier and Scherer, 2011

Towards quantifying the health and social benefits of nature: improved climatic conditions

Heat stress is a major driver of mortality. Climate projections suggest the incidences of it will increase in the future. Likewise, the urban heat island effect (UHI) intensifies risks for city populations. The risks from heat stress have significant health, social and economic impacts that justify appropriate policy responses across a range of governance levels. The literature reviewed in this chapter suggests that nature-based solutions should be incorporated into strategies for addressing heat stress.

Methods: This task focused on the existing research on the valuation of the health and social benefits of nature and biodiversity protection with respect to improving climatic conditions. Quantifying the benefits helps to communicate them to a wider audience. Data which directly links nature-based solutions to heat stress is sparse, and data which quantifies benefits (particularly in monetary terms) even more so. An exploratory assessment of the contribution of nature to heat stress has been made here. This will build on the research outlined in this chapter, and build an exploratory methodology to support future research and suggest possible policy implications.

Step 1: Key variables and causal links

- Assess data from the literature.

- Review data on the EU-wide scale of health costs associated with heat stress. Identify independent variables.
- Develop the evidence base on the contribution of nature to heat stress, i.e. where does Natura 2000 or green infrastructure offer benefits? Identify dependent variables and relationships.

Step 2: Cases and developing a comprehensive method

- Develop an exploratory methodology: Bottom up – Draw on valuations of nature-based solutions to heat stress at the case level.

- Explore how a more complete picture of the contribution of nature to heat stress can be established.

Step 3: Policy Implications

- Conclusions – In the context of the robustness of the evidence, what can be said on the benefits of nature for heat stress?
- Policy implications – How can further work in this area support sustainable policy making, drawing on the multiple benefits of nature?

Step 1: Key variables and causal links

Climate forcing (maximum temperatures, occurrence of heat waves): Climate projections suggest that the risk of heat stress will increase in the future. Around 75% of Europeans live in urban areas, which will be exposed to rising average and extreme temperatures resulting from climate change (EEA, 2012d).

Urbanisation and UHI (% of urban populations and level of UHI +^{o}C): The UHI effect can increase urban temperatures by up to 7-12^{o}C compared to non-urban areas (Depietri et al., 2012; Lauwaet et al., 2015).

Health (morbidity and mortality associated with heat stress): High temperatures increase the incidence of respiratory and cardiovascular disease, renal failure, heat stroke, and have indirect impacts on food and water-borne disease (Kovats, 1999). Europe's 2003 heat wave caused up to 70,000 deaths over 4 months (EEA, 2012d). JRC PESETA II estimated that annual healthcare costs attributable to climate change will be €932 million in 2071-2100 under A1B emissions, with annual mortality costs in excess of €12 billion by 2100. A 1°C increase in temperature above a 29°C threshold would increase respiratory mortality by 3.5% among 64-75 year olds (Ciscar, 2014).

Society (age, gender, income): Age, gender and wealth can determine vulnerability to heat stress. In France, during the 2003 heat wave, mortality rates doubled in the most deprived cantons (Rey & Fouillet, 2009).

Jobs and growth (heat induced output losses as % of GDP): There is established evidence on the impacts of climate change on the economy (Stern, 2006; OECD, 2009; Heal et al., 2014). Analysis demonstrates that, purely from an economic perspective, adapting to climate change is preferable to inaction. This is the basis for global climate mitigation and adaptation efforts, including via the UNFCCC. Beyond the outlined health impacts, the negative impacts of heat stress on labour output are increasingly well understood. For Germany, Hubler et al. (2008) predict heat-induced output losses of between 0.1% and 0.5% of GDP (€2.5-10.4 billion) per annum by 2100, a fourfold increase compared to 2008. Across the EU, it has been estimated that in 2041-2070, 6 million working days will be lost to health impacts linked to heat under the A1B scenario (Ciscar, 2014).

Benefits of nature (measures of urban green): Nature can help to reduce the risks associated with heat stress by providing cooling from shade and evapotranspiration (Ennos, 2012). The magnitude of cooling is dependent on the configuration, type, size, health and density of vegetation (Zupancic et al., 2015). Small parks also offer relief on hot days. Air temperatures in the Teofilo de Braga garden (0.24 ha) in Lisbon, were up to 6.9°C cooler than the surrounding area (Oliveira et al., 2011). For Manchester, it was estimated that an increase in green or tree cover of 10% in high density residential areas would keep maximum surface temperatures up to 2080 at or below the same level as 1961-1990 baseline conditions (Gill et al., 2007). One study in the USA looking at vegetation amongst other heat stress management strategies in Atlanta, Philadelphia, and Phoenix, estimated that between 40 and 99% of heat related mortality could be offset with vegetation and albedo enhancement (Stone et al., 2014).

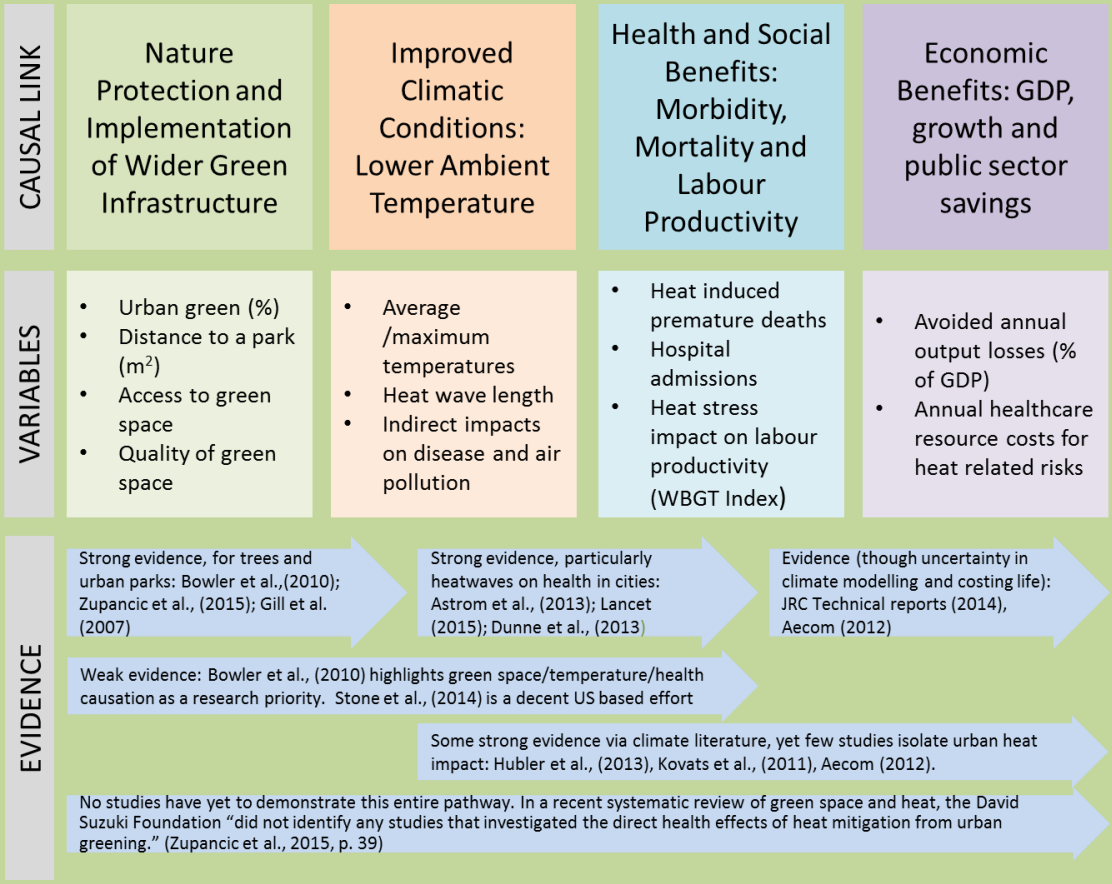
Step 2: Cases and developing a comprehensive method

Cases (bottom-up): Few studies have explored how the interaction of the UHI effect and climate change could impact health risks (Tomlinson et al., 2011; Kalkstein et al., 2013). For example, Skopje, Macedonia has included the goal to "Improve urban planning and reduce the urban heat island effects" in its Climate Change Health Adaptation Strategy (WHO, 2011). Skopje experiences a reference UHI of around 2.25°C, and climate projections show temperature increases of 6.85°C by 2080. From 2006-2010, there were an estimated 316 additional cases of cardiovascular disease and 344 additional cases of respiratory disease in Skopje, with 13 mortalities from cardiovascular disease and 1 from respiratory disease. The estimated average annual cost over the same period was €1.03 million or €2.50 per inhabitant. Considering the role nature can have in mitigating heat stress, one might consider the potential savings for Skopje based on this research.

Drawing on research on the benefits of nature, investment in green infrastructure could contribute to addressing the UHI effect, and significant investment in green infrastructure could offset maximum temperature increases up to 2080 (Gill et al., 2007; Stone et al., 2014). Hence, investment

in green infrastructure could mitigate health risks and the economic costs of impacts. However, it is simply not possible to conclude this given the lack of robust analysis.

Impacts (top down): With the JRC PESETA II project estimating annual healthcare costs attributable to climate change of €932 million in 2071-2100, and annual mortality costs in excess of €12 billion by 2100, EU-wide investment in greening to support heat stress alleviation could provide significant savings to European cities. Estimating potential EU-wide public health benefits in relation to existing or future application of nature-based solutions is not within the scope of this project.



Step 3: Policy and research implications

Cities that currently experience heat stress from climate change and UHI effects, or are forecasted to, will benefit from greening strategies. Assessments of the impacts of green infrastructure on heat stress suggest that nature-based solutions could be used to significantly reduce negative impacts on public health and the economy. Drawing on existing research, it is plausible that significant investments in greening could offset heat stress and the UHI effect up to 2080, but there is a lack of evidence to substantiate this.

Effective policy responses to heat stress will most likely need to incorporate wider policy options, primarily climate change mitigation, but also local initiatives such as awareness raising, public information and early warning systems for severe heat waves. Establishing the cost-effectiveness of nature-based solutions as a package of policy options would support research and policy making in this area.

A recent systematic review concluded that "while there is a large and growing evidence base on the

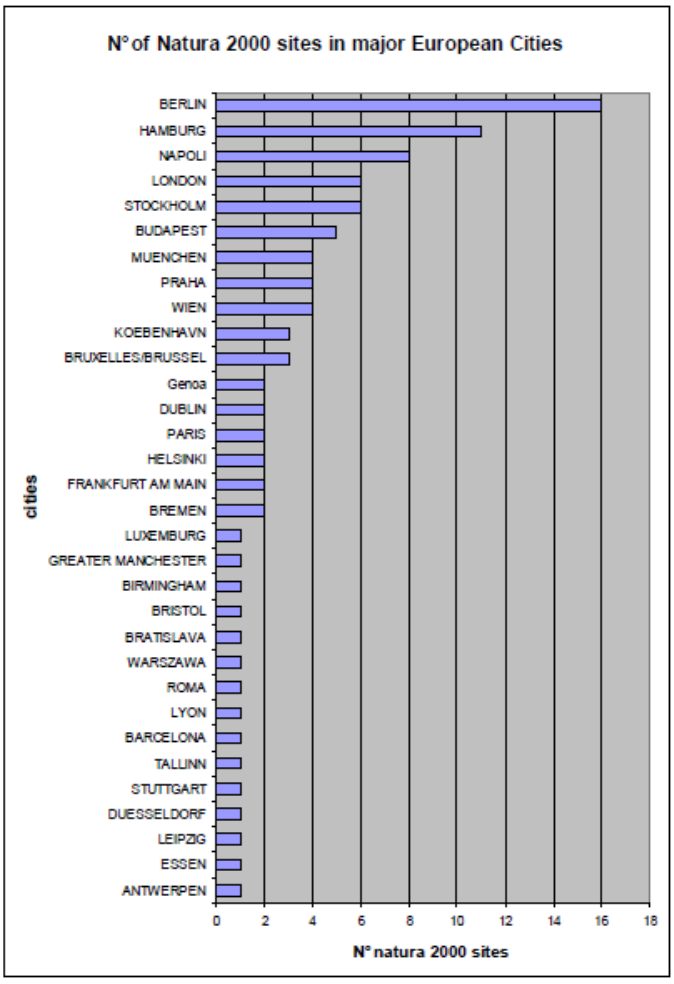
impacts of heat on human health, as well as separate studies on heat mitigation from green space, few studies directly associate observed heat mitigation from green space with direct health impacts" (Zupancic et al., 2015, p. 39). Similarly a meta-analysis of the economics of health impacts of climate change in Europe concluded that there is "limited and fragmented" evidence and research was urgently needed (Hutton & Menne, 2014).

What insights are there on Natura 2000 sites providing benefits – and to whom?

Urban Natura 2000 sites can offer valuable cooling co-benefits. Large natural spaces such as those covered by the Natura 2000 network offer both relief during extreme events, and contribute consistently to reducing ambient air temperatures including reducing the UHI effect (Bowler et al., 2010).

Whilst the majority of the Natura 2000 network are located outside of cities, many sites are located within city boundaries and consequently have the potential to contribute positively to urban micro climates. Although specific studies pertaining directly to Natura 2000 sites, climate change adaptation and health are limited, a few examples illustrate climate change adaptation benefits well. In these cases, urban cooling can be regarded as one of several ecosystem services originating from the sites (Depietri et al., 2011).

Many Natura 2000 sites are located in cities, and consequently contribute to urban cooling. A study in 2006 (Sundseth & Raeymaekers) attempted to assess the number of Natura 2000 sites which were urban. In their study they focused on urban areas with a population greater than 500,000, or 32 major cities.



At this time, the network consisted of around 18,000 sites. Within the 32 cities, they identified 97 Natura 2000 sites. These are shown in the bar chart on the right. They also found great diversity between these urban sites. For example, some sites were little more than a few hectares in size whilst others were over 1,000ha.

Today the Natura 2000 network includes over 27,000 sites amongst the EU28 (COM, 2015a), and if we consider that many urban conurbations exist with populations less than 500,000, the number of relevant sites is likely to be considerably more than this.

Green Roofs in the Mid Vistula Valley, Warsaw, Poland

The Vistula River runs through the centre of Warsaw and is Poland's longest river. The middle section of its valley; including the part which runs through the capital; is an Natura 2000 site which focuses on the conservation of a number of bird species – including the Little Tern Little (Sternula albifrons), Ringed Plover (Charadrius dubius), Ringed Plover (Charadrius hiaticula), Common Sandpiper (Actitis hypoleucos) and Sand Martin (Riparia riparia) (Elas et al., 2013).

As Research has shown that the most regulated and developed parts of the river lack breeding sites. Thus, efforts have been made by local conservation groups to re-naturalise the river and protect the habitats of the birds. This has included developing floating barges and restoring early plant growth on river islands (Walków, 2006; Elas et al., 2013).

Away from the river and within the city, conservation efforts can be further supported through green infrastructure. Whilst GI may not provide natural habitats for the birds they can help to increase local biodiversity, including valuable insect and avian populations. The green roof on the Copernicus Science Centre on the banks of the Vistula River, and within the Natura 2000 site, provides a good example of this, even providing a nesting site for a duck. This green roof provides valuable insulation in summer months. Traditional roofs in Warsaw can get as hot as 80°C, whilst the biologically active surface remains at ambient temperature (Jurkiewicz, 2014). This example demonstrates the role of GI in supporting urban biodiversity but at the same time providing valuable ecosystem services by reducing UHI.

Photo source: http://www.world-architects.com/en/projects/25854_The_Copernicus_Science_Centre

The majority of urban Natura 2000 sites are temperate forests, followed by grasslands, both in terms of number of sites and the area covered (Sundseth & Raeymaekers, 2006, p. 12). This is significant because it has been shown that whilst grasslands can show better cooling qualities in the short term, particularly through evapotranspiration from soils; in extreme heatwaves such as those in August 2003, the conservative water use of forests provide better cooling properties than grasslands (Teuling et al., 2010). It is during these sustained summer heat events when the health risks are highest. Examples of large forests close to cities, particularly those included within the Natura 2000 network, such as Brussels, Berlin, Prague, Stockholm, and Copenhagen, consequently represent valuable resources to Europe's cities.

Brussels, Belgium – Urban forests and urban heat

The Belgian National Climate Change Adaptation Strategy highlighted the increased risks which the country will face. The domains of heat and water, and the interaction of the two, were identified as particularly affected by climate change (Belgian Climate Commission, 2010). Although heat waves in Belgium are still relatively uncommon, they are anticipated to be a feature of every summer by the end of the century (IPCC AR5, 2014). In 2003, the heat wave resulted in an additional 1,300 deaths in Belgium. Additional health concerns relate to diseases such as botulism and vector borne disease such as tick-borne encephalitis (TBE), Lyme disease, and visceral leishmaniosis (Belgian Climate Commission, 2010, p. 19). Protecting natural ecosystems is identified as one of the 5 key strategies for adapting to climate change (Belgian Climate Commission, 2010, p. 44).

The capital, Brussels, is particularly vulnerable to these risks as some of them may be amplified by UHI. Natural spaces, particularly rich woodlands, will provide important relief and cooling in the case of heat waves (Belgian Climate Commission, 2010; Teuling et al., 2010). Whilst the centre of the city lacks green space, the Brussels-Capital Region benefits from a high density of natural spaces on the east and south west borders. The Regional government of the Brussels Capital Region has designated three Special Areas of Conservation under the Habitats Directive, which together cover 2300 ha or 14% of the Region. The largest of these is the vast Sonian Forest which covers 2077 ha (Sundseth & Raeymaekers, 2006, p. 26; Bruxelles Environnement, 2013). However, these parks will also need support in the future. A changing climate will also impact upon the suitability of habitats for different species. One study on climate impacts in the Sonian Forest suggested that the beech trees which the forest is famous for will struggle under future conditions, necessitating careful management strategies (GxABT, 2009).

Although there are a lack of studies directly linking Natura 2000 sites and their ability to cool, this does not indicate that Natura 2000 sites do not help mitigate the impacts of extreme temperatures; neither does it invalidate the importance of preserving these natural spaces.

Studies to date indicate that people do access Natura 2000 sites for recreational purposes, thereby improving their health and mitigating the impacts of living in urban environments. What is often absent from these studies is an indication of when people are accessing these sites. Lafortezza et al. (2013, p 105) state that “The Natura 2000 network can be interpreted as GI cells that already provide ecosystem services, such as food, air quality, carbon sequestration, flood management, water treatment, local climate conditions, soil erosion prevention etc., but the system benefits at a continental scale could be greater if there was more network connectivity between them.” This statement implies that the understanding of the benefits of Natura 2000 sites could be extrapolated from the benefits of GI at a smaller scale.

3.3 The role of supporting instruments and governance

Addressing the impacts of climate change, in particular rising temperatures and urban heat islands, requires action by a broad range of stakeholders at local, regional, national and supranational levels (see Table 1). Each of these stakeholders has a role to play from regulation to implementation. This section presents and discusses some of the supporting instruments and governance mechanisms that are currently in place and under development to address the impacts of climate change on human health.

Regulation and legislation from city to national and supranational scale

The case examples presented thus far demonstrate that mitigating urban heat islands often requires local and regional action. However, local action regularly requires the support of regional governments, national governments and international governing bodies. Through the introduction of regulation and legislation, they create an environment that makes way for local governments to create plans and policies that promote green infrastructure and protect nature as a priority. For European cities, the European Union empowers local governments through directives that bind member states to achieving targets, many of which would not be achieved without local governments taking action. Moreover, the EU is supporting a number of initiatives that enable local governments to interact with each other and share knowledge and experience, such as the EU Mayors Adapt initiative.

However, national governments continue to play an important role. Generally, planning is guided by national laws that determine how often local governments are required to revise and update comprehensive development plans and the procedures that must be followed in their development. This process has been guided historically by political interest, in other words, votes for development rights. However, with the global plea for action on climate change, this is seeing a shift in favour of local governments enabling the environment to take precedence over development interests. An example of this shift is the Scottish Government who is supporting local governments by simplifying statutory processes around comprehensive plans, enabling local authorities to innovate with policies and strengthen the protection of the environment. Support from higher levels of government is important for the ability of local governments to take ‘risks’ with policies and say ‘no’ to individual projects that go against the greater good. When regulations and legislation are in support of local governments, planners and policy makers have the ability (and confidence) to go forward with plans and policies that may not be favourable in the short run, but are ultimately beneficial in the long run.

Strategies and plans

Closely related to regulation and legislation are strategic approaches of cities and regions to mitigate urban heat islands and the expected impacts of extreme temperatures. For the majority of local governments, comprehensive development plans are the means by which they communicate their vision for the city in a given period. Depending on the country, as discussed, national governments determine the timescales in which these plans must be produced. Comprehensive development plans are broad in their objectives. In the past, they were focused primarily on land-use and economic development. With the increased recognition that cities have the capacity to bring about real changes, these plans now

include strategies for addressing climate change, in particular green infrastructure and the protection of nature. Some cities have even moved towards (or returned to) the inclusion of human health as a core objective, as it is part of creating a case for promoting green infrastructure and other policies that mitigate climate change. The success of comprehensive plans is dependent on a range of supporting policies and plans generated by cities.

Investments in green infrastructure can be effective at the building and neighbourhood scale, but also on a city and region scale. From a city perspective, regulation and policies are important which foresee a minimum amount of accessible green space for citizens and further support instruments, for example, by increasing the number of trees lining streets. This is where the plans that support and emerge from the comprehensive development plan play a role. Local area plans or neighbourhood plans permit planners and policy makers to engage directly with communities. This is an opportunity for building relationships with communities and creating the opportunities to educate the public on the benefits of nature protection and green infrastructure. For example, consulting with the public on the plans for their neighbourhood is an opportunity to show how improved land-use planning can be a cost-effective way to mitigate climate change and incorporate public health aspects (Younger et al. 2008). Medium to long-term oriented planning can help to set priorities for the development of green infrastructure and give guidance to residents and investors. Such planning processes allow for consulting with stakeholders that have a focus on health and social aspects of urban development.

Green corridors for urban well-being: City of Barcelona, Spain

The City of Barcelona has developed an ambitious Green Infrastructure and Biodiversity Plan 2020. The plan builds on the idea of multiple benefits of green space in the city and the creation of green corridors. This is achieved by maintaining existing green spaces and creating (small-scale) new ones. The Green Diagonal Avenue (Diagonal Verda) is an example of green connectivity in the city of Barcelona. It is a linear park across the eastern part of Barcelona that will connect a major highway interchange (Nus de la Trinitat) in northern Barcelona, to the waterfront. Projects like these are considered as major achievements in the city, but their realisation is challenging, especially as Barcelona is such a dense and compact city. This density is also affecting other challenges such as the adaptive capacity to deal with climate change and the accommodation of society's demand for green space. The local authorities are well aware of these circumstances and consider them in their planning. To guarantee coherent development within the city, the Green Infrastructure and Biodiversity plan is embedded in future city planning. To guarantee coherent development with the surrounding area of the city, a collaborative partnership with the Province (Diputacio) of Barcelona was established.

Source: http://w110.bcn.cat/portal/site/ MediAmbient/

In relation to the physical built environment, building codes and regulations play an important role in the incorporation of green infrastructure and the protection of nature. As the built environment changes slowly over time and buildings and other urban infrastructure

are in use over several decades, the management of redevelopment and new buildings is critical. The instruments chosen by different cities vary; some cities will set requirements for new buildings to have specific green infrastructure elements. For example, Copenhagen has mandated the use of green roofs, while Sheffield in the UK provided guidelines that have turned into national standards. Concerning preserving green spaces and nature, local governments may create incentives for developers to use brownfield sites, such as the "City Deal" in Scotland. Local governments, like Glasgow City Council, have invested in infrastructure on brownfield sites through the City Deal, thereby making them development-ready (Scottish Government 2015). This example highlights how local governments face the challenge of profit-maximising private sector developers. Climate-proofing measures can imply additional costs for developers. For local governments, ensuring that developers do include green elements can be a long fought battle.

Cities face further challenges in greening the built environment. Tree planting is often put forth as an easy policy goal to achieve. However, trees require maintenance, the responsibility of which may or may not lie with the city. For example, in Portland, Oregon, citizens are responsible for maintaining trees even if they are on public property. Then there are issues with planting trees. The roots of tree require space and, depending on the age of the city, that space may not exist as there may be exiting sewage systems, electricity wires, and gas pipelines underground. Temporary solutions such as planters are an option for cities, as they provide new ways of incorporating trees into the urban fabric. Temporary solutions can also be a means of harnessing community interest by participating in the maintenance of planters and eventually trees.

In addition to action on developed land, protecting open, undeveloped spaces and interconnecting landscapes can equally contribute to providing microclimatic regulation. Such green corridors and networks can provide further benefits such as connecting habitats and helping to protect biodiversity on a landscape scale. This area of action is important from a city and regional perspective, and at times requires cooperation with different jurisdictions. The protected status of land, for example, according to national nature protection laws or through supranational legislation, can facilitate the preservation of undeveloped land that typically provides several ecosystem services simultaneously, including climatic regulation to moderate heat islands.

However, it should be mentioned that policy responses for addressing urban heat stress would need to go beyond aspects of the built environment. They also need to address the practical preparedness of health systems to manage extreme temperatures, awareness raising regarding good practices for self-protection during heatwaves (including emergency services such as cool rooms), but also social cohesion and trust-building (Huang et al. 2013).

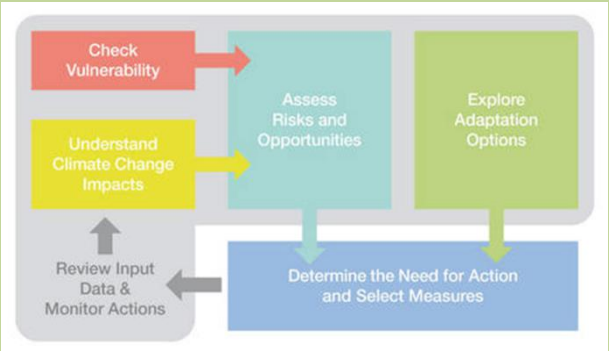
Thus, planning processes are not only limited to the built environment but need to take a wider approach to identify vulnerable groups especially affected by heatwaves, including their geographic identification. Furthermore, a number of related policy areas such as emergency and disaster risk planning need to be involved as well.

Knowledge, local capacity and cooperation

Analysing and mitigating the negative public health impacts of urban heat islands requires knowledge and capacity. Regional and local governments are recognized as being the levels of government that can move the climate adaptation agenda forward (Corburn 2009). Higher levels of government and international organisations are necessary to provide not only financial support, regulatory policy and legislation, but also programmes that foster knowledge exchange between cities (Proust et al. 2012). The EU has recognized through its EU Cities Adapt project and subsequent Mayors Adapt project, that cities are at the forefront for addressing climate change, with a range of planning tools, programmes and innovative strategies.

Future Cities Project – Adaptation compass

The Adaptation Compass, currently being applied in BENELUX, is a decision-making tool for taking action on climate change in cities. It gives guidance to incorporating both climate change assessments and vulnerability analyses into a risk assessment procedure (Future Cities 2014). The tool can be applied at different scales (region, city, project area) and is able to accommodate local information. The tool structures the decision-making process and helps planners and experts in cities by providing-good practice examples.



National governments also have a role in supporting local governments. While projects like the EU-UHI can provide cities with data e.g. in the form of heat maps to inform their policy actions, national governments can for example develop heat-warning systems. The EU and the World Health Organisation have put forward this as an action for governments for mitigating the adverse impacts of heat. Countries such as France have developed Heat-Health Warning Systems (WHO 2008). Cities still have to plan responses to heat waves for both the short and long term. In the short term during the course of a heat event, the WHO has provided guidelines for developing a heat plan. For the long run, cities can address the built environment and vulnerable populations.

New York is an example of a city that is approaching its UHI adaptation comprehensively and collaboratively. Through the New York City Regional Heat Island Initiative (NYCRHII), which is a partnership between the state, the city and scientists, the city has developed a response plan that merges the science of heat islands, green infrastructure, economics and politics. The result is a plan that uses a combination of responses (green roofs, tree planting, surface lightening) to address UHI in New York City in a cost-effective manner and that takes into consideration the neighbourhood characteristics. Beyond this initiative, the city of New York maintains a comprehensive database of environmental and health indicators by neighbourhood (New York City 2015).

Communities and individuals: grassroots projects

Local communities and individuals can become instrumental stakeholders and decision makers in implementing nature based solutions to urban heat. Many aspects of the benefits of nature for urban heat are linked to behaviour and rely on citizens actively making use of green spaces. Consequently, for some benefits, there is only so much authorities and wider stakeholders can do. Furthermore, citizen action and grass-roots initiatives provide powerful and at times cost-effective tools when green spaces are threatened, by alternative uses or when public finances are tight. Facilitating communities to engage in managing their own local environments is a complex process.

If a community cannot take ownership because their collective and individual security is perceived to be threatened, green spaces run the risk of turning into places of dereliction and under-utilization, and thereby losing their appeal as a valuable asset for urban microclimate and public health. Another related issue is the willingness of those in charge to plant trees and create green spaces of greatest need, often in lower income neighbourhoods. Therefore, implementation of these projects requires community buy-in. Citizens need to engage with these projects and understand the benefits to them. However, public comprehension and desire to engage in policy dialogues, especially on climate change, are limited. People are more likely to engage with their most explicit or pressing needs, such as employment, food and shelter, even though both the risks and solutions will often be linked to more complex or less immediate environmental factors. Engagement on the benefits of nature and green infrastructure to climate change adaptation needs to use language and focal points that make sense to the broader population. This is something many local governments recognize and strive to achieve.

Several cities have demonstrated success with 'grass roots' initiatives that resonate with communities, such as Arnhem, Glasgow and Dublin. Arnhem's heat mapping exercise has also been seen as an opportunity to engage the community to understand the impacts of heat. Glasgow's greening efforts initiated by the private sector with community participation have gained a foothold in the city's current planning actions.

Overall, local governments are making process in developing and implementing policies that mitigate the impacts of climate change and adapt the urban environment. The response to the health impacts of climate change, particularly in the case of rising temperatures and urban heat islands by governments has been reactive and only recently is becoming more proactive as the climate science shows that temperatures will continue to rise. As cities have demonstrated, formulating policies that enable people to mitigate and adapt will require the acknowledgement of barriers, collaboration by all stakeholders and education.

Table 3.2 synthesises a number of the above aspects of relevance to cities, regions, countries and the international level. A wider use of carefully selected and strategically placed green infrastructure, together with a long-term oriented policy of protecting nature in urban and peri-urban setting, can be an important element in mitigating urban heat islands and strengthening urban resilience as regards to climatic impacts. Understanding the challenge of urban heat stress, including its spatial dimension, and creating awareness of it are important prerequisites to formulate strategies and plans that can target the short, medium and long term. A number of instruments for implementation do exist and cities and regions

can make use of the existing legal framework to experiment with new approaches. For some aspects, changes to the legal framework might be useful, e.g. for defining minimum standards for green coverage and green spaces in the course of urban development. Finally, providing adequate financial sources for investing in green infrastructure and protected areas, as well as maintaining them, is an important condition for realising the health (and further) benefits of nature in urban and peri-urban areas.

Table 3.2: Climate resilience through nature governance: role of stakeholders, policies and measures-Examples

	Knowledge – understanding the problem and solutions	Awareness and integration of knowledge	Policy, objectives, Strategies and plans	Instruments, measures, legislation	Financing and investment
Global	IPCC; IPBES	UNFCCC; UNCBD	UNFCCC targets (e.g. 1.5^{o} C Paris target)	REDD+	Adaptation funds
EU	RTD (2016 H2020 call) European Commission policy studies (DG Climate, DG Environment); SPI networks; MAES – mapping	Guidelines on e.g. cohesion policy for climate adaption	Climate strategies integrate nature; Cohesion policy rules recognise nature and climate adaptation		Cohesion Policy funding (2014-2019); LIFE; TEN-GI
National	National research; Monitoring and mapping; National climate service centres		Integration of nature in climate adaptation strategies; Health strategies; Green infrastructure strategies	Schemes for payments for ecosystem services; Grants; Loans; Green public procurement	Environmental funds
Regions & Cities	Climate/heat mapping; Vulnerability assessments	Awareness raising; Heat emergency plans	City climate adaptation strategies	Pilot projects with potential for scaling up	Investing in parks; tree lined streets
Private Sector	Assessment of cooling benefits of green roofs and walls; Assessment of multiple benefits of landscape architecture and planning	Communicate effectiveness of green solutions	Opportunities for citizens to buy into reforestation / greening schemes		Building: Investment in green roofs and green walls; Landscape planners and landowners
Civil Society & Citizens	Identifying vulnerable groups	Communicate risks and opportunities for action		Tree ownership programmes; carbon offsetting schemes; bonds.	Own investment in green roofs; Making use of public green space
Research	Provide robust research on heat island reduction through nature and development of heat maps	Expert groups supporting evidence based policy making			Research grants (e.g. EU Horizon 2020)

Source: Own representation

3.4 Conclusions

The role of nature areas and wider green infrastructure is likely to increase under conditions of climate change in densely built European cities. Green spaces do not only provide microclimatic cooling and regulation services, but can also serve as oases during heatwaves and provide health benefits to wider population groups. The abundance of well-maintained green infrastructure and its accessibility, especially to vulnerable groups in society is pertinent.. Solutions based on green infrastructure typically provide more than one benefit and in many cases, multiple health benefits. For example, green roofs and green walls combine cooling, air quality and noise mitigation benefits, part of which are not traditionally taken into consideration when evaluating projects or urban development plans. A comprehensive assessment of these benefits is one the challenges when developing green infrastructure solutions for urban heat islands. Without comprehensive inclusion of these multiple benefits, green spaces will invariably be undervalued.

The practical case examples from different European countries in this chapter point to the importance of local action for mitigating the UHI effect and its health impacts on the population. Thus, strengthening the role of local communities, including their technical and organisational capacities, will help promote more proactive and collaborative action. This action can also test and evaluate different green infrastructure solutions, including different governance settings where health, social and nature stakeholders cooperate.

While local government and stakeholders can concentrate on developing programmes and plans, encouraging community engagement and promoting collaboration across different professional and social groups, there remains a role for the national and supranational levels to support local and regional action. The support can comprise providing information, such as scenarios of climate change in different regions, guidance on the evaluation of the benefits and value of nature, as well as providing funding for projects that are of significance for achieving wider objectives of nature protection. The wider benefits for microclimate and cooling, and its public health contribution provide further arguments for green infrastructure projects, including financing protected areas. Finally, international organisations can support action at different levels by fostering knowledge exchange about emerging practices in Europe and globally, and by providing practical information about climate change scenarios and the associated impacts of heat waves on human health.

From a perspective of urban resilience to climate change, greening strategies can be an important tool to mitigate the adverse impacts of climate change. Solutions can be tailored to the local context and the needs of citizens. These solutions often provide several benefits in the areas of public health, but also wider associated benefits, for example, with biodiversity.

4 Noise Mitigation

4.1 Noise as the second-worst environmental challenge in Europe

Exposure to excessive noise is considered the second-worst environmental cause of ill health after ultra-fine particulate matter ($PM_{2.5}$) pollution (WHO, 2011). Environmental noise is present in urban areas and natural environments and is caused, in particular, by transportation and industrial activity. At the European level, the largest cause of noise comes from road traffic. The World Health Organisation estimates that 40% of the population in EU countries is exposed to road traffic noise at levels exceeding 55 dBA[2]; 20% is exposed to levels exceeding 65 dBA during the daytime and more than 30% is exposed to levels exceeding 55 dBA at night.

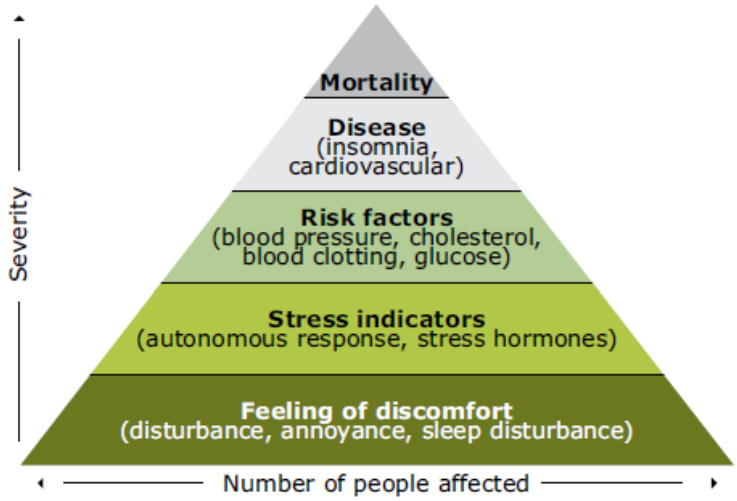
There is evidence of a wide range of auditory and non-auditory consequences of noise. Auditory consequences mainly include hearing impairment and tinnitus. The main non-auditory effects are annoyance, sleep disturbance, stress, hypertension and cardiovascular diseases, and impaired cognitive development of children. This section will look at the evidence of health impacts from environmental noise. Moreover, it will explore the evidence on how green infrastructure can reduce noise exposure and annoyance. We also describe the scale of these benefits, in terms of the number of people and incidences of impacts. Where possible, avoided public health and personal costs are also described.

Health impacts of noise exposure

Evidence of the health impacts of environmental noise exposure is increasing. Epidemiological studies have shown that noise can cause both **auditory effects** such as hearing loss and tinnitus, and multiple non-auditory health effects, such as annoyance and sleep disturbance, increase in the occurrence of hypertension cases and cardiovascular diseases, and the impairment of schoolchildren's cognitive development. Studies on health effects of noise exposure first concentrated on occupational noise and its consequences on hearing loss. Research focus then expanded to included social noise (social activity, music playing) and environmental noise (road, rail and air traffic, urban noise, and industrial construction) and to a wider range of non-auditory effects (Basner et al., 2014). Non-auditory effects are mediated by psychological and psychophysiological processes, and in particular, stress. The pyramid below is a common way of presenting the chain of effects caused by noise exposure.

[2] A-weighted decibels (dBA) are an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted system, the decibel values of sounds at low frequencies are reduced, compared with unweighted decibels, in which no correction is made for audio frequency.

Figure 4.1: Pyramid of noise effects



Source: EEA (2014a), Noise in Europe. Pyramid by Babisch (2002) based on WHO (1972)

Hearing loss can be caused by a one-time intense noise event or long-term exposure with sound pressure levels higher than 75–85 dBA, e.g. in industrial settings (Basner et al., 2014). Noise-induced hearing loss comes from the loss of auditory sensory cells in the cochlea, which cannot regenerate (Basner et al., 2014). Tinnitus can be defined as the sensation of sound in the absence of an external sound source (WHO, 2011). It comes from chronic exposure to high level noise exposure and negatively affects daily life by causing sleep disturbance, reducing attention, and sometimes resulting in depression.

Annoyance is the predominant response to environmental noise exposure as it interferes with daily activities, rest and sleep, and can lead to increased stress, feelings of discomfort, or anger (Basner et al., 2014). EEA estimates that twenty million adults are annoyed by environmental noise in Europe and eight million suffer from sleep disturbance (EEA, 2014a).

Sleep disturbance is one of the most serious effects caused by noise. Sound pressure levels of 33 dBA can provoke physiological reactions during sleep including cortical arousals, body movements, and awakenings. Repeated noise-induced arousals reduces sleep quality by disturbing sleep structure (delayed sleep or early awakenings), and increasing time spent awake and in superficial sleep stages (Basner et al., 2014). Lack of sleep (less than 6 hours per night) is generally associated with obesity, diabetes, hypertension and cardiovascular diseases (Münzel and al. 2014). Sleep disturbance can also increase daytime sleepiness, reduce cognitive performance, well-being and cardiovascular functions the following day (Griefahn et al., 2006 and 2008; Elmenhorst et al., 2010 cited in Münzel et al., 2014).

Münzel et al. (2014) reviewed existing literature on **cardiovascular impacts** of environmental noise exposure. Studies reviewed provide evidence that environmental noise increases stress hormone levels (fight-flight reactions, secretion of catecholamine, increased cortisol levels). Stress reactions in turn result in physiological reactions such as increased blood pressure, heart rate and cardiac output, which disturb sleep structure, and reduce its quality by inducing more rapid eye movements and more time spent in superficial sleep

stage (Basner et al., 2010 and 2011 cited in Muntzel and al. 2014). Long-term exposure to noise – and in particular nocturnal noise – may in turn develop into more permanent clinical symptoms such as hypertension, cardiovascular diseases (myocardial infarction and strokes). Although physiological reactions decrease after several nights (Basner et al., 2011 cited in Muntzel and al. 2014), habituation is not complete, even after several years of exposure.

Road traffic has been associated to **hypertension, myocardial infarction, coronary heart disease and stroke** by different cases (Babisch et al., 1994 and 2005, cited in Münzel et al., 2014) and cohort studies (Gan et al., 2012; Sørensen et al., 2012 cited in Münzel et al., 2014). Münzel et al., (2014) consider that this data indicates that exposure to noise levels of 55 to 60 dBA, which affects a large proportion of the population, may be associated with cardiovascular diseases. Similar studies have been conducted for aircraft noise. A study near Heathrow in London also provided evidence that high levels of aircraft noise were associated with increased risks of stroke, coronary heart disease, and cardiovascular disease, in terms of both hospital admissions and mortality (Hansell et al., 2013). Another recent study found a significant association between night-time aircraft noise and heart disease and stroke for people who had been exposed for twenty years or more (Floud, Blangiardo, Clark et al., 2013).

Studies have also reported **other health impacts** from road traffic such as increased risks of diabetes (Sørensen et al., 2013). The study found that a 10dB higher level of average road traffic noise at diagnosis and during the 5 years preceding diagnosis was associated with an increased risk of incident diabetes, with incidence rate ratios (IRR) of 1.08 (95% CI: 1.02, 1.14) and 1.11 (95% CI: 1.05, 1.18), respectively.

Other studies have demonstrated the link between noise exposure, especially during the night, and medication intake. A cohort study conducted in Marseille in France showed that night-time exposure to noise levels greater than 55 dBA leads to a small but significant increase in the purchase of higher numbers of anxiolytics–hypnotics (Bocquier et al., 2013).

Many studies have demonstrated the negative impact of noise on **children's learning performance and cognitive development**. There is growing evidence of impaired reading abilities, memory, learning of written material, and problem solving because of disturbance in listening and understanding, attention deficit, annoyance, or indirect effects of sleep disturbance (Hygge, 2011). Several studies have observed in particular the impacts of chronic aircraft and road traffic noise on schoolchildren. Hygge at al. (2002) conducted an experiment on children exposed to aircraft noise before the opening of the new Munich International Airport and the termination of the old airport. The study showed that in the group close to the new airport, long-term memory, reading and speech perception were impaired. After the closure of the old airport, short-term memory improved in the group of children studying nearby. Stansfeld et al. (2005) conducted a cross-national study on children's groups exposed to aircraft and road traffic noise. Exposure to aircraft noise was associated with reading impairment and loss of recognition memory. Exposure to road traffic noise resulted in increased episodic memory and annoyance. However, sustained attention, self-reported health, or overall mental health aspects were not affected. A recent study assessed the influence of typical ambient noise in residential areas to which children

are exposed to at home and at school (Pujol et al., 2014). Exposure to ambient noise was found to have a negative impact on children's score in French and mathematics tests.

The burden of disease and economic cost of environmental noise is high in Europe. In 2011, the WHO estimated the burden of disease of environmental noise in Europe, expressed in disability-adjusted life-years (DALYs). The WHO estimated that at least one million healthy life years are lost every year from traffic-related noise. According the report, DALYs lost from environmental noise are 61,000 years for ischaemic heart disease, 45,000 years for cognitive impairment of children, 903,000 years for sleep disturbance, 22,000 years for tinnitus and 587,000 years for annoyance in the European Union member states and other western European countries (WHO 2011).

In addition, the European Environmental Agency (EEA) estimates that environmental noise causes at least 10000 cases of premature deaths and 43000 hospital admissions in Europe each year (EEA, 2014a). In its report on the implementation of the Environmental Noise Directive in 2011, the European Commission estimated that the social cost of rail and road traffic noise in the EU amounted to €40 billion per year.

A study in the UK, estimated that daytime noise levels of ≥55 dB cause an additional 542 cases of hypertension-related myocardial infarction, 788 cases of stroke, and 1,169 cases of dementia per year. The cost of these additional cases was valued at around GBP1.09 billion, with dementia accounting for 44% (Harding et al., 2013). Few studies have quantified avoidable deaths and morbidity from environmental noise. A study in Madrid estimated that a reduction of equivalent diurnal noise levels of 1 dBA would result in 284 avoided annual deaths due to cardiovascular causes in the over-65 age group.

Access to quiet urban areas decreases annoyance and supports health. A lot of research has been conducted on the benefits of a quiet side - quite façades or quiet courtyard - in urban dwellings — for noise annoyance and adverse health effects. These studies are important with regard to the use of green infrastructure – especially green walls and green roofs – in cities.

There exist numerous studies on the effects of having a quiet side or façade on noise annoyance, sleep disturbance and concentration problems (Bodin et al., 2015; Kluizenaar et al., 2013; Van Renterghem and Botteldooren, 2012a; Kluizenaar et al., 2011; Gidlöf-Gunnarsson and Öhrström, 2010, Öhrström et al., 2006). All these studies conducted surveys on inhabitants that had or did not have a quite side where they lived. All studies concluded that access to a quite side was associated with less noise annoyance. Boding et al. (2015) found evidence of decreased concentration problems in the surveyed population who has a window facing a yard, water or a green space. According to Van Renterghem and Botteldooren (2012a), having a bedroom located at the quiet side leads to a greater decrease in noise annoyance and reduces noise-induced sleep disturbances.

Öhrström et al. (2006) collected information from 956 people via questionnaires. The study concluded that having a quiet side of one's dwelling reduces disturbances by an average of 30–50% for the various critical effects, and corresponds to a reduction in sound levels of 5 dB at the most-exposed side.

Gidlöf-Gunnarsson and Öhrström (2010) however mention that access to quietness only partly compensates the exposure to high noise levels. In their study, 16% and 29% of the surveyed population were still annoyed at 58–62 and 63–68 dB, respectively. In addition, Kluizenaar et al. (2013) indicated that despite low noise levels at the quiet façade, adverse effects from noise were still to be expected if noise levels at the noisy façade are high.

4.2 Benefits of nature protection and biodiversity to noise reduction and public health

Natural areas and noise reduction

There are two main ways of reducing noise pollution: reduction at source, through adaptation of e.g. vehicles, tyres, road surface, and traffic management measures; and noise abatement by anti-propagation measures, such as increasing the distance between the source and receiver, building noise barriers, or insulating buildings. Reduction at source is usually considered the most cost-effective approach. However, anti-propagation measures can be a useful complement to measures taken at source.

The use of vegetation can participate to hampering noise propagation by absorbing or diffracting noise. There is also evidence that the presence of vegetation influences noise perception, regardless of its real effectiveness in reducing noise.

Vegetation can reduce sound levels through two direct processes; redistribution and absorption of sound energy. Only absorption leads to effective transfer of energy into heat. Redistribution occurs through reflection, diffraction and scattering of sound when encountering trunks, branches and foliage and can achieve noise reduction at a single receiver (Van Renterghem, 2015). Vegetation also has several indirect effects on sound levels, the main one being the 'acoustical ground effect', which is the 'phenomenon by which sound reflected from the ground and travelling to a receiver along the reflection path either reinforces or cancels sound that arrives at the receiver directly' (Hosanna, 2013). Vegetation makes the soil porous and acoustically soft, which decreases especially low-frequency noise (Van Renterghem, 2013).

The presence of vegetation reduces annoyance

Several surveys carried out in Italian urban parks have shown that non-acoustical parameters significantly influenced the perception of the sound environment. In Milan, a survey carried out in five urban parks with 231 interviewees (Brambilla et al., 2013), showed that users rated quality of quietness worse than the quality of the soundscape. The results indicate that the notion of soundscape is broader than the notion of quietness and includes parameters such as visual aspects (e.g. the design of the park and presence of vegetation).

Gidlof-Gunnarsson and Öhrström (2007) conducted a questionnaire study in urban residential neighbourhoods with high road-traffic noise exposure in Sweden to examine whether the presence of green areas affects noise perception. The study was conducted among two test groups; a group of residents living in dwellings with access to a quiet side, and a group with no access to a quiet side. For both groups, the presence of green areas

reduced long-term noise annoyances and the prevalence of stress-related psychosocial symptoms.

A survey carried out in Grenoble, France, showed that vegetation in a city square influences the perception and evaluation of noise levels in the urban environment (Marry and Delabarre, 2011). Twenty-nine people were surveyed about three different city squares during two different seasons, and the results showed that participants frequently mentioned the impact of vegetation on reducing noise levels. When asked to rank the positive and negative features of a city square's sound environment, participants ranked nature first in the positive elements. Similarly, when participants were asked to describe the ideal and the worst sound environments for a city square, the most frequent features of the ideal sound environment were natural sounds and vegetation, and the absence of vegetation was the most frequent feature of the worst sound environment.

Natural sounds influence noise perception

The improvement of soundscape quality in the urban environment is an alternative approach to noise reduction. Soundscape research is a multidisciplinary field involving not only acoustics, physical science and engineering, but also psychology, sociology, architecture, anthropology and medicine, which considers the perception of the acoustic environment in context, as well as the relations between the person, their location and the sound environment.

De Coensel et al. (2011) conducted a listening study in which binaural recordings of different types of road traffic noise are combined with the sound of a fountain and of birds at different sound levels. Participants were asked to assess the loudness of the road traffic and the pleasantness of the sound environment. Results showed that adding fountain sounds to soundscapes dominated by road traffic noise reduced the perceived loudness of road traffic noise only if traffic noise has low temporal variability (highway and major road traffic noise). Adding bird sounds made the soundscape significantly more pleasant for participants in almost all investigated conditions, although it was found to reduce the loudness of traffic noise only in the case of highway noise. As a result, soundscape quality is not only influenced by the loudness of unwanted sound but also to the meaning association with different sounds.

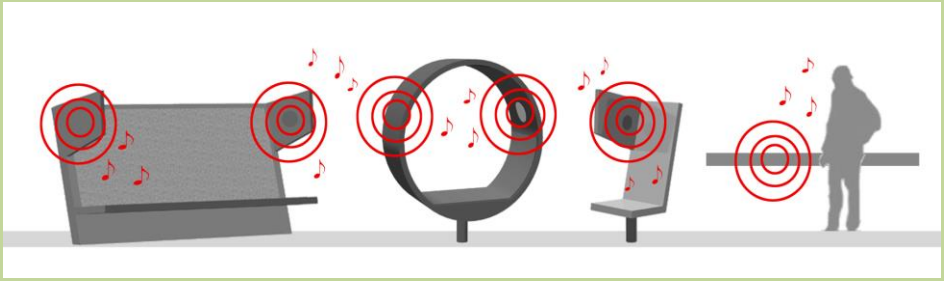
Several other studies demonstrated the potential of water sounds to reduce traffic noise annoyance, provided that the level of the water sounds is similar or not less than 3 dB below the level of the traffic noises (Jeon et al., 2010, Nilsson et al., 2010; Galbrun and Ali, 2013).

Using natural sound to improve the sound environment has already been applied in practice in several cities as a complement to the construction of sound barriers.

Nauener Platz Soundscape, Berlin, Germany

The remodelling of the Nauener Platz in Berlin won the European Soundscape award in 2012. The prize is awarded to projects that provide an innovative solution to noise problems in cities.

Nauener Platz Park is situated between roads, which made it unpleasant for residents. The park was therefore reconstructed by urban planners and acousticians to improve its soundscape and increase its attractiveness for inhabitants. Residents were consulted on the areas they believed were the noisiest and on the best ways to improve the atmosphere of the park. A 1.5-meter high gabion wall was constructed achieving a traffic noise reduction of 6 dB in the playground. In addition, 'audio islands'; benches playing birdsong and water sounds; were installed throughout the park to mask the noise of the traffic. Positive effects were noticed immediately; more families come to the park and kindergarten classes come to play in the morning. Even though traffic is still the dominant noise source, surveyed users report that the general soundscape has improved by the addition of natural sounds and the increase of human sounds due to increased frequentation.



Sound devices, Barbara Willecke

Table 4.1: Causal links, hypothesis, measures and evidence – an overview

What Environmental and health pressures could biodiversity help address and what indicators are useful?	**What specific benefits could in principle (and actually) be measured?** What quantitative indicators are used?	**What benefits can be measured in monetary terms?**	**Who are the main beneficiaries of biodiversity measures?**	**What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?**
Reduction of noise exposure leading to a reduction of related hearing impairment, annoyance and sleep disturbance, and in turn to a reduction of related cardiovascular diseases, hypertension cases, cognitive impairment, diabetes, and mental health problems.	▪ Reduced annoyance ▪ Avoided premature deaths; cardiovascular events, DALYs ▪ Avoided hospitalisation and medical treatment ▪ Avoided loss of productivity, lost working days	▪ Avoided hospitalisation costs ▪ Avoided loss of output	▪ Urban and peri-urban populations in general ▪ Populations living close to major noise sources – airport, highway, railway ▪ Populations living in areas with a low share of green space ▪ Children, persons with predisposition to certain diseases (e.g. cardiovascular disease), persons subjected to high levels of stress	▪ City green infrastructure (green walls, ro parks and green belts) has a significant r in noise reduction in urban areas. ▪ Natura 2000 network contributes to the development of quiet areas as per Environmental Noise Directive
Vegetation can improve soundscape by: ▪ **Reducing noise exposure through absorption and redistribution** ▪ **Reducing annoyance via psychological effect of nature on noise perception** **Indicators:** ▪ **Noise exposure level (dB)** ▪ **Perceived annoyance**	Specific benefits - examples: ▪ Environmental noise causes at least 10,000 cases of premature death each year (EEA, 2014a) ▪ Noise causes 43,000 hospital admissions in Europe per year (EEA, 2014a) ▪ In the UK, daytime noise levels of ≥55 dB have been estimated to cause an additional 542 cases of hypertension-related myocardial infarction, 788 cases of stroke, and 1,169 cases of dementia (Harding et al., 2013)	Monetary benefits – examples: ▪ In the UK, additional hypertension-related myocardial infarction, strokes, and cases of dementia have been estimated to cost around GBP1.09 billion annually. (Harding et al., 2013)	▪ In Madrid, a reduction of equivalent diurnal noise levels (LeqD) of 1 dBA would result in 284 avoided annual deaths due to cardiovascular causes in the over-65 age group	Green infrastructures: ▪ Green roadside façades: 2-3dB ▪ Green wall inside courtyards: 4 dB ▪ Green roofs: 7.5 dB for ridge roofs and 3dB for flat roofs ▪ Low-height barriers near tramway: 10-15 dB for receivers up to 40 meters from the barrier at 1.5 meters high ▪ Vegetated barriers on bridges: 4 dB for motorway; 10dB for tramway ▪ Tree belts: up to 6 dBA at a distance of 50 m for a 15 meter deep tree belt; up to 10 dBA for a 30 meter deep belt ▪ Trees behind noise barriers: Up to 5 dBA at a distance of 100 m in strong downwind near highways ▪ Effect of forest ground: 3 dBA

What insights are there on Natura 2000 sites providing benefits and to whom?

The Environmental Noise Directive[3] (2002) intends to preserve quiet areas in agglomerations and in open country. The definitions of 'quiet area' are relatively vague and leave important discretion to competent authorities to define them. A quiet area in an agglomeration is 'an area, delimited by the competent authority, for instance which is not exposed to a value of L_{den} (sound level during the day, evening and night) or of another appropriate noise indicator, greater than a certain value set by the Member State, from any noise source'. A quiet area in open country is an area, delimited by the competent authority, that is undisturbed by noise from traffic, industry or recreational activities' (END, art. 3). The Natura 2000 network can contribute to the development of quiet areas as per the Environmental Noise Directive, as the conservation of certain species requires low levels of noise pollution. Reviews of the implementation of the Environmental Noise Directive in Member States and in particular of the determination of quiet areas, have identified overlaps with natural protected areas in several countries (Germany, the Netherlands, Romania, Slovenia) (Milieu, RPA, TNO, 2010).

What insights are there on GI providing benefits – what type of GI provides what type of benefits and to whom?

Conclusions of scientific papers disagree on the effectiveness of tree belts. Recent numerical research has however brought a new perspective on the issue. Numerical work done by the University of Gent has demonstrated that narrow belts can be relatively effective for reducing road traffic if they are well-designed (Van Renterghem et al., 2012). In general, trunks and forest floor are responsible for the largest noise reduction, which call for a high density of trees when designing tree belts (Van Renterghem, 2013). Studies have shown that there is a linear relationship between noise shielding and the depth of the tree belt (Van Renterghem, 2013). However, tree density is limited by the necessity of preserving access to water, nutrients and light. The choice of a specific planting scheme, tree ordering and spacing, as well as trunk diameter, can also influence sound reduction. In particular, dense rectangular planting schemes with the smallest spacing along the road length axis improves noise shielding, while relaxing the need for high biomass density. On the contrary, trunk height does not influence noise reduction (Van Renterghem, 2013).

A 15-meter deep tree belt can achieve a reduction up to 6 dBA at a distance of 50 m, and a 30 meter deep belt up to 10 dBA (Hosanna, 2013).

[3] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise

Tree belt along the ring road of Thessaloniki

Researchers in Thessaloniki (Samara and Tsitsoni, 2007) measured road traffic noise along the ring road of the city at two locations for two months; one through a belt of trees and the other above grass-covered ground. The number of vehicles per minute, the type of vehicles and type of vegetation in both areas were included in the analysis as control values. The results showed significant noise reduction through the belt of trees rather than above grass-covered ground. The largest reduction (6dB) was observed in areas with that had been reforested with Pinus brutia.

Vegetation is frequently used in combination with noise barriers for its visual effect. Vegetation improves the integration of the noise barrier into the environment improves its visual aspect and breaks the monotony of the barrier. However, planting vegetation along a noise barrier can also have acoustic effects. Trees can improve the effectiveness of traditional noise walls along roads by acting as windbreaks. Refraction of sound by wind behind a noise barrier has negative effects for downwind receivers. A field experiment (van Renterghem et al., 2002) demonstrated that placing a row of trees behind a noise wall decreases the effect of the wind behind the barrier because the canopy of trees provides wind shelter. Noise reduction can reach 5 dBA at a distance of 100 m in strong down winds near highways (Hosanna, 2013).

Planting vegetation along the top edge of the noise barrier can also significantly improve the acoustic performance of the barrier at a short distance behind the wall (Hosanna Toolbox, 2014). For a pedestrian or cyclist moving one meter behind the barrier, the noise reduction due to a one-meter wide barrier is 8–12 dB, compared with an uncapped barrier of the same overall height. Vegetation planted at the foot of the barrier, such as grass and bushes, softens the soil and increases the ground effect (Danish Road Institute, 2010). Vegetation planted between the road and the barrier also disperses the noise both before and after reflection from the noise barrier.

In several cities in Germany, green spaces are integrated into noise protection measures with the construction of cut-and-cover motorway tunnels. In this case, nature is not meant to enhance noise reduction but to integrate the tunnel into the landscape and serve other purposes such as recreation, construction of houses, or the development of non-polluting transport.

The Hamburger Deckel – Greening the highway in Hamburg, Germany

The A7 highway going through the city centre of Hamburg is one of the longest and busiest highways in Germany. As the traffic increased, noise levels in the area began to deviate from the national noise standards. The city had to find remediation measures to keep noise volumes down for inhabitants. The solution consists of covering three sections of the highway by tunnels and creating a variety of accessible green spaces (open meadows, parks, community gardens, bike paths, recreational areas) on top, which will be embedded into the green network of the city. Besides cutting highway noise, the project will reconnect neighbourhoods previously separated by the highway and fits into the city's ambition to increase non-polluting modes of transports. The construction of 2000 new homes is also projected around the park area. The project will start in 2015 and be completed in 2022.

Photo: Hamburger Deckel – anticipated Stellingen section
Source: City of Hamburg (2012)

An earth berm can be an effective alternative to a noise barrier, although they require more space alongside the road. If they are the same height, a soft berm with limited slope angles, can achieve similar noise reduction as a noise wall (Hosanna Toolbox, 2014). Earth berms can also be planted, which increases their absorption capacity. In addition, earth berms are less affected than noise walls by downwind effects, and can therefore be preferred to noise walls in certain locations (Van Renterghem and Botteldooren, 2012b). The shape of the berm can influence noise screening; in particular, studies have found that asymmetric berms with non-flat surfaces (for instance staircase shaped berms) resulted in a greater noise reduction than smooth trapezoidal berms. On a flat rural floor, stepped earth berms can reduce noise by 4 dBA compared with a conventional 4m high berm (Hosanna, 2013).

Parc des Hautes Bruyères, Paris, France

A former industrial zone in Villejuif (southern suburb of Paris) was converted into a 23 hectare park. The park is a buffer area located between a highway and a residential area – the park is 600 meter wide at its largest point. In particular, a large earth berm (60 meter wide) along the highway acts as a noise barrier. The noise level in the park is consequently 20dB lower than at the highway. A quiet area, the so called silent garden ('jardin de silence') – with the shape of an amphitheatre – has also been created in the park at 12 m below the ground level, to promote recreation and rest. In this area, noise levels are 20dB lower than in the rest of the park. Thanks to the park and the earth berm, inhabitants located at the east of the park are exposed to noise level below 55dB.

The Hosanna project studied the use of low-height (1 meter high) absorbing barriers in urban environments, especially in street canyons and along tram or rail tracks. The project demonstrated that low-height barriers can protect pedestrians, cyclists, and nearby

residents from noise, if the barriers are well designed and located near the sound source (Hosanna, 2013).

As part of the Hosanna research project, the effects of a low vegetated noise barrier were tested in a field questionnaire study carried out in 2011 (Rådsten-Ekman et al., 2011). A 14x0.4x1 meter noise barrier was built in central Lyon, France, to protect a busy street from road traffic noise. The barrier was made of a metallic structure, filled with a substrate on which forty plants per square meter were grown on both sides. The effects of the barrier were evaluated by acoustic measurement before and after the barrier was built and by a questionnaire filled out by 349 pedestrians in which they were asked to evaluate the sound environment behind and at the side of the barrier. Field measurements concluded that the barrier decreased the sound pressure from 67 to 62 dB at sitting height (1.2 m), 3.5 m from the roadside. Questionnaire responses showed that the barrier improved the overall quality of the soundscape – rated slightly calmer and slightly more pleasant by respondent – and reduced road-traffic annoyance. However, most of the respondents still perceived the sound environment as annoying.

Similar experiments have been conducted for low-height barriers near tramway lines. 1 meter high by 0.4 meter wide vegetative barriers placed close to two-track tramway lines achieved a noise reduction of 10-15 dB for receivers located up to 40 meters from the barrier at 1.5 meters high.

As part of the project, experiments also tested the effects of vegetative barriers in reducing the noise from traffic travelling over bridges. One meter high vegetative barriers were found to reduce noise levels in neighbouring areas by up to 4 dBA in the case of a four-lane motorway, and by up to 10 dBA for a two-track tramway (Hosanna, 2013). Another interesting example of low-height vegetative barriers as sound barriers is the Buitenschot Park, near Schiphol airport.

Buitenschot, near Schiphol airport, Netherlands

Schiphol is the largest airport in the Netherlands and the fourth busiest airport in Europe. Runway 18R-36L; originally created to reduce noise levels by redirecting traffic over lower densely populated areas; led in turn to high ground noise levels in surrounding urban areas such as Hoofddorp. After years of protests from Hoofddorp Noord residents, Schiphol Group committed to reduce ground noise levels by 10dB. The solution came from the realisation that ridges and furrows created by ploughing in the surrounding areas could reduce ground noise levels. This natural process was exploited in the creation of Buitenschot, a 33 hectares park located between Runway 18R-36L and Hoofddorp. The park is composed of a series of 3 meters high ridge structures, with an interval of 11 meters, and a second series of ridges rotated at 18° compared to ridges built parallel to the polder. The ridges absorb and diffract noise that breaks down in the interval between them. The intervention by the artist Paul de Kort in the design facilitated the integration of noise reduction, art and leisure. The park was conceived as an attractive location for recreation, with walking and cycling paths. The park opened in October 2013.

Photo: Buitenschot, Image © H + N + S
Source: Bull, G. (2014)

The presence of acoustically rigid materials in urban environments leads to a significant amplification of road traffic noise, which is even higher in narrow streets (Van Renterghem et al., 2015). Vegetation in built-up areas can reduce sound levels through (1) sound absorption and (2) sound diffusion when a sound wave encounters the vegetation and by (3) sound transmission when a sound wave is passes through the vegetation (Hosanna Toolbox, 2014). Vegetation and soil substrate in particular increase absorption and sound diffusion in urban areas.

Trees along the road can contribute to the scattering of sound by branches, twigs, and leaves in tree canopies (Hosanna, 2013). Noise reduction coming from trees in street canyons has been estimated to be relatively small, around 2dB (Hosanna, 2013).

Noise reduction in Alverna, Netherlands

The N324 is a busy main road that connects the city of Nijmegen with villages and towns in the south of the Netherlands. It runs through the village of Alverna and causes noise disturbance for its residents. In order to reduce noise levels, a project was developed to restructure the road and to reduce noise levels. The project took a very extensive interactive approach that involved different stakeholders such as residents, businesses, local and provincial government and the local university. Moreover, the project was funded by local, regional, national, and European funding.

The project resulted in a sustainable solution for noise reduction and the creation of a pleasant and green environment due to the reduction of traffic lanes, a partly sunken road, low-level sound barriers, the use of 'quiet' asphalt, and a reduction in the maximum speed limit in Alverna. The project aims to reduce noise levels by 10dB due to the implemented measures.

Source: Historic, sustainable solution for traffic noise reduction in Alverna

Several studies have shown that noise reduction from green façades falls between 2-3 dB. According to Wong et al. (2010), green walls reduce street noise by 2.5 dB to 3dB and decrease internal reverberation between facades on each side of the street. Studies conducted has part of the Hosanna project found similar results: 'considering a single street with 19m-high facades on both sides and assuming non-vegetated facades with a broadband absorption coefficient of 0.1, placing green wall on all façades may yield noise reduction of 2–3 dB at a height of 1.5–4m' (Hosanna Toolbox, 2014). Similar reduction has been found in the case of a green wall in an urban square (3 dBA with vegetation covering all facades in the square and the adjoining street) (Hosanna, 2013). In courtyards however, noise reduction has been estimated to be slightly larger. An average noise reduction of 4 dB can be achieved by covering all courtyard façades by green walls (Hosanna Toolbox, 2014).

Noise reduction by green walls is affected by the width of the gap between them and the type of vegetation and substrate used. The noise absorption effect is more efficient in narrower spaces, and is more effective for mid to high frequencies.

Recently, Azkorra et al. (2014) have demonstrated that green walls can have a great potential as sound insulation tools for building. Their laboratory tests have shown a sound reduction index of 15 decibels which could even be improved with better design. The study also confirms that green walls provide good absorption capacities, similar or better than other building material.

Green sound barrier in Lyon, France

Quai de Saône in Lyon is an embankment that is located between the river Saône and a road. In order to reduce the noise coming from the road traffic, a 1-meter high green noise barrier was built. A study investigated the reduction in noise levels after the construction of the plant barrier. A reduction of 67 to 62 dB was found at sitting height. Moreover, noise acceptability was tested through the use of questionnaires. The responses of this questionnaire showed a reduction in traffic-related noise annoyance. Respondents said that the environment became slightly calmer and more pleasant.

Source: Rådsten-Ekman et al., 2011

Verde –Turin

An apartment complex in Turin was created by the architect Luciano Pia, which involved the development of a green architecture with trees, shrubs, green walls and green roofs. The aim of the new apartment complex was to improve the visual aspect of the building and to enhance environmental factors. For example, the greenery produces 150,000 litres of oxygen per hour and absorbs 200,000 litres of carbon dioxide per hour after sunset. Another benefit from the greenery is the reduction in noise levels.

Source: Wolpow, 2015

Green roofs are particularly efficient at enhancing quietness at indirectly exposed sides. Numerical work (Van Renterghem and Botteldooren 2008; 2009), followed by in-situ (Van Renterghem and Botteldooren, 2011) and laboratory measurements (Yang et al., 2012) demonstrated the potential of green roofs in reducing the intensity of sound waves over buildings, due in particular to the porous substrate they are made of. Green roofs have higher noise reduction potential in street canyons and at indirectly exposed façades.

Noise reduction is highly influenced by the shape of the roof. A 10 cm thick vegetated substrate placed on a ridge roof can reduce noise propagation by 7.5 dBA over a courtyard. The same substrate placed on a flat roof will achieve a reduction of traffic noise around 3 dBA (Van Renterghem, 2015). Vegetated low-height barriers along the edge of a flat roof can decrease noise by approximately 1 dBA for a 0.6m high barrier, with an additional 1 dBA if the street width is not larger than 10 meters. If low barriers are placed on both sides of the building, noise can be reduced by an average of 3 dBA (Hosanna, 2013).

Green roofs in Frankfurt Airport, Germany

Frankfurt Airport is the largest in Europe. Since 1990, numerous green roofs have been installed in the airport, including on the two terminal building. The total coverage area is estimated to be around 40,000 square meters. Terminal 1 has the largest green roof of the airport, built in 2005 and measuring 17,000 square meters. Dunnett and Kingsbury (2008) have shown that a 10 cm deep green roof at Frankfurt Airport reduced sound transmission into the buildings by 5 dB.

Photo: ©Fraport AG, Greenroofs (n.a.)

4.3 The role of supporting instruments and governance

EU and national level activities

At EU level, the Environmental Noise Directive of 2002[4] is the main instrument addressing environmental noise pollution control. The Directive requires Member States to establish noise maps of major roads, railways, airports and agglomerations (over 100,000 inhabitants) according to common methods, indicating noise levels (day and night) for each source of noise pollution. It further requires Member States to draw up noise action plans for the same areas to manage noise pollution and take reduction measures, especially in areas where noise can have a harmful effect on human health, and to draft actions plans to preserve quiet areas in agglomerations and in open countryside. The Directive does not set noise limit values and leaves it to the discretion of Member States to define noise management measures and quiet areas.

Anti-propagation measures were taken in all actions plans. These measures are predominant in action plans for major roads, and to some extent for major railways, but less in other areas. In agglomerations, measures proposed in action plans were mostly related to land use and urban planning, followed by traffic management measures. Most plans also include measures related to insulation and sound transmission reduction such as the construction of acoustic barriers, however not necessarily using vegetation. In airports, operational measures were mostly taken (EEA, 2014a). A general assessment at EU level of the use of nature and green infrastructure in noise action plans has not been conducted.

The large margin left to Member States in the designation of quiet areas has led to divergent approaches (European Commission, 2011). Although the main criterion in the designation of quiet areas is the L_{den} level (average sound levels at day, evening and night), a

[4] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise

few Member States (Belgium, Denmark, UK, Ireland, Luxembourg, Germany) have given priority to green spaces and/or to spaces that are open and have value to the community. In these cases, noise policy is integrated into local land use policies and contributes to green infrastructure maintenance.

Noise planning policy in England

In March 2012, the UK Government revised its national planning policy on noise as part of the National Planning Policy Framework (NPPF). The Framework elucidates how planning should prevent the natural environment from being affected by unacceptably high levels of noise. The NPPF also introduced a new Local Green Space designation process, which can be used to protect green areas on several grounds, including tranquillity. The designation of quiet areas under the Environmental Noise Directive is linked to the Local Green Space designation. Only areas designated as Local Green Space with tranquillity as a factor in their designation, are eligible to become quiet areas, as these areas have already been demonstrated as being important to their local communities. Only a small number can be designated as quiet areas; outstanding areas or those particularly valued by local communities for their quietness and whose benefits extend beyond their immediate locality.

Source: DEFRA, 2014

In Denmark, quiet areas are designated by municipalities, within local plans. If L_{den} is the main criteria, quiet areas should also be accessible to the public (Milieu, RPA, TNO, 2011). In Dublin, the city council has designated eight quiet areas, because of both sound levels and the value these areas have to the local community. In Luxembourg, the designation of quiet areas under the END is linked to the Sectoral Landscape Plan (Plan Sectoriel Paysage (PSP)), which aims to preserve and develop Luxembourg landscapes in the context of the European Convention on landscape (Milieu, RPA, TNO, 2011).

Local action and investment

Besides noise action plans, cities can promote noise reduction through infrastructure development and rehabilitation. Urban development and renewal can provide opportunities to integrate noise reduction measures or measures improving the soundscape of an area. For instance, the 'Parc des Hautes Bruyères' (see box) has been built on a former industrial area.

Cities can also incentivise individuals to invest in green infrastructures. A large number of cities provide subsidies for the construction of green roofs; among them are Brussels, Basel, Stuttgart, Lausanne, The Hague, Ghent, Amsterdam, Rotterdam, Linz, London and Dusseldorf.

Infrastructure managers

The Environmental Noise Directive requires Member States to draw up noise maps and noise action plans for major roads, railways and airports. Infrastructure managers have a key role in the development of and investment in noise protection infrastructure. For instance, the Buitenschot Park represented an investment of €3 million from Schiphol Group and Stichting Mainport en Groen, a foundation that invests in green and recreational facilities around Schiphol airport.

Citizen involvement

The involvement of inhabitants is crucial in the development of noise reduction measures. As indicated before, perception of noise can diverge from the level of exposure. When remodelling Nauener Platz park in Berlin, local residents were asked which areas they found the most noisy and annoying and 'sound walks' with inhabitants were organised to ensure that the noisiest areas were identified and that solutions would be designed for these areas.

4.4 Conclusions and recommendations

Recent research has demonstrated that nature and green infrastructure has the potential of reducing noise levels. Vegetation along roads can increase the effectiveness of traditional noise barriers and enhance their integration in the landscape. In urban environments, low barriers close to the noise source, green walls and green roofs, have proven to reduce exposure for nearby residents and pedestrians. Surveys have also shown that nature has a significant influence on noise perception and can reduce inhabitants' noise-related annoyance. Although the use of vegetation cannot replace anti-noise measures taken at source, urban planning and traffic management measures, the many impacts of vegetation on noise, air pollution, temperature, and wellbeing makes it an interesting tool for city councils and urban planners.

The Environmental Noise Directive is the main policy instrument that places obligations on cities for the development of noise reduction measures in hotspots, and the preservation of quiet areas. The vague definition of quiet areas in the Directive has been pointed out as a weakness that has created confusion and led to a divergent interpretation between member States. Although the European Environment Agency calls for the integration of biodiversity issues in the identification of quiet areas (EEA, 2014b), a stronger focus on the noise benefits of biodiversity could be adopted to further promote the preservation of green spaces as quiet areas.

5 Direct Health Benefits

5.1 Introduction

This chapter focusses on the relationship between the presence of green spaces and nature in people's living and working environment and the impacts on their overall health and well-being. It looks at whether promoting such green areas in people's direct living space results in more pleasant and peaceful, as well as less stressful environments.

The goal of the review is not to investigate to what extent the presence of green spaces and nature in people's living and working environments results in health and well-being benefits because of leisure, recreation and sport activities. Moreover, the health benefits due to healthier lifestyles and active participation in nature (e.g. physical activity) are not considered. These are described in Chapter 6 on healthy lifestyles and nature and Chapter 7 on outdoor recreation and physical activity.

The review therefore mainly focuses on people's mental health benefits as a result of nature and green spaces in close proximity to their living environment (without making active use of these green areas). Moreover, the benefit related to the prevention of allergies is considered, as this is also a direct health benefit that does not require people to make active use of green spaces.

5.2 Direct health and well-being benefits in people's living and working environments

This chapter presents the evidence on linking nature protection and biodiversity to the well-being and health of people living and working in green environments. The second part specifically focuses on protected areas and wider green infrastructure.

What are the causal links between people's health and green sites in their direct living and working environments?

The following section sets out the narrative showing the links between the presence of green infrastructure and sites in people's working and living environments and the health benefits experienced by these people. It should be noted, however, that the evidence showing such direct benefits of green spaces and vegetation in people's direct living and working environment is not extensive and a clear consensus has yet to emerge. For example, a systematic review in 2011 found that there is a "weak evidence for the links between physical, mental health and well-being, and urban green space" (Lee et al., 2011).

While public health effects have been linked to green spaces through their purported effects on the level of physical activity of citizens (and therefore positive impacts on chronic diseases such as diabetes, cardiovascular disease and cancer), there is uncertainty about the actual contribution of green spaces in this process. The main reason for this is that establishing a causal relationship is difficult as the links are complex and not easy to

disentangle. Health within an environmental context should therefore be considered as a multifaceted and holistic phenomenon (Morris, 2003).

There are, however, indications that positive correlations exist, which are presented below. The first sub-section addresses the differences in terms of health between people living in urban and rural areas, and discusses in particular planning and infrastructure strategies by local and regional authorities that consider green spaces to be beneficial for the inhabitants of a specific area. Next, the impact of the availability and presence of green spaces is discussed and the effect of their proximity is analysed in further depth. The third section focuses specifically on the mental health benefits that people can experience from having green sites and infrastructures in their direct living and working environment. The last section discusses the impact green areas have on the prevalence of allergies such as hay fever and asthma.

Living in urban or rural areas: what are the differences in terms of health?

Cities make up only two percent of the earth's surface, yet more than half of the world's population lives in cities. In Europe, the percentage of people living in cities is even higher: in 2010, 75% of all Europeans were living in cities and urban areas, and this percentage is expected to rise to 80% by 2020 (European Commission, 2010). While living in urban areas or cities brings many benefits (e.g. more job opportunities and a close proximity to daily activities), other factors such as air pollution and noise can be far more acute in these areas. Green areas in people's living and working environments can have a direct positive effect on their health and wellbeing as well as their overall quality of life.

When looking at populations in rural areas, research shows that these people face different health problems: chronic diseases are more prevalent and people are more likely to be obese and to engage in sedentary behaviours such as physical inactivity and smoking (Mainous et al., 1995; Hartley, 2004). On the other hand, populations living in rural areas are more likely to be surrounded by green spaces, report overall a better quality of life and experience a more favourable work-life balance allowing them to spend more time at home and with the family (Eurofound, 2006).

Several studies have explored the levels of stress recovery in rural versus urban areas. A study by Korpela et al. (2010) showed that in rural areas, extensively managed nature areas such as forests, meadows, and beaches, people experience a quicker stress recovery compared to built-up green spaces such as green areas within housing blocks, tree avenues, and decorative plantations. Furthermore, a literature review of Velarde et al. (2007) studied the landscape and scene types used in environmental psychology studies and their impacts on human health. They found that natural landscapes have a more positive effect on health compared to urban landscapes. Moreover, the greener the urban areas, the more benefits they provided for the health of people, mainly resulting in short-term recovery from stress or mental fatigue. Hartig et al. (2003) also showed that people recover faster from stress in nature settings compared to urban settings, which was measured by looking at the stress levels of participants when they were sitting or walking in different settings.

In conclusion, research suggests that rural areas have a more beneficial impact on the mental health and stress recovery of people compared to urban areas. However, green areas in urban settings can have a positive impact too, as discussed in the following sections.

The general health impacts of the presence and close proximity of green spaces

Various studies have indicated that it is plausible that the presence of green spaces close to people's living environment has a positive impact on their general health. It should however be noted that these studies do not explain the mechanisms by which green space has a positive effect on population health, nor do they demonstrate whether different types of green space have a greater or lesser impact in urban environments. A further concern is that results of population studies may not necessarily transfer into different cultures and countries.

A Dutch study by de Vries et al. (2003) investigated whether people living in greener areas are happier than people living in less green areas. Data on the self-reported health of 17,000 people was analysed and land-use data was linked to estimate the amount of green space in people's living environment (cross-sectional study design). The three health indicators that were used were: number of health problems experienced in the past 14 days; perceived general health measured on a five point scale; and the score on the Dutch version on the General Health Questionnaire. The authors conclude that living in a greener environment was positively related to all three of the available health indicators and the association was somewhat stronger for housewives and older people; two groups that are assumed to be more dependent on, and therefore exposed to, the local environment. Furthermore, for all three health indicators, the relationship with green space was somewhat stronger for lower educated people.

Another Dutch study by Maas et al. (2006) investigated the strength of the relation between the amount of green space in people's living environment and their self-reported general health. More than 250,000 people completed a questionnaire on socio-demographic status, background and perceived health as well as their living environment (urban or rural). Based on the postal code of the participants, the percentage of green space within a one to three kilometre radius was calculated and categorised as agricultural land, natural green (forest, grasslands, etc.) and urban green. The results of the study clearly showed a positive interaction: the percentage of green space inside a one to three kilometre radius had a significant positive effect on people's perceived general health. In areas where 90% of the environment around the home was green, 10.2% of residents reported feeling unhealthy. In areas where 10% of the environment was green, 15.5% of residents reported feeling unhealthy. This relationship was found across all degrees of urbanity and was most apparent among the elderly, children, housewives and people from lower socio-economic groups. In urban areas, the proximity of green space became more important, as further described in the next section.

Another study conducted by the same Dutch researchers (Maas et al., 2009), found that there was not only a relationship between green spaces in people's living environment and their self-perceived health, but also for doctor-assessed diseases. Particularly the presence of green spaces close to people's homes (within 1 km) had an effect on the prevalence of a

number of diseases (both mental and physical health conditions) that are highly prevalent in society. The relation was strongest for people who spend most time around their house (children and people from lower socio-economic groups).

Similar studies in Denmark (Stigsdotter et al., 2010; Nielsen et al., 2007) showed that Danes living more than 1 km away from the nearest green space report poorer health and health-related quality of life, and experience more stress than people living closer to a green space. The study showed that greater distance from home to green spaces was a better predictor of higher stress levels for all groups and obesity in younger respondents (aged 25 or below) than reported use of green spaces. The researchers argue that there is clear relationship between the distance to a green space and the amount of use. Having access to a private garden or green area near the home was also associated with reduced levels of stress and obesity.

United Kingdom: Study East London, UK (2006)

A qualitative study was conducted to examine how open public spaces (such as parks) are experienced by people and what their impact is on overall well-being. Many people felt that public spaces enhanced their well-being and that the spaces provide a range of therapeutic functions. For example, people indicated that they could unwind in green spaces, that they enjoy observing others there or go there to seek solitude. Moreover, people were positive about the presence of water (e.g. in the park or near a footpath) as it provided opportunities for reflection or allowed them to escape the pressures of domestic life.

Source: Dines et al., 2006

The Dutch studies mentioned above (Maas et al., 2006; 2009; de Vries et al., 2003) are based on cross-sectional data from large samples, which leaves the possibility open that the findings may be due to selection effects. A study by White et al. (2013) was able to control for time-invariant heterogeneity (e.g. personality) and compared the self-reported psychological health of the same individuals at different points in time. People might move home, and the researchers were therefore able to compare responses of the same people in different locations. Secondly, a fixed-effects analysis was conducted to control for any other factors that may influence people's overall well-being (e.g. income, marital status, crime rates). The study explored the relationship between urban green space and mental distress as well as well-being. The researchers found that, on average, people have both lower mental distress and higher well-being when living in urban areas with more green space. Although effects at the individual level were small, the researchers argue that the potential cumulative benefit at the community level highlights the importance of policies to protect and promote urban green spaces for well-being.

Kaunas, Lithuania

With a size of 15,700 hectares, Kaunas is the second largest city in Lithuania. It has a green area of around 8,300 hectares. Residents of this city have been involved in a cohort study of the PHENOTYPE project, which is a European project that studies the potential mechanisms and human health benefits from land use planning and green space management (see box below).

As part of the PHENOTYPE project, two studies analysed the impact of green spaces on the health of inhabitants in Kaunas, by calculating the distance to green space from the homes of the participants. Firstly, an association was found between the presence of green spaces within 300m of the residence and better self-perceived general health and mental health (Trigueros-Mas et al., 2015). A second study showed that pregnant women who live more than 300 meters away from green spaces, have a higher blood pressure compared to those who live within 300 meters from green spaces (see figure 6.2) (Grazuleviciene, et al., 2014).

Photo: Baltcoming website, http://www.baltcoming.com/lithuania/travel-ideas-lithuania/kaunas-the-devilish-city-of-music/

PHENOTYPE Project

PHENOTYPE, an EU project funded through the 7th Framework Programme of DG Research, aimed to collect evidence on the human health benefits of exposure to natural outdoor environments. As part of the project, studies were conducted in Lithuania, the Netherlands, Spain and the UK, where green spaces were measured with satellite imagery. The study identified significant positive health effects when people live or work in green areas (e.g. residential areas, school spaces). Examples identified of direct health benefits from green living or working areas are:

- An increase in birth weight and head circumference of new-borns (Dadvand et al., 2012);
- A decrease in obesity rates, particularly due to forests (Dadvand et al., 2014);
- A decrease in behavioural problems in children, such as less hyperactivity, fewer emotional symptoms and peer relationship problems (Amoly et al., 2014; Balseviciene et al., 2014);
- Better working memory in children (Dadvand et al., 2015);
- Reduction in mental health problems and a decrease in intake of drugs (Triguero-Mas et al., 2015);
- Less depressive symptoms in pregnant women (McEachan et al., 2015);
- Reduction of cardio-vascular diseases in elderly (Tamosiunas et al., 2014).

Figure 5.1: Blood pressure of pregnant women living within/more than 300 m from green spaces

Crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) for increased blood pressure according the proximity to city parks.

Blood Pressure Categories	Green Space Distance	Cases N (%)	Crude		Adjusted	
			OR	95% CI	OR [a]	95% CI
Normal 120–129/ 80–84 mmHg	<300 m	434 (24.9)	1		1	
	300–1,000 m	1046 (59.9)	1.03	0.85–1.25	1.06	0.87–1.29
	>1,000 m	265 (15.2)	1.31	0.99–1.73	1.37	1.03–1.82
	Continuous [b]		1.08	1.01–1.15	1.09	1.02–1.17
High-normal 130–139/ 85–89 mmHg	<300 m	76 (22.4)	1		1	
	300–1,000 m	199 (58.5)	1.12	0.82–1.52	1.10	0.80–1.51
	>1,000 m	65 (19.1)	1.83	1.22–2.75	1.74	1.14–2.66
	Continuous [b]		1.14	1.04–1.27	1.14	1.02–1.26
Hypertension ≥140 or ≥90 mmHg	<300 m	122 (25.8)	1		1	
	300–1,000 m	285 (60.1)	1.00	0.77–1.30	1.01	0.76–1.35
	>1,000 m	67 (14.1)	1.18	0.81–1.72	1.18	0.79–1.77
	Continuous [b]		1.02	0.93–1.12	1.02	0.93–1.13

Notes: OR (crude odds ratios) are based on multinomial regression models, and reflect the risk for an increase in blood pressure category depending on the distance to city parks, compared to the reference group (optimal blood pressure <120/80 mm Hg). [a] OR adjusted for age, education, socioeconomic position, passive smoking, BMI, chronic disease, parity, and stress. [b] OR increase per every 300 m increase in the distance to city parks.

Source: Grazuleviciene, et al., 2014

Two longitudinal studies in Japan demonstrated that living in areas with green infrastructures positively influences the longevity of older people in an urban area. Takano et al. (2002) interviewed over 3,000 Tokyo residents aged 70 years and over and asked questions about the accessibility of walkable green space in their neighbourhood. The mortality rate in the cohort was followed and Takano found a positive relationship between the presence of walkable green space and lower mortality rates. Another study in Japan by Fukuda et al. (2004) showed that living in an area with less vegetation was significantly associated with female mortality rates but not with male mortality rates.

Similar findings were identified in a study conducted by the Scottish Government, which explored the relationship between the amount of green space in relatively deprived urban areas and mortality rates (Scottish Government, 2014). Different methods were used, such as health surveys, geographic modelling, focus groups, neighbourhood surveys, cortisol testing, and green-space mapping. This study found that middle-aged men living in deprived urban areas with high amounts of green space have a 16% lower risk of dying compared to the same age group living in areas with lower amounts of green space. For women, no significant differences could be identified.

The study by Maas et al. (2009) also found that older people live longer in areas where there is more green space close to their homes. Moreover, a study by Mitchell and Popham (2008) published in The Lancet found that people living closer to green space in England had lower death rates.

Vitoria-Gasteiz, Spain

Vitoria-Gasteiz is the second biggest city in the Basque Country after Bilbao, and held the title of European Green Capital in 2012. The city has a high proportion of green public areas, ensuring that the entire population lives within 300 m of an open green space. Numerous tangible measures are in place to assist and increase biodiversity and ecosystems services. A 'Green Belt' surrounds Vitoria-Gasteiz and there are numerous urban green areas in the city. Natura 2000 sites and wetlands protected under the Ramsar Convention are integrated into the belt.

Source: EC Green Capital website, http://ec.europa.eu/environment/europeangreencapital/winning-cities/2012-vitoria-gasteiz/

Photo: Quality Brochure Vitoria Gasteiz, http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/04/ENV-11-012_Vitoria_EN_web.pdf

Zupancic et al. (2015) conducted a review to provide planners and policy makes with information regarding the health benefits of urban green spaces and to recommend how to best design green areas in a city. The report identified specific features of green spaces that are most likely to result in health benefits for residents:

- High density of green spaces in the neighbourhood;
- Distance to green spaces;
- Variety of plants;
- Perceived cleanliness;
- Perceived safety;
- Features in green spaces that stimulate play;
- Presence of grass and large trees;
- Presence of water features;
- A community garden;
- Accessibility to everyone regardless of age and mobility level

Impacts of green spaces on people's mental health

A study by Maller et al. (2006) reviewed a wide range of studies that looked at the human health benefits of being in contact with nature or having nature in your close surroundings (e.g. a view of nature from the window). A large number of studies showed that nature fosters recovery from mental fatigue and that it has a restorative function. A UK policy paper on green urban spaces includes a range of mental health benefits, such as reduced self-reported stress levels, improved mood, and higher levels of confidence as a result of green spaces (Drayson and Newey, 2014). Moreover, a large body of evidence was also found for therapy that involves nature promoting faster recovery from illness for patients (Burls, 2007).

The abovementioned effect has been explained by the 'attention restoration theory of Kaplan' (1995). This theory states that the more we have to make an effort to pay attention to something, the more we experience fatigue. In natural environments, objects such as

sunshine, the movement of leaves and clouds do not demand much effort to observe, while crossing a street in a busy street demands a lot of effort. This could explain why nature improves our mental health (Kaplan, 1995). Some healthcare providers in the UK acknowledge the role of nature and its benefits for recovery from illness and have started projects to create green spaces around healthcare sites (see case below).

United Kingdom: NHS Forest

NHS Forest is a national project in the UK where green spaces were created near healthcare sites. Patients have a view of the green landscape from their windows and can go outside to walk through the green area. The project aims to improve the health and wellbeing of staff, patients and communities. Studies have shown that people experience rest and relaxation and it is believed that it has benefits for the rehabilitation and recuperation process. The green spaces are seen as part of the healing process for patients, and NHS Forest has therefore developed a guideline for green space design for health and well-being.

Sources: Shackell and Walter (2012); Website NHS Forest: http://nhsforest.org/

Photo: NHS Forest website: http://nhsforest.org/university-hospital-north-staffordshire-plants-over-12000-trees-nhs-forest

Several experimental studies (Health Council of the Netherlands, 2004; van den Berg et al., 2007; Hartig et al., 1991; Roe et al., 2013) have also showed the positive relationship between green space and restoration from stress and mental fatigue. More specifically, exposure to nature has been found to have a positive effect on mood, concentration, self-discipline and physiological stress. Maas et al. (2009) found that green space was important in affecting anxiety, depression, loneliness and social support; a lack of green space had negative effects on these factors. Morris (2003) found several studies that argue that the benefits of viewing green space or nature results in enhanced emotional well-being, reduced stress, and (in certain situations) improved health.

The presence of green space and its capability of attenuating negative health impacts of stressful life events was also investigated by a Dutch study in 2010 (van den Berg et al., 2010). It showed that people living in an environment that has a high amount of green space in a 3 km radius were less affected by experiencing a stressful life event than people with a low amount of green space in this radius. However, the moderating effects of green space were found only for green space within 3 km, and not for green space within 1 km of residents' homes. The researchers argued that this is presumably because the 3 km indicator is more affected by the presence of larger areas of green space, that are supposed to sustain deeper forms of restoration.

The Green Health Household Survey of the Scottish Government produced data on the impacts of green spaces on mental health (Scottish Government, 2013). This survey included 100 residents in four deprived communities in Scotland, and measured stress levels according to the 'Perceived Stress Scale' as well as by looking at the cortisol levels of these

residents. The survey found that for every 4% increase in green space, men's stress levels were on average 1 point lower. For women, no significant impact could be identified.

Larbert Woods, Scotland

Larbert Woods surround the Forth Valley Royal Hospital in Scotland. The woodland has been reconstructed in order to improve the green space for staff, patients, visitors and the local community as well as to improve the overall health and well-being of people. In addition to this, a special rehabilitation program has been set up to make use of this new green space. Its aim is to help patients relax and slowly build their strength in outdoors. The main outcomes of the programme are improved mental wellbeing of patients and improved positive attitude.

Source: Greenspace Scotland, 2013

A recent German household study looked at the effect of different types of urban land use on life satisfaction in German cities (Krekel et al., 2016). The study included almost 11,000 household and 22,000 individuals who participate in the German Socio-Economic Panel on a yearly basis. The distance and coverage from the types of land where measured with satellite imagery from the European Urban Atlas. The researchers found a positive relationship between green urban areas and life satisfaction rates.

Another study quantified the relationship between health and the presence of trees in urban environments (Kardan et al., 2015). The study found that an increase in health perception with every extra ten trees in a city block. This increase is comparable with the increase in health perception associated with people earning 10,000 Canadian dollars more or being seven years younger. However, socio-economic status and other demographic variables had a large influence on the relationship between greenery and health.

Studies thus indicate that green spaces in cities may be of importance in managing stress and that green spaces may play an important role as health-promoting environments. However, it should be noted that access to green spaces and short distances to green areas from people's homes cannot be directly linked to any health indicators: the robust evidence is not (yet) available. Overall, it can be stated that evidence indicates that experiencing nature and having green spaces in our close proximity makes us generally happier, healthier people.

Branching out project UK

The Branching Out project is a course aimed at people who use mental health services in the Glasgow and Clyde area. The course mainly focuses on activities in the outdoors, and includes an element of relaxation. The course has been evaluated through questionnaires and interviews with participants. Results show that the self-reported self-esteem and confidence of participants increased due to the course.

Source: Wilson, 2009

Impacts of green spaces on allergies

Besides the positive effects of green spaces on mental health, a positive correlation between the presence of green infrastructure and green spaces in people's direct living environment and the prevalence of allergies has been suggested. Currently, more than 1 in 5 people in the EU have an allergic disease, making it the most prevalent chronic disease in Europe (Zuberbier et al., 2014). Moreover, the prevalence of allergies is expected to further increase in the future, especially among youngsters.

Various studies suggest that growing up and living in microbe-rich environments can reduce the development of allergies or "atopy", a hereditary tendency to become sensitized and produce antibodies in response to ordinary exposure to allergens (Björksten et al., 2004; Kabesch et al., 2004; Von Hertzen et al., 2006; Haahtela et al., 2013; Ege et al., 2011; Hanski et al., 2012). Researchers argue that exposure to certain microorganisms such as those present in green environments can positively influence the human immune response (e.g. hay fever). The availability of green areas and rich biodiversity in the direct living environment of people can thus decrease the incidence and prevalence of allergies.

A recent study by Ruokolainen et al. (2015) concludes that a reduced contact of children with environmental biodiversity, including environmental microbiota in natural habitats, has adverse consequences on the assembly of human commensal microbiota and its contribution to immune tolerance. They showed that living at a distance of 2 to 5 km from forest and/or agriculture significantly reduced the chance of atopic sensitization in children of 6 years or older, suggesting that early-life exposure to nature is very important. Other studies confirmed these findings, and showed a lower prevalence of atopy and atopic diseases in children living in rural areas compared to children living in urban areas (Von Hertzen et al., 2006; Bråbäck et al., 1994; Björksten et al., 1998; Majkowska-Wojciechowska et al., 2007). This effect was mainly explained due to the fact that children in rural areas are more exposed to soil microorganisms, whereas these microorganisms in urban areas are limited due to less green space.

Concerning hay fever, a study by Ziello et al. (2012) showed that the amount of pollen in the air is higher in urban areas compared to semi-rural areas. The researchers even suggested that urban planning can play a role in the increase of pollen in cities, for example by planting plants and trees with high allergenic pollen. Another study by Albertine et al. (2014) found links between elevated levels of CO_2 and an increase in the production of pollen.

Table 5.1: Causal links, hypothesis, measures and evidence – an overview

What environmental and health pressures could biodiversity help address and what indicators are useful?	**What specific benefits could in principle (and actually) be measured?** What quantitative indicators are used?	**What benefits can be measured in monetary terms?** (note that for some areas we do not expect much)	**Who are main beneficiaries of biodiversity measures?** (note key stakeholders, esp. if minorities or vulnerable)	**What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?**
Green spaces / nature in people's living environment can have a positive and direct impact on their direct health through improved mental health, lower stress levels, lower prevalence of diseases, lower levels of allergies and longevity.	It has been difficult to link direct health benefits to the presence and availability of green spaces in people's living environment. There are uncertainties about the actual contribution of green spaces in this process. The main reason for this is that establishing a causal relationship is difficult as the links are complex. Indicators used in studies that attempted to show these benefits include self-perceived health (surveys), morbidity data from general practitioners, mortality data.	No evidence or data was identified.	General population, in particular people who spend a lot of time around their home (e.g. the elderly, children, people from lower socio-economic groups, housewives)	The presence of green infrastructure is presumed to have a positive impact on people's physical and mental health. In addition, a positive impact on preventing the development of allergies is assumed. No concrete examples could be identified of Natura 2000 sites that are situated in the direct living environment of people, and their impact on health and well-being of communities.

What insights are there on Natura 2000 sites and Green Infrastructures providing benefits and to whom?

In the course of this literature review, it was not possible to identify concrete examples and information on the specific impacts of Natura 2000 sites and protected areas in people's direct living and working environment on their health and well-being. As described in other chapters (on indirect health benefits and on outdoor recreation and physical activity), the available information mainly focuses on the active use of such sites through recreation, sports and leisure.

However, based on the information collected through the literature review, it is likely that Natura 2000 sites and wider green infrastructure have a positive effect on:

- The prevalence of allergies;
- The overall mental health of people;
- The longevity of people; and
- The overall well-being and happiness of people.

People also seem to appreciate green areas and sites close to their living environments, as the presence of nature and green space has an effect on property values.

A study by Wu et al. (2014) showed that, while previous studies on property value have mainly concentrated on public resources such as transportation, hospitals and schools as important factors in housing prices, the effect of green space has an impact on property value too. The study focused on Shenzhen, China, and results showed that proximity to a central business district (CBD) produced the greatest effect on housing prices, followed by distance to a park, distance to school, distance to arterial road, and distance to subway.

Moreover, a study by the Greater London Authority (2003) showed that housing prices in London are not determined by a single specific parameter, but by a wide set of indicators; the amount of green space in wards is the fifth most significant indicator in explaining the variation in average house prices. The first four indicators are level of income support, travel time to central London, average air quality and dwelling density. Additionally, the study showed that a 1 per cent increase in green space in a typical ward could be associated with a 0.3 to 0.5 per cent increase in average house price.

A positive relationship was also found in a study by Kolbe et al. (2015) in the city of Cologne. Here, the researchers found that certain urban green spaces have a positive effect on house prices; parks, forests and water. An inverse relationship was found between the price of houses and the presence of fallow land and farmland.

5.3 The role of supporting instruments and governance

Examples of supporting instruments and tools for analysing the direct impacts of green spaces in people's living and working environments are spatial planning tools for urban planning or mapping tools showing the proximity issues of green spaces to people's houses.

Coalition for a Liveable Future, United States

This coalition has produced various heat maps for the region including:

- Proximity to Green Space & Outdoor Recreation
- Proximity to Publicly Accessible Parks
- Proximity to Publicly Accessible Natural Areas


Proximity to Publicly Accessible Parks

The first heat map (proximity to green space and outdoor recreation) shows (a) proximity to publicly accessible parks; (b) proximity to publicly accessible natural areas; (c) proximity to locations for accessing the water by boat; (d) proximity to recreation facilities such as sports fields and swimming pools; and (e) proximity to green spaces that are available for limited public use, such as school sports fields. The series also includes a composite heat map that combines all of the indicators, and a version of the composite map that shows access by neighbourhood.

Source: Website, http://clfuture.org/programs/regional-equity-atlas/maps-and-analysis/
Photo: Coalition for a liveable future, http://clfuture.org/atlas-maps/proximity-publicly-accessible-parks-0

Governance examples showing how cross-sectoral cooperation can facilitate the implementation of green spaces and urban planning that considers health and well-being aspects include urban development strategies.

5.4 Conclusions and recommendations

The complex relationships between environmental factors and human health, taking into account multiple pathways and interactions, should be seen in a broader spatial, socio-economic and cultural context. While robust evidence showing the direct impacts of green areas in people's living and working environment on their health is scarce, various studies indicate that positive influences are likely. More specifically, the key messages of this review could be listed as follows:

- Green areas in people's living and working environments can have a direct positive effect on their health and wellbeing as well as their overall quality of life.

- However, there is only weak evidence showing the links between people's health and the presence of urban green spaces. Their actual contribution is uncertain. This is mostly because establishing a causal relationship is difficult as the links are complex.

- The impact of green spaces in people's living environment on their health is difficult to measure and disentangle; health within an environmental context should be considered as a multifaceted and holistic phenomenon.

- However, various studies suggest that direct health impacts of green spaces in people's living environment are plausible:

    - The amount of green spaces within a close radius to people's living environment seems to have a significant positive effect on people's perceived (self-reported) general health.

    - The presence of green spaces within a close radius of people's living environment also seems to have an effect on morbidity rates of a number of diseases that are highly prevalent in society.

    - People living close to green spaces report a higher health-related quality of life, experience less stress and are less affected when experiencing a stressful event.

    - Studies show a positive relation between green space and restoration from stress and mental fatigue. Exposure to nature also seems to have a positive effect on mood, concentration and self-discipline.

    - Evidence shows that green spaces can promote a faster recovery or rehabilitation from ill health.

    - The availability of green spaces in people's living environment also seems to have an effect on longevity; older people live longer in areas where there is more green space close to their homes.

    - People who benefit mostly from green spaces in their living environment are the elderly, children, homemakers and people from lower socio-economic groups. These groups spend a large share of their time in/around their house.

    - Exposure to green areas in a natural setting (rural areas) seems to have more positive effects on health and wellbeing of people compared to green space in urban areas.

- Overall, studies indicate that having nature and green spaces close to our living environments generally makes us happier and healthier people. However, the robust evidence underpinning the exact health pathways and associations is not (yet) available.

6 Healthier Lifestyles, Nature Experience

6.1 Introduction

This section focusses on the benefits of nature on human health and wellbeing in terms of natures' effects on everyday life in the whole life span. We start with some examples of how contact with nature supports children's development and what the value of integrating being in nature and visiting nature could be to the educational system. We explain how adults can benefit from nature in their everyday life and how being in nature can support wellbeing in different periods of life. We present evidence form scientific peer-reviewed papers and give practical examples from projects and programs that have been developed to support people's wellbeing in nature. This section explores evidence of nature's positive effect on people (mental health, stress reduction) and the importance of contact with nature and visiting nature throughout one's life. Moreover, we discuss therapeutic use of nature and problems that might occur if people are not in contact with nature.

In modern urbanized societies, there is an increase in occurrence of several diseases related to lifestyle, including insufficient physical activity, acute and chronic stress, and insufficient recovery from stress. This kind of lifestyle is an increasing problem and a cause of long-term effects on health (e.g. Booth et al., 2008; Lopresti et al., 2013). Stress is an important public health concern. For short periods, stress is not dangerous, but rather a part of normal human functioning. If the tension goes on too long, several wide ranging conditions can occur, including infections, cardiovascular, gastroenterological and immunological diseases, diabetes, depression and aggression (Kivimäki et al., 2002; Wellen et al., 2005; Nilsson et al., 2011). Mental disorders account for about 20% of the burden of disease in the European region, rising to 26% in the countries of the European Union (EU). Depression alone is responsible for about 15% of all days lived with disability. Some countries, such as Denmark and the Netherlands, have reported that up to 50% of long-term sick leave and disability payments are due to mental disorders, mostly depression (WHO webpage, accessed 14.05.2015). In light of this, one of the key goals is to reduce and prevent stress related diseases in modern urbanised societies.

6.2 Benefits of nature on human health and wellbeing in terms of lifestyles

It is hypothesised that lost contact with nature is one of the reasons why people have developed so many health problems (Wilson, 1984). There is new research suggesting that the reduced actual contact with nature and biodiversity affects the human commensal microbiota and its immunomodulatory capacity, meaning that loss of biodiversity is related to non-communicable diseases (Hanski et al., 2012).

Nowadays contact with nature has become a challenge, especially in big cities. Nature areas are still not considered a necessity for healthier lifestyles, particularly in urban areas where the competition for land is intense, land values are high, or funds for maintenance are low. Compact city policies and heavy urbanization in many European cities have led to even

greater pressure on urban green areas. Therefore, the public health benefits of forests and other nature areas must be better understood and more effectively communicated (Africa et al., 2014).

Current educational and health care practices are not making efficient use of the resources that nature has to offer. Nature could have a larger role in health care system in preventing stress-related illnesses, instead of treating the consequences of lifestyle-related diseases. In the following section, the benefits of nature during lifetime are discussed.

Children and nature

There is evidence that nature areas are related to children's better functioning (concentration, physical activity, self-esteem, emotion regulation). Evidence also suggests that adults are less likely to visit forests and nature areas if they have not visited them in their childhood. Spending time in nature in childhood is essential for several aspects later in life. For example, positive emotions in nature are the basis for later nature experiences, environmental concern and even choosing one's occupation later in life. Many environmentalists or professionals working with nature remember nature visits, playing freely in nature with other children or visiting nature with teachers and parents (Chawla, 1998). If there is no habit of visiting nature as a child, it is harder to develop this habit as an adult. An adult visits forest and nature areas less likely if one has not been in the forest as a child (Ward Thompson et al., 2008).

Educational information on bog ecosystems and nature experiences in Austria and Germany

School children and their teachers experience inspiring educational information on bog/mire ecosystems in Austria and Germany (Bavaria). Alliance for Bogs in the Alps has been an Interreg funded collaborative effort, co-financed by the EU, The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management as well as counties of Salzburg and Tyrol. The project activities have focused on both green infrastructure next to Tyrolian towns and in particular Natura 2000 sites (e.g. Grassau and Nicklheim in Germany, Schwemm in Austria). The children can get familiar with the flora and fauna of bog ecosystems. The nature paths and illustrative information on ecosystems that is openly available on the web, contribute to positive, socially shared nature experience and open an opportunity for longer-lasting nature hobbies for the children. Through the project, education in nature and about nature becomes fun and entertaining.

More information: http://www.alpen-mooralliance.eu/home/

There is some empirical evidence of how being in contact with nature affects children and how it is related to their improvement in school. The evidence suggests that green areas can be used for children to function better. Green playing and studying environments support the social and cognitive development of children and adolescents who have motivation and attention difficulties (Laaksoharju et al., 2012). Children with attention deficits concentrate better after walk in the park and parents also rate their child's symptoms as better after activities in green settings than after activities in non-green settings (Faber Taylor and Kuo, 2009). Green schoolyards improve well-being and diminish physiological stress (Kelz et al., 2013), strengthen attention, reduce behaviour problems, and enhance factors associated with resilience in children of all ages (Chawla et al., 2014). The restorative outcomes

(emotional variables and behavioural effects) have greater positive influence in the forest setting compared to conventional indoor school settings for adolescents (aged 11), and children with poor behaviour benefit from activities in natural settings the most (Roe and Aspinall, 2011). Green areas that are close to one's home support physical activity. The proportion of neighbourhood greenness is positively associated with the frequency of physical activity undertaken by 11-13 year olds in their free time outside of school (Janssen and Rosu, 2015). Being in nature seems to be related to environmental concern. There are several correlational studies supporting this hypothesis, but much less evidence is from experimental studies. Collado et al (2013) showed that 10 year old children who spent their summer camp in nature were more environmentally friendly than those children who spend their two weeks summer camp in the city.

Tammela forest daycare, Finland

The "Forest dwarfs" daycare group was initiated by the proactive Tammela municipality staff and strongly supported by active volunteers from the parents' society, who raised funding for facilities such as a firewood shelter used in daily activities. In the forest daycare group, there are 10 children, a kindergarten teacher and a daycare specialist. Being in nature, using materials from nature and using books and literature about nature is integrated into everyday daycare activities. Children spend most of the day in the forest, walking at least 2 km every day to the destination , playing in forest, preparing food and eating in nature. The approach provides a multi-faceted view of forest ecosystems which is grounded in the appreciation of nature and offers opportunities to children to experience nature from their own perspective, teaches them skills and gets them to exercise. In autumn 2013 children who started school continued activities in the forest one day per week. The aim is to continue the forest relationship throughout school years and to offer a solid basis for being interested in forests and nature in adult years as well.

More information: http://www.peda.net/veraja/tammela/tammitarhan_paivakoti/metsatontut

Homo ecos projects for children, Latvia

Within the **"Eko turbulence"** project, children and youth had the opportunity to develop an understanding of themselves as part of the environment, examine their habits and explore the possible consequences of human action. Creativity is also promoted through practical action, such as innovating with recycled materials. Throughout the project there are four workshops for youth that focus on meadows, forests, paper and material recycling, as well as four workshops for children on waste, recycling of materials, energy and their own bodies.

Within the **"Speak for Nature**" project, 25 young people aged 18 to 25 years spent 10 days exploring natural diversity and its components, and through video and photographs were able to reflect on the vivid and memorable stories they learned about nature in order to share these experiences with others.

Homo Ecos is an environmental organisation that unites people in Latvia and abroad. Over the past years, "Homo Ecos" has received financing from Latvijas vides aizsardzības fonds, the Department of Education, Culture, Youth and Sports of the Riga City Council, the European programme "Youth in Action", and the Soros Foundation Latvia. The organisation offers services related to environmental topics, such as giving lectures, renting out space for seminars, and providing consultations on sustainable development topics. Homo Ecos have developed a series of

sustainable souvenirs and gadgets from recycled materials. The donations received in exchange for these souvenirs are used to bring their plans closer to reality.

Source: http://www.homoecos.lv/eng/

Nature benefits during adulthood

The strongest evidence of the positive effects of nature on human health and well-being concern mental health (Bowler et al., 2010; van den Berg et al., 2015). The restorative effect that nature provides is needed as working life is increasingly stressful, and living in urban environments exposes citizens to noise, pollution and visual disturbances. The evidence shows that the more people use green areas, the better their mood and wellbeing is (Grahn and Stigsdotter, 2003; Korpela et al., 2010). People experience restoration in nature and these experiences raise their general wellbeing. Experimental studies show that urban parks, in comparison to the built city environment, have positive effects on participants' mood, stress levels and attention restoration. In a Finnish study for instance, people visited urban green areas (well-constructed urban park and city woodland) after their working day and their mood and positive feelings were raised after being there , compared to the city centre (Tyrväinen et al., 2014).

Community eco gardens foster healthy lifestyles, Koprivnica, Croatia

The "Community of Eco-gardens" is a Croatian counterpart of the wider contemporary social movement of urban gardening, associated with healthy nutrition and self-sufficient food. The community was initiated by NGO Kopriva's project and currently provides plots for 46 urban gardeners in the City of Koprivnica. Its aim is to inspire people to take action to foster their psychosocial wellbeing. It makes use of unbuilt land parcels in urban areas and offers urban residents meaningful opportunities to spend time in green spaces. The effects are realized through healthy food combined with meaningful activity together with like-minded people. The community has been expanding and welcoming new gardeners via an open call and social media. The aim has been to provide a common tool shed as well as other facilities for children to play and adults to socialize. While the initiative was made by an NGO, the city of Koprivnica is an important stakeholder providing arable land for urban gardeners and safeguarding the availability of running water.

More information: http://koprivnica.hr/en/novosti/projekt-zajednicki-eko-vrtovi-dostupna-jos-jedna-parcela-za-vrtlarenje/

Restoration-enhancing therapeutic forest trails: Finland, Sweden, Luxemburg and France

Metla (Finnish Forest Research Institute, currently known as Natural Resources Institute Finland) and University of Tampere, collaborated to create the first restoration-enhancing therapeutic forest trail There is strong evidence of nature's positive effects on mental health. The evidence shows that nature has restorative, stress-reducing effects and even a short break from work in a green area can have positive stress-reduction effects. This knowledge can be used in city planning for example. Green areas close to work environments may reduce stress levels.

There are examples of how nature or forest trails can be designed to improve psychological restoration. These forest trails, with psychological signposts, can be used in rehabilitation work in enhancing the restorative experience. The content of psychological signposts is based on attention restoration theory (Kaplan and Kaplan, 1989) which encourages concentration on the self and bodily feelings, taking noticing of nature; and supports social interaction.

with psychological signposts to enhance the restorative (stress-reducing) experience. The project was funded by the European Regional Development Fund (ERDF) and the Council of Tampere Region. An initial pair of trails includes a mix of forest and countryside trails, the shorter being 4.4 km and the longer 6.6 km. The signpost instructions aim to induce relaxation, improve mood, induce cognitive reflection and attentional restoration, and enhance the search for a favourite place which can be socially shared. According to the user survey, 80 - 90% of visitors reported enhanced mood after walking the trail. Corresponding trails with the same psychological exercises were established in Sunne in Sweden in September 2012; in Nommern, Luxembourg in April 2013; in Brouvelieurs in France in September 2013 and in Parkano in Finland in 2014. All trails use existing networks of trails in ordinary, managed forests with easy access for visitors. The augmentation of the "Power forest" concept was carried out as part of a cross-country Leader project "Forest trails" – a noteworthy example of high impact of EU funding to transfer innovations in nature-based health-promoting activities.

Sources: http://www.metla.fi/uutiskirje/ForHealth/2012-01/finland-1.htm
http://www.vaxtlust.se/projektbloggen/oppningsceremoni-3110-for-well-being-trail-i-amberg-sunne#more-3316
http://www.mullerthal-trail.lu/en/well-being-trail-nommern
http://lagirafequirit.blogspirit.com/archive/2013/09/20/temp-bb428a174afaca913562b58fceeb5674-2978547.html

For physiological recovery, there is somewhat less evidence of an effect. There are studies from Japan, Korea and China showing that nature environments lower blood pressure and pulse rate, reduce cortisol level, suppress sympathetic nervous activity, enhance parasympathetic nervous activity and there is even evidence of improved natural killer cell count and activity (Park et al., 2010; Li, 2010; Mao et al., 2013; Horiuchi et al., 2013). In these studies, the sample size has been rather small and the results of these studies should be replicated in Europe in order to validate their results in different cultures. There is also more research needed on the type of green areas. So far, most of the comparisons have been made between largely used and popular green areas in comparison to built-up environments.

There exists some evidence that nature environments lower blood pressure and pulse rate, reduce cortisol level and suppress sympathetic nervous activity. More scientific evidence is needed about the restorative effects of nature and evidence on individual differences in nature experiences.

> "Factors such as age, health status, psychological characteristics, fitness, and education level likely influence the effect of nature exposure. The results linked to influence of national and cultural background remains limited, as does the effect of environmental education across the life course." (Africa et al. 2014, p. 14)

The important factor of restoration is getting a break from everyday life. For example we know that forest professionals do not report as much feelings of restoration after forest visits as non-forest professionals (Lindern et al., 2013). There is a need for more evidence on how place of residence influences positive experiences form nature (e.g. urban-rural). We do not currently know how nature experiences and perceived benefits differ between rural inhabitants and urban dwellers. In addition to scientific research, monitoring strategies should be developed for health benefits gained in nature.

Monitoring system for health effects during nature visits, Finland

The first Finnish study on national park (Natura 2000 sites) visitors' perceptions of the effect of their visits on their social, mental and physiological well-being was conducted fairly recently. The data was gathered in 2013 and reported in 2014. A total of 2,052 field questionnaire respondents and 873 follow-up questionnaire respondents provided data. Results provide evidence on positive well-being impacts.

Exploration of health benefits can be a very useful addition to visitor monitoring implemented in natural settings and a worthwhile addition to these questionnaires. This enables a systematic, long-term and nationwide approach to monitoring the benefits. The web survey provides important additional data to estimate the benefits in-depth and to enhance services on-site. Recreation and contact with nature have diverse and profound health enhancing effects that are highly valued by the visitors of protected areas. Evidence provided by the surveys has helped to demonstrate and communicate the importance of nature experiences, e.g. how important it is to provide citizens with opportunities to experience nature, and to increase the possibilities for those who have had limited access.

More information: Kaikkonen et al (2014) Health and well-being from Finnish national parks – A study on benefits perceived by visitors. Nature Protection Publications of Metsähallitus. Series A 208. http://julkaisut.metsa.fi/assets/pdf/lp/Asarja/a208.pdf (in Finnish; abstract in English)

Nature and therapeutic interventions

Using nature for healing has a long history. Many hospitals, especially psychiatric ones, centres for the elderly and sanatoriums, were built in aesthetically beautiful nature areas. Many of these hospitals have been closed due to centralisation in health care systems. However, nature is used as a tool for therapeutic interventions in several health care institutes, often based on good practical experiences and positive feedback from patients. There is limited but growing research evidence on the effects of treatments using nature (e.g. Adevi and Martensson, 2013; Pálsdóttir, 2014). The evidence shows that nature-assisted therapy has a small but reliable level of effectiveness as a resource for public health (Annerstedt and Währborg, 2011).

Hungary's unique medicinal Lake, Lake Hévíz

Lake Hévíz, with an extent of 4.4 hectares, is the world's second largest thermal lake. Due to its unique hydrological characteristics, primarily linked to the water's sulphur content, the lake has been used as a medicinal lake since the 19th century. The Saint Andrew Rheumatism Hospital, located next to the lake and with over 780,000 patients in 2014, carries out medical treatments, which are mainly applicable for rheumatic and locomotor diseases (Interview with Gy. Németh). As well as the direct health benefits of these therapies, the lake also provides recreational benefits to its visitors. The Hévíz Spa and St. Andrew Rheumatism Hospital manage the lake and the surrounding protection area. The hospital actively cooperates with the Balaton Uplands National Park: educational events are jointly organised by the hospital and the national park.

There are some good examples of therapeutic gardens with ongoing scientific research, like the Alnarp Rehabilitation Garden (Swedish University of Agricultural Sciences (SLU), Alnarp campus) and the Healing Forest Garden Nacadia (Danish University). Evidence-Based Health Design (EBHD) is used in these gardens, which is a process that calls for landscape architects to make practice decisions based on integrating best available research evidence and proven experience with their practice expertise and knowledge of client attributes (Grahn and Stigsdotter, 2003). The research projects in the gardens are multidisciplinary and include scientists, practitioners and students.

Alnarp Rehabilitation Garden, SLU, Sweden

The aim of Alnarp Rehabilitation Garden is to pilot the effectiveness of nature-based rehabilitation (NBR) on different user groups. Three main groups have been studied: individuals recovering from stress-related mental disorders, stroke and war neuroses (i.e. with refugees). Participants with severe stress and/or mild to moderate depression, significantly reduce their health care consumption when participating in NBR. One year after rehabilitation, the costs for primary care had dropped by 28% for the intervention group in Alnarp, and in terms of days spent in hospital, they had fallen by 64% (Währborg et al., 2014).

The local municipality, the Skåne region, has supported the initiative to start NBR in rural businesses, now expanded to 11 gardens. This project is financially supported mainly by the Skåne Region and the European Social Fund, and also the Swedish Social Insurance Agency, the Federation of Swedish Farmers and the Swedish Public Employment Service. For this project, €1.3 million per year was reserved for the project with a capacity to treat 250 – 300 patients each year.

More information: http://www.slu.se/en/departments/work-science-business-economics-environmental-psychology/the-alnarp-rehabilitation-garden/

Healing Forest Garden Nacadia, Denmark

The Healing Forest Garden Nacadia is situated 30 kilometres north of Copenhagen. The therapy garden is connected to research and education at a Danish university. The project was initiated in 2007 and four years later the garden was ready. Nacadia's design is based on an exploratory model of an evidence-based health design (E-BHD) process. The goal is to provide an outdoor space for nature-based treatment for patients with stress-related illnesses. The treatment at Nacadia has a salutogenic (health creating) perspective. Treatment is offered year-round, and the framework for the treatment is the same every day, carried out in a group of eight patients led by two horticultural therapists and an assistant gardener. The treatment includes nature meditation and gardening activities. The experiences in the healing garden are used in continuing education and training courses on nature-based therapy, targeted to psychologists, psychotherapists etc.

More information: http://ign.ku.dk/terapihaven-nacadia/

http://www.nataliapantelidou.com/default.aspx?lang=en-GB&page=2&newsid=30

There are attempts to use forests for therapeutic interventions. These programs need collaboration between universities, medical doctors, health-care practitioners, psychologists, local municipalities and forest managers.

The thematic research program Forest and Health, Faculty of Forest Sciences at SLU, Sweden

Forest and Health is an interdisciplinary program which since 2007 has been working closely together with medical doctors, psychologists, physiotherapists and others at the Stress Clinic, University Hospital of Umeå, researchers at the Department of Public Health and Clinical Medicine and the Department of Psychology at Umeå University, as well as researchers at Swedish Agricultural University in Umeå and Alnarp.

Forest and Health has been funded by the Faculty of Forest Sciences (SLU), Sveaskog forest company, Umeå municipality, the Swedish Forest Agency, the Swedish Forest Society, Petersson-Grebbe foundation, Västerbotten County Council and the Centre for Environmental Research (CMF), Umeå. A graduate student has been funded by the Swedish Research Council Formas.

Forest and Health includes the following projects:

1) EnRest (Environments for Rest) "A comparative study of two stress-recovery environments"

2) ForRest (Forests for Rest) "Nature's role in stress and exhaustion disorder"

3) Green rehabilitation in family forest farms from a rural perspective.

4) MiniRest "The immediate effects of outdoor environment on stress and burnout"
   5) A GPS-study of choice of environment for people with stress-related fatigue

5) The optimal character and management of rehabilitation forests in combination with timber production

Source: http://www.slu.se/en/departments/forest-ecology-management/research/forest-health/

In Finland, forest environments are used for alcohol abuse treatment and weight control intervention.

Goaikkanas-project, Meahcceterapiija – Forest therapy in Enontekiö, Northern Finland

A culturally specific alcohol abuse treatment for indigenous Sami people in northern Lapland was initiated in 2007 with funding from the Finnish Ministry of Social Affairs and Health. The core actor is an association, and the activity has been supported by a regional authority and social and health care departments of a few northern Finnish municipalities.

This forest therapy treatment uses clients' local environment, language and culture. The idea is that cultural appreciation and understanding creates an atmosphere in which the treatment may succeed. The activities are family and community centred, and nature plays a crucial role. Action-orientation and creativity shape the methods that are used. The program includes outdoor and creative activities, fishing, boating, preparing food, outdoor singing, quizzes and games, as well as learning relaxation techniques and giving healthy lifestyle guidance.

The project is long-term in nature and the outcomes have been good. The participants especially appreciate the possibility of being outdoors. In 2014 the project received the "Effective!" honorary prize from the donor, Finnish Slot Machine Association, because of the concrete results and the customer-oriented manner of reaching the target group.

More information: http://www.samisoster.fi/toiminta/goaikkanas-projekti (in Finnish)

Contact with nature in everyday life

Nature areas should be easily accessible for psychological restoration, stress relief, and physical activity. Therefore, gardens, recreation areas and parks should be easily accessible and near everyday living environments. This is especially important for families with small children, older people and people with disabilities. The design of green areas should be elaborated for different users. For instance, safety is the biggest concern for everyday walking of older people (Broekhuizen et al., 2013). Recreation tracks close to social centres need more places for rest and smaller well-designed areas for smelling and touching different plants and trees to activate senses.

Gardens in urban environments give possibilities for being in nature. Gardening provides opportunity for positive experiences, improved mood, moderate-intense physical activity, and self-esteem (e.g. Rappe et al., 2008). Gardening is associated with healthier dietary practices, lower body mass index (Zick et al., 2011), improved mental health, and increased social engagement (Litt et al., 2011). Domestic gardening for older age groups is important to their physical and psychological wellbeing (Scott et al., 2015). Direct contact with nature rich in biodiversity (soil, plants) could also raise immunomodulatory capacity. A new emerging theme of research has linked biodiversity of vegetation type around one's home with increased biodiversity of microbes on the skin, and in turn, a decreased risk of atopy (Hanski et al., 2012).

The positive effects of gardening for example are combined in a program for unemployed in Norway, where voluntary work (social engagement) and positive psychological and physiological effects of nature are used for promoting active lifestyles.

Green work at Kirkerud gård, Hakadal, Norway

Kirkerud gård farm is hosting a therapeutic horticulture intervention. The Norwegian Labour and Welfare Administration promotes a Green Care program on mental health. Kirkerud gård offers work-related horticultural activities in the garden and nearby area for unemployed people who have difficulties in meeting the requirements of the ordinary work force. The activity is adjusted to the participants' work capacity and mental health and it provides participants with a sense of integration in society until they find a job. Activities at the farm follow the principles of motivation and meaningfulness, aiming to provide the clients with a sense of achievement and responsibility over their own lives. Nature is expected to inspire thoughts and emotions at the Kirkerud farm, and nature contact thus contributes to personal growth. The activities in contact with nature aim to evoke enjoyment and inspiration, subsequently leading to positive feelings, which helps with trusting one's own capabilities.

More information: http://www.kirkerudgard.no/ (in Norwegian)

Gardening has been used elsewhere in rehabilitation programs. Horticulture is used in rehabilitation and vocational training in Finnish prisons. The first evaluations have been done to measure the effects on the well-being of inmates.

Nature-based rehabilitation project for adult male inmates in Kerava Prison, Finland

In the "Roots to Freedom" project, funded by the European Social Fund (ESF), horticultural activities were offered for open and closed prison departments in 2013 and 2014. Inmates participated in growing plot gardens and box gardens, including a cooking course or yard maintenance during the summer 2013. For evaluating the project, participants filled out a questionnaire consisting of open ended questions and scaled statements. From the participants, 60% were of the opinion that the activity had had positive effect on them and 57% thought that the activity would benefit them after release. Horticulture was reported to encourage participants, give opportunities to strengthen self-esteem by using existing knowledge and skills and learning new ones, and increase confidence in coping after release. Group activities contributed to social interaction among inmates and between inmates and staff. By positive feedback from others, inmates identified favourable characteristics in themselves, which encouraged mutual relationships. Horticulture seemed to be a means of carrying out on-site activities that support rehabilitation by creating semblances of everyday life in a restricted environment (Rappe et al., 2016).

More information: https://sites.google.com/site/juuretvapauteen/
http://www.inworkproject.eu/toolbox/index.php/good-practice-collection/good-practice-european-wips/activity/2-uncategorised/91-activity-environmentally-friendly

Table 6.1: Causal links, hypothesis, measures and evidence – an overview

What environmental and health pressures could biodiversity help address and what indicators are useful?	**What specific benefits could in principle (and actually) be measured?** What quantitative indicators are used?	**What benefits can be measured in monetary terms?**	**Who are the main beneficiaries of biodiversity measures?**	**What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?**
Exposure to green space has positive impacts on stress reduction **Being in nature (urban park and urban woodland) increases positive emotions and feelings of vitality (Tyrväinen et al., 2014).** **The proportion of green and open space is linked to self-reported levels of mental health (Barton and Pretty, 2010)**	Stress markers e.g. mood, anxiety, emotions, blood pressures. Avoided work absence, hospitalisation/treatment cases.	From stress reduction: value of sick leave, burn out, avoided hospitalisation costs	From stress reduction: those who have poor access to nature (e.g. the elderly and children) All ages and socio-economic groups (Maas et al., 2006)	City green infrastructure (trees and parks) support stress reduction.
Children with ADHD function better after being in nature **(Faber Taylor and Kuo, 2009)**	Concentration, self-efficacy		ADHD children, their parents, teachers	
Treatments and programmes for alcohol abuse (Heikkilä, 2014)	Percentage of employment after program	Value of lost work days	Unemployed people who abuse alcohol	Access to green areas support activities in nature
Green areas support mental well-being in care of the elderly **(Rappe et al., 2008)**	Subjective well-being		People with old age Elderly people	Environment rich in biodiversity has qualities to enhance senses
Horticultural rehabilitation improves inmates' well-being (Rappe et al., 2016)	Subjective well-being		Inmates	Possibility of working in a garden has qualities to enhance well-being

What insights are there on Natura 2000 sites providing benefits – and to whom?

The review of the existing research shows strong evidence on nature's positive effects on mental health. Nature has restorative, stress-reducing effects and even short visits in nature areas can have positive effects on stress reduction. The research results and experiential information from practical projects using nature for rehabilitation for different target groups are also promising.

There is also some evidence that nature areas outside cities such as Natura 2000 and protected areas are efficient in delivering mental health benefits. The key issue in receiving these health benefits is repeated use. There is currently a limited amount of information about the length of the health effects linked to nature visits. Moreover, visiting Natura 2000 sites and protected areas and the powerful nature experiences had in these sites may, however, serve as a trigger to people to move towards healthier lifestyles. This is an argument that is increasingly also linked to health-promoting effects of nature-based tourism. Quite often when talking about the necessity of being outdoors, it is not so important to get focused on the details of e.g. how long one should be there, 5 or 15 minutes to gain health benefits. When working with vulnerable groups, it is necessary to keep in mind that to be able to go outdoors is fundamental for quality of life – a short time is always better than nothing.

The investigation of collected cases shows that the most prevalent health and well-being benefits of Natura 2000 sites are related to the fact that those areas represent recognized locations that have specific ecological values. Natura 2000 sites are attractions as such, associated with profound ecological information that may be used for educational purposes. This is why school children and youth in general are important beneficiaries of Natura 2000 sites, along with adults who are already interested in nature, exercising or experiencing nature. Furthermore, Natura 2000 sites provide venues for several special groups such as people with disabilities and those in rehabilitation, as the facilities in or next to the sites support the activities of those groups.

National Forest Park of Athalassa, Nicosia, Cyprus

Athalassa National Forest Park is a natural green space with several protected species of flora and fauna. The park covers 840 hectares and includes lakes, a botanical garden, nature trails and an environmental awareness centre managed by the Ministry of Agriculture, Environment and Natural Resources. It is situated south of Nicosia and it is surrounded by the suburbs of Aglantzia, Strovolos and Latsia. Bicycle and walking paths have been created throughout the park allowing visitors to enjoy the area without disturbing the habitats. For visitors the park offers opportunities for relaxation, recreation, physical exercising and environmental as well as educational awareness raising.

Source: http://documents.rec.org/publications/GreenSpace_issue04_EN_Feb2014.pdf

What insights are there on GI providing benefits (healthier lifestyles) – what type of GI providing what type of benefits to whom?

The positive mental health benefits of nature exposure are a rather well studied topic in Europe and elsewhere. Nature has restorative, stress-reducing effects and even a short break from work in a green area can have positive effects on stress reduction. This knowledge should be used in the planning of work and living environments. For example, green areas within and nearby work environments, if actively used, would help in daily recovery from work.

The main role of nature in urban and peri-urban environments should be linked mainly to preventing illnesses and supporting people's mental health and well-being in general. Nature is an important tool to support health and well-being of people during their various life stages. Moreover, mental health benefits are received both from active and passive use and therefore the benefits, if available, could support the majority of citizens in Europe. These benefits can be largely increased and maintained both by the public and private sector with adequate provision as well as good design and planning of health-promoting environments. Moreover, there is large potential to develop nature-based health services further by using urban, peri-urban or rural nature areas as part of the service. This work needs cross-sectoral co-operation with authorities in health and social service sectors as well as with nature management and planning agencies.

The current research knowledge is based on some experimental studies that evaluate clear positive short-term health effects of exposure to green/blue spaces. There are fewer studies, however, on the health effects of long-term nature exposure, which is an essential information for policy makers to develop guidelines for urban planning. The evidence from empirical studies shows that most of the results are based on correlational studies and because of that, there is only limited evidence for a causal relationship between green areas and mental health. The mechanisms that deliver the health benefits of nature environments may vary in different countries, cities and towns depending of the quality of the green infrastructure. Moreover, the benefits may vary due to cultural differences linked to the use of nature areas in Europe and individual differences in the perceived benefits by users. More interdisciplinary work is needed between researchers and different stakeholders to plan and conduct intervention studies, and to evaluate their effectiveness.

Moreover, there is limited information in studies about the quality of nature areas in terms of what type of vegetation is present or what the size and form of the areas are.. Identification of the protection status of the studied environment is also absent for a large part of studies. In addition, the definition of "greenness" or "biodiversity" is somewhat blurred; studies may refer to biodiversity as a quality feature almost equally linked both to public urban parks and to protected areas. There are, however, considerable differences in biodiversity linked to different types of nature areas.

In fact, there are currently only two studies that assess mental health benefits based on the quality of green spaces, using different non-validated audit tools and based on subjective judgment (Gascon et al., 2015). In a Swedish study, access to serene and spacious green spaces was associated with a reduced risk of poor mental health in women who were physically active measured with the General Health Questionnaire (Annerstedt et al., 2012). A cross-sectional study conducted in the Netherlands took into account street greenness

and its relation to better mental health (De Vries et al., 2013). It seems that there is not a standardised approach to define exposure to green or blue space, and each study defines surrounding greenness and access to green space in its own way (Gascon et al., 2015). This has led to the consequence that urban planning generally takes a one-sized-fits-all approach by setting broad provision-based targets and guidelines for urban green infrastructure (Shanahan et al., 2015).

London - Queen Elizabeth Olympic Park, UK

Located in East London and a formerly deprived area, the Olympic Park has been at the heart of a major urban regeneration plan. A number of activities are taking place such as gardening, urban farming, meeting of community groups (e.g. obesity related). The aim is that the park provides real, positive benefits for the people of east London. The beneficiaries include the local youth, people with disabilities, and those who want to practice community sports. A growing family of volunteers embodies the spirit and energy of the park. The visible role of civic society in developing the activities within this green space makes this Olympic Park a unique example of nature-health-social nexus. The development of this region may thus be viewed and further investigated as a system of health-promoting social activities in nature.

More information: http://queenelizabetholympicpark.co.uk/our-story/get-involved/current-projects

Green Exercise Partnership, Scotland

Across Scotland, Green Exercise Partnership (GEP) brings together a range of actors so that a Natural Health Service can complement the National Health Service. A key work stream for the GEP is working with the National Health Service to make use of environmental assets surrounding health care settings as a health-promoting resource. A demonstration project started in 2010 which has enabled the green space around number of hospital sites to be developed for therapeutic purposes for patients, and for physical activity and relaxation for staff, visitors and the neighboring community. Landscape and access improvements bring a range of health benefits, as well as enhancing biodiversity and delivering more cost-effective estate management systems. At some sites, information about other green exercise assets such as local paths or Health Walk Groups is being collected so that health practitioners can promote nearby opportunities to their patients.

Isle of Wight Green Gym (http://www.footprint-trust.co.uk/greengym.htm)
Discovery Quest in Norfolk (http://publications.naturalengland.org.uk/file/10620067)
http://www.discoveryquest.org/

6.3 The role of supporting instruments and governance

Healthier lifestyles and nature experiences in citizens' everyday lives may be catalyzed with various governance mechanisms targeted to special audiences. To achieve the potential benefits from healthier lifestyles, health and social departments in cities and municipalities are relevant actors to be incorporated. Successful activities need to not only involve green space but also health and social care professionals. There is also evidence from a few cases

(those involving urban gardening or therapy farms) that NGOs and small enterprises may be important initiators or catalysts, if only given the opportunity to make use of nature. NGOs are particularly active cross-sectoral collaborators. Discernible examples from different parts of Europe also show that EU funding, in particular through the structural funds, has been important to bring relevant lifestyle-related activities to natural parks or other green infrastructure areas.

For children and the elderly, the promising case examples above suggest placing green areas next to day care centres, schools and seniors' homes, or enhancing the use of existing ones. They should also be made more attractive by collaboration between city planners, landscape architects and service designers, and of course the users themselves.

In the same way, employers would for example benefit from healthier workers if business centres had close proximity to a small green space that can easily be enjoyed during a walk at lunch time or on the way from parking lot or commuter traffic station. Evidence above suggests that even small green areas may bring about positive health and well-being impacts, thus availability of green spaces and access to them are pivotal in bringing opportunities to a large group of people. This challenge may be tackled by collaborative efforts between city planners and the construction industry.

The Ikaalinen forest trail example above illustrates the potentially important role of regional councils and EU's development funds in providing financial support for infrastructures that facilitate greener lifestyles. Dissemination of scientific evidence and promising examples from different EU countries may be used as justifications for raising the profile of supporting greener lifestyles on the thematic ranking lists of development programmes (including the European Structural and Investment Funds).

Research and development programmes, such as "Wellbeing from Forests" in Finland and "Forest and Health" in Sweden appear to have catalyzed novel interdisciplinary collaboration between various research, funding and practitioner organizations, yielding pioneer projects that investigate and practically promote positive health impacts from being in and experiencing nature. Often the practical pioneer work relates to therapy, rehabilitation or other green care activities, supported by local municipalities and providing work for micro-sized enterprises.

Research knowledge and evidence should be used more in policy making. Good practices which could be based only on experiences are often used more than evidence-based research or best practices. What is needed in cross-sectoral projects is to strengthen the voice of research in relation to development and to interweave research together with planning, implementation and evaluation of the projects. Funding instruments should also be launched which allow for both research and development together in the same projects. In addition, researchers should make usable and comprehensible packages about their findings for politicians so that politicians could use them in their work.

6.4 Conclusions and recommendations

From the scientific evidence and practical experience that has been discussed from projects across Europe, a number of recommendations can be derived. Key goals for health promotion for urban, peri-urban and rural populations include:

- To strengthen partnerships and communication between different research disciplines, health and environment sectors. Since the field is multidisciplinary, there are always challenges concerning the nature of relevant evidence and reliable research methods.

- To promote understanding of the health and well-being benefits of nature through media and community projects that raise public awareness

- To promote access to nature in schools, workplaces, hospitals, healthcare centres and homes for the elderly.

- To train teachers, health workers and administrators of public natural spaces to facilitate nature encounters. Teachers and other practitioners should be more aware of nature's positive influences on child development. There is a need to develop networks for teachers, local environmental management institutes/organisations and nature centres.

Governance structures on a broader level need to provide encouragement to transdisciplinary programmes that focus on nature and wellbeing benefits and contain a strong practical dimension. Simultaneously, local governments are responsible for offering suitable facilities, health and social care services, and enabling regulation for offering green care services.

7 Outdoor Recreation and Physical Activity

7.1 Health risks related to low physical activity

In this chapter, we focus on the contribution of natural environments to outdoor recreation and physical activity in urban and rural areas, both as green infrastructure and as protected areas. We discuss how the supply of nature environments can support the health and well-being of citizens and illustrate how different nature-based projects can promote physical activity.

The research evidence shows that nature stimulates people to be more physically active. The definition for physical activity is a broad one. The main focus of the overview is mainly on everyday recreation activities such as walking, cycling, outdoor play, working in the garden and other activities taking place in nature areas, and less on sports and other competitive physical activity. Physical activity is also an essential part of many outdoor recreation activities in national parks and other protected areas such as hiking, snowshoeing, canoeing and cross-country skiing.

Traditionally, physical activity is related to energy expenditure and being physically fit. The other positive effects of exercise in nature, such as positive emotions from being in nature, supportive community relationships, stress reduction, improved mental health and aesthetic experiences, are less discussed in research related to physical activity. Due to recently acknowledged health risks of sedentary behaviour, even light physical activity is now considered significant in terms of health risk reduction (Tremblay et al., 2011). In this chapter, we concentrate on studies that look at the contribution of nature on physical activity in a larger scale.

This chapter discusses the importance of natural environment for physical activity and the influence of physical activity in green areas on human health and wellbeing. Moreover, examples of interventions and programs promoting physical activity in green areas are presented. We also discuss governance mechanisms that support or constraint using green areas for physical activity.

In Europe, low physical activity levels are one of the biggest health risks. Approximately one third of adults do not reach the recommended level of aerobic physical activity in Europe (34·8%, worldwide 31·1% respectively), where the physical inactivity is defined as not meeting any of these three criteria: 30 min of moderate-intensity physical activity on at least 5 days every week, 20 min of vigorous-intensity physical activity on at least 3 days every week, or an equivalent combination achieving 600 metabolic equivalent (MET)-min per week (Hallal et al., 2012). Moreover, the proportion of individuals who do not reach the recommended level of moderate-to-vigorous physical activity among 28 European Union countries is 28.6%, from 12.4% in Sweden to 53.7% in Cyprus, with wide inequalities between and within countries (Gerovasili et al., 2015). Based on the European Social Survey (including 29 European countries), the likelihood of not reaching the recommended physical activity level is highest among the younger age group (18-24 years old in this study)

(Marques et al., 2015). Physical inactivity has become the fourth leading risk factor in Western Europe and other high-income regions. Globally, physical inactivity causes approximately three million deaths per year, (Lim et al., 2012) as well as 6–10% of coronary heart disease, type 2 diabetes, and breast and colon cancers (Lee et al., 2012). As a cause of death, inactivity is considered as a "new smoking" as it causes as many deaths as smoking (Lee et al., 2012).

Overwhelmingly due to physical inactivity and unhealthy diet, more than half of the EU population is overweight or obese (WHO, 2013). The WHO considers obesity as one of the greatest public health challenges of the 21st century as it significantly increases the risk of chronic diseases such as type-2 diabetes , cardiovascular disease, hypertension, coronary-heart diseases and certain cancers, as well as psychological problems for individuals associated with obesity (Eurostat, 2015a). The prevalence of overweight adults varies between 30-70% and obesity between 10-30% in EU countries (WHO, 2015). Worldwide, the proportion of overweight adults is increasing; between 1980 and 2013, the prevalence in men increased from 29% to 37%, and in women from 30% to 38% (Marie et al., 2014). The problem arisesindependent of gender, age-groups or other socio-economic factors.

In Finland, only one quarter of adults (Husu et al., 2010) and half of 7-12 year-old children (Gråsten et al., 2014) meet the health-enhancing physical activity guidelines. The Prevalence of overweight/obesity is 65% among Finnish men and 46% among women (Männistö et al., 2015). For Finnish boys and the girls, these prevalences are 26% and 21%, respectively (Marie et al., 2014). The prevalence of being overweight and obesity has over trebledamong 12-18 year old boys and girls since 1970 (Kautiainen et al., 2009).

"There is a large body of evidence across a variety of study designs which suggests that decreasing any type of sedentary time is associated with lower health risk in youth aged 5-17 years. In particular, the evidence suggests that daily TV viewing in excess of 2 hours is associated with reduced physical and psychosocial health, and that lowering sedentary time leads to reductions in BMI" (Tremblay et al., 2011).

Challenges with obesity and type 2 diabetes are extremely costly to the society. Among the top ten countries worldwide with the highest health expenditures for diabetes, three of those were EU countries (Germany, France and Italy) in 2015 (IDF Diabetes Atlas, 2015)

In addition to causing costs to society, these lifestyle-related health issues significantly lower the quality of life at an individual level. Evidence shows that green exercise (activity in the presence of nature) leads to positive short and long-term health outcomes. A study in the UK by Bird (2004) estimated that if 20% of the population who live within 2 km of a green space used it for 30 minutes of physical activity per day on five days per week, the saving to the National Health Service could be over £1.8 million (€2.7 million) per year (Bird, 2004). An improved understanding of the empirical links between GI and health will lead to increasingly detailed and accurate estimates of the economic implications of GI.

7.2 Health benefits based on physical activity in green areas

Natural environment, physical activity and preventon of diseases

There is a large amount of literature about the positive effect of physical activity on physical and mental health (see e.g. Lee et al., 2012). There are plenty of studies about the positive effects of physical activity on human health, but only few studies have analysed the effects of exercise in a natural environment on health and wellbeing. The question is, if physical activity in nature could produce some additional effects, is there something in nature that raises the positive effects of physical activity?

The literature shows that nature areas are attractive environments for physical activities across Europe. A large share of recreationists consider natural environments as more attractive activity settings than built up areas. Among natural areas, forests are considered one of the more attractive types of nature, although landscape variation is highly appreciated (Tyrväinen et al., 2005).

In urban nature areas, walking tends to be the most common recreational activity. Other common activities are cycling, jogging and roller skating, as well as having picnics and picking berries and mushrooms, depending of the qualities of nature areas. Physical activity is one of the key mechanisms explaining possible health benefits linked to urban nature areas. However, several studies have shown the link between the health and natural environment which are independent of physical activity. The other mechanisms include restorative, stress-alleviating experiences, and social interaction, cohesion and/or safety (Korpela et al., 2014).

Avoiding a sedentary lifestyle has a variety of health benefits, both preventative and restorative. For example, increased physical activity linked to access to green spaces is associated with a reduced risk of stroke (Wannamethee and Shaper, 1999), cardiovascular disease (Lee et al., 2001; Sesso et al., 1999) and obesity (Nielsen and Hansen, 2007). Availability of nearby GI therefore not only encourages people to take more physical exercise, but also to travel more sustainably by either foot or bicycle through green spaces which has an additional benefit in reducing CO_2 emissions produced by other transport (Moffat et al., 2010).

For example, active contact with nature, i.e. recreational walking in a natural setting, as opposed to an urban environment, has been found to significantly reduce blood pressure (Hartig et al., 2003). Participating in activities in green settings reportedly improves the functioning of 7-12 year old children with attention deficit disorder (Faber-Taylor and Kuo, 2009). One suggested mechanism for such associations is that emotional changes triggered by nature can induce or mediate physiological changes (Tzoulas et al., 2007).

In addition to observations about the positive impact of increased contact with nature, the relationship has also been studied in reverse. For example, environmental stress caused by the removal or deterioration of natural habitat has been linked to chronic anxiety, chronic stress and high blood pressure (Henwood, 2002), and the perception of ill-health of inhabitants of Karachi, Pakistan (Qureshi et al., 2010).

Extensive literature suggests exercising and being physically active in green areas has especially positive effects on mental health. Physical activity in green areas has several benefits for human health and well-being, for example, feelings of restoration and emotional wellbeing (e.g. Hartig et al., 2014). Contact with nature has restorative effects; it helps people to cope with and recover from physical and mental stress, and improves mood and perceived health (Keniger et al., 2013). Mitchell (2013) assessed whether physical activities in natural environments produces greater health benefits than physical activity elsewhere. Analysis of the Scottish population-level data showed that regular use of natural environments was associated with a lower risk of poor mental health. This association was not found in other environments. Some experts are still not convinced whether the presence of green areas or nature is a causal factor in health effects or whether the benefits are dependent on the regularity of physical activity. However, the evidence from recent meta-analysis shows that physical activity in nature in comparison to other environments is related to higher vitality levels, attention restoration, diminished negative affects, and general mental health (Thompson et al., 2011).

The evidence suggests that exercising and being physically active in green areas provides not only physical health benefits but also positive effects on mental health. There is strong evidence that green areas support the level of physical activity undertaken. The evidence shows that proximity of green areas improves physical activity and that green spaces should be relatively close to residential areas. This effect is observable if the green areas are no more than 1 km from home (Neuvonen et al., 2007). A Canadian study showed that participants who reside in the highest quartile of greenness, based on a 500m buffer, participate in leisure-time physical activity more when compared to those in the lowest quartile. The association was stronger among younger adults, especially women (McMorris et al., 2015). Outdoor walking is associated with higher levels of enjoyment, and people tend to exercise for longer periods when outdoors (Neuvonen et al., 2007; Focht et al., 2009; Gladwell et al., 2013). For example, in Helsinki, Finland, those respondents who lived in the suburbs with the greenest areas had on average 169 close-to-home recreational visits per year. In the centre, where there is less green space, the number of visits was 137, which was a statistically significant difference (Neuvonen et al., 2007). In the suburbs, outdoor recreation is related to leisure time physical activity and to self-rated health (Pietilä et al., 2015). For children, playing outdoors is associated with higher levels of physical activity compared to playing indoors (Sallis et al., 2000).

Natural environments are described as more challenging, dynamic and stimulating environments. The natural environment stimulates imagination and different movements (Boldemann et al., 2006). This means that green areas and environments that support outdoor activities have direct positive links to health. In addition to the amount of green areas in residential areas, the landscape attractiveness contributes to the frequency of visits to green areas (Giles-Corti et al., 2005; Roemmich et al., 2006). A study conducted in Australia suggests that people who live near attractive public open spaces walk almost twice as likely at moderately active levels than those who do not have access to public open spaces (Carnegie et al., 2002).

The evidence suggests that green areas increase the level of physical activity. In Europe, there are several projects that promote people going outdoors. some of which have been

very successful (e.g. see below the example of Moved by Nature project in Finland). Attractive opportunities for outdoor recreation in natural parks close to highly populated areas have been established for example in Zagreb, Croatia (the Medvednica Nature Park), and Sintra-Cascais, Portugal (Quinta do Pisão) see Appendix for details.

Restorative and pleasant experiences while being outdoors

The evidence suggests that people want to spend more time exercising in green areas. There are comparative studies where comparison is made between indoor and outdoor environments. Physical activity in nature seems to provide additional mental health benefits over indoor activities (Barton and Pretty, 2010). Furthermore, nature has beneficial effects on social cohesion and sense of belonging. Also, outdoor settings in fitness centres are rated as more restorative compared to indoor exercise alternatives, and the restorative quality predicts the frequency of exercise (Hug et al., 2009). This means that people want to spend more time in green areas and therefore health effects accumulate. The causal chain model by Korpela et al (2014) indicates indirect health benefits of nature. The model tested the links between self-reported participation in nature-based recreation and emotional well-being through restorative experiences. The restorative experiences in nature were more important than social company (Korpela et al., 2014).

An example of a project providing natural outdoor environments for citizens, Finland

OPEN AIR projects were conducted by Parks & Wildlife Finland in 2012-2014 as part of their Healthy Parks Healthy People Finland programme. OPEN and AIR formed a project partnership. OPEN focused on providing quality natural outdoor environments for the citizens of Oulu, aiming to motivate people to spend time outdoors and engage in regular physical activity in green spaces. The network of recommended green spaces for inhabitants and visitors including also several Natura 2000 sites, as advertised as Oulu Outdoor Zone (http://www.visitoulu.fi/en/activities+nature/oulu+outdoors+zone/). Communicated as a form of preventive medicine, it is hoped to replicate the model across Finland. AIR in turn was about finding new ways to provide therapy in natural environments and protected areas for different target groups, utilizing “OPEN” locations, and involved nursing students. The projects were funded by the European Social Fund and European Regional Development Fund.

More information:
http://www.metsa.fi/sivustot/metsa/fi/Hankkeet/Rakennerahastohankkeet/OpenAir/Sivut/openairenglish.aspx

Nature-based exercise which makes a difference, Green Gyms, UK

The Green Gym is a concept developed by the British Trust for Conservation Volunteers (BTCV), Shell UK and Countryside Agency (now Natural England). The Green Gym aims to combine physical activity with environmental protection. The Green Gym aims to promote physical health by moderate physical activity and mental health through restoration in nature. Participants are invited to join free and fun guided outdoor sessions on e.g. planting trees, sowing meadows, or establishing wildlife ponds. The activities thus improve the greenness and biodiversity of participants' surroundings. The program encourages sustainable behaviour and has combined motives to raise awareness and promote positive attitudes towards nature conservation and to promote sociable and enjoyable exercise in the natural environment, contributing to improved physical and mental health. The activities also encourage the participants to walk and cycle more.

The Blue Gym is a similar concept, with the same framework as Green Gym but uses blue spaces instead.

More information: http://www.tcv.org.uk/greengym

Which environments support physical activity and health effects?

The clearest differences are found between green areas and built-up environments. There is evidence that physical activities in natural areas (e.g. urban parks) compared to built-up environments have a positive influence on human health and wellbeing. Middle-aged adults exhibit improvements in feelings of restoration, positive emotions, and vitality when walking home after work through an urban park or woodland, versus the city centre in Helsinki, Finland (Tyrväinen et al., 2014). Experimental studies with pre- and post-test design show better cognitive and affective functioning after being in green environments (the test period is usually from half an hour to one hour). The cognitive functioning includes increased memory performance (Bratman et al., 2015) and restoration from cognitive fatigue after mentally challenging tasks among adults and children with attention deficit (Berman et al., 2008; Faber-Taylor et al., 2009; Shin et al., 2011). The results show that not all outdoor areas (built-up areas vs green areas) are equally good for stress relief and restoration during outdoor visits.

There is not enough evidence to say which kind of natural areas are the best for physical activity in nature. A meta-analysis of ten studies in the UK (Barton and Pretty, 2010) shows that participants had improved mood and self-esteem in every green environment and the presence of water enhanced these effects. The health and well-being effects for men and women where somewhat similar. Both men and women had similar improvements in self-esteem after green exercise, but only men show difference for mood. It is not clear why this effect occurred. The change in self-esteem is also highest for younger people, with diminishing effects with age. Probably the most important finding is that the mentally ill have the greatest self-esteem improvements. This means that being in green areas and green exercise should be incorporated into mental health services and as well as other health care services. The environment provides an important health service.

Evidence from preference studies suggests that large green areas, mainly forests and other extensively managed areas are preferred for outdoor activities (Tyrväinen et al., 2007). Although the presence of accessible attractive green space is likely to engage residents in frequent physical activity, current knowledge does not allow a classification based on the characteristics of green spaces that directly encourage use for physical activity. The key attribute for classifying green space in relation to health is its functionality for physical activity (Semanzato et al., 2011). A number of studies have examined barriers and opportunities in the use of parks and green areas and their influence on physical activity levels for the population using them. Many of the barriers are related to demographic or social characteristics, such as age, gender, race/ethnicity, socio-economic status (Lee et al., 2001). Others are related to specific physical features of the green areas, and might be easier to be dealt with through planning and design solutions. There is a need for more research regarding features that can promote the use of nature areas for physical activity (Semanzato et al., 2011).

Programs and other initiatives promoting physical activity

Nature areas are used for various kinds of outdoor activities. Protected areas are typically important for nature-based tourism across Europe, although in Nordic countries recreation and nature-based tourism has expanded also to commercial forests that include private lands. In Finland, only 27% of overnight visits of all nature-based tourism trips take place in protected areas, as a large share of the trips are linked to second home visits (Sievänen and Neuvonen, 2011). In Finland, during the year 2014 there were 2,287,000 visits to protected areas. In Europe the participation rates to forests recreation (Denmark, Finland, France, Germany, Hungary, Ireland, Norway, Slovakia, Switzerland and UK) vary between 40-100 per cent (Sievänen et al., 2007). The difference in percentages could be partly an artefact of methodology, but there are likely cultural, or regulation differences in different countries.

Currently the visitor monitoring methods between countries vary and do not allow exact comparisons. In Nordic and Baltic countries, ongoing work aims at harmonizing the visitor-monitoring methodology in nature areas. Information on visitors to nature areas is essential for managing outdoor recreation to ensure quality recreation experiences and tourism development. Kajala et al (2007) published a manual, available online which focuses on practical matters: how to carry out visitor counting and visitor surveys and how to report the results.

Parks & Wildlife Finland: Health impact assessment as part of national park visitor monitoring

Parks & Wildlife Finland, a part of Finnish state forest enterprise Metsähallitus, conducts regular visitor monitoring surveys in the national parks and other nature conservation areas. Parks & Wildlife Finland launched a Healthy Parks Healthy People Finland programme in 2010 with an aim to improve population health through nature experiences, activities in nature, and nature-connectedness. As part of the programme, Parks & Wildlife Finland developed a survey to assess the health impact of the national parks and other state-owned protected areas. Since 2013, the organisation has collected information on national park visitors' perceptions of the social, psychosocial and physical health and well-being benefits as part of the regular visitor monitoring. The original data was collected in 2013 in Kevo Strict Nature Reserve and Kurjenrahka, Patvinsuo and Repovesi National Parks, which are all Natura 2000 sites, representing northern, south-western,

south-eastern and southern Finland respectively. Park visits were found to improve mood and enhance psychological well-being in particular (Kaikkonen et al., 2014). Average economic value for the participants' perceived health benefits, evaluated by the visitors, was €208. This figure is drawn, however, from a pilot study, and the methodology has not yet been scientifically evaluated by economists working in health economics or valuation of ecosystem services (Vähäsarja, 2014).

Access to natural areas promotes physical activity directly, but physical activity is also an essential part of mushroom and berry picking activities, as well as fishing and hunting. National laws regulate the activities in forests and other nature areas across Europe.

In Nordic and Baltic countries, however, freedom to roam or everyman's right regulates activities in forests and other undeveloped land that allows access to private forests including the opportunity to pick mushrooms and berries.

Discovering nature through physical activity, France

Three Regional Nature Parks in the **Nord-Pas de Calais** region (Avesnois, Caps et Marais d'Opale, Scarpe-Escaut) have partnered with the regional council to form a unique type of public organization. It is funded by the region and aims to improve citizens' opportunities to move outdoors. The role of ENRx (Espaces Naturels Régionaoux Nord-Pas de Calais) is to pool services, coordinate inter-park programmes and transfer their experiences and know-how to the regional level. The priorities are communication, eco-events, Natura 2000, sustainable mobility and health & well-being.

Within this framework, a new network "Sport-Nature-Health" has been established. The objective of this initiative is to enable people to discover nature and biodiversity through physical activity. The network focuses on those people who don't practice sports. Meetings involve awareness raising, discussion with various experts, relaxation and laugh therapy to make it engaging and entertaining, as well as workshops to learn about cycling, Nordic walking, canoeing, etc. The participants encounter a nature-health challenge with a daily objective of 10,000 steps or three lots of 10 minutes of moderately intense activity. The use of existing hiking trails is encouraged, and guides employed by the park are available to assist.

Source: http://www.europarc-ai.org/wp-content/uploads/2015/02/Health_Webinar_MDesbois_ENRx_15122014.pdf

Quantifying the Health and Social Benefits of Nature: Physical Activity & Outdoor Recreation

The health benefits of regular exercise are well established; however, in Europe most people do not follow recommendations for regular exercise. Physical exercise can reduce the risk of cardiovascular disease, diabetes, and forms of cancer, as well as supporting mental health. The costs of physical inactivity are a significant burden on public health, society and the economy. The literature and cases reviewed in this project suggest that nature and biodiversity can facilitate physical activity. Based on the best available evidence, the study team attempted to quantify potential benefits of nature for physical education.

Methods: This task focused on the existing research on the valuation of the health and social benefits of nature and biodiversity protection with respect to physical recreation. Quantifying the benefits helps to communicate them to a wider audience. A growing body of evidence directly links nature based solutions to physical inactivity (including robust methodologies). Nevertheless, data which quantifies benefits (particularly in monetary terms) are rare. An exploratory assessment of the contribution of nature to exercise has been made here. This will build on the research outlined in this chapter, and build an exploratory methodology to support future research and suggest possible policy implications.

Step 1: Key variables - assess the data from the literature

- Review the EU wide scale of health costs associated inactivity. Identify independent variables.
- Develop the evidence base on the contribution of nature to outdoor physical activity – i.e. where does Natura 2000 or GI offer benefits. Identify dependent variables and relationships.

Step 2: Cases and Impacts

- Explore existing analysis on the benefits of nature to exercise.

- Explore how a more complete picture of the contribution of nature to physical exercise can be established

Step 3: Policy and research implications

- Conclusions – in the context of the robustness of the evidence what can be said how the benefits of nature for physical recreation
- Policy implications – how can further work in this area support sustainable policy making drawing on the multiple benefits of nature.

Step 1: Key variables and causal links

Physical activity (recommendations and practice): Physical activity is any movement of the body which requires energy expenditure, "it is a fundamental means of improving physical and mental health" - the WHO provide Global Recommendation on Physical Activity for Health (WHO, 2010). In the WHO Europe region physical inactivity accounts for: more than half of the population (WHO Europe, 2015)**.**

Health (burden of disease, morbidity and mortality, DALYs, obesity): For WHO Europe, the impacts of inactivity are estimated to be 1 million deaths per year and 8.3 million disability-adjusted life years (DALYs) (WHO Europe, 2015)**.** Trends globally and in Europe are towards less activity. Inactivity

contributes to obesity, in 2012 across the EU-27, 17% of adult men and women were obese (ISCA/Cebr, 2015). Health risks linked to inactivity include heart disease, stroke, Type II diabetes, colon cancer, breast cancer, psychological well-being and depression (Warburton et al., 2006).

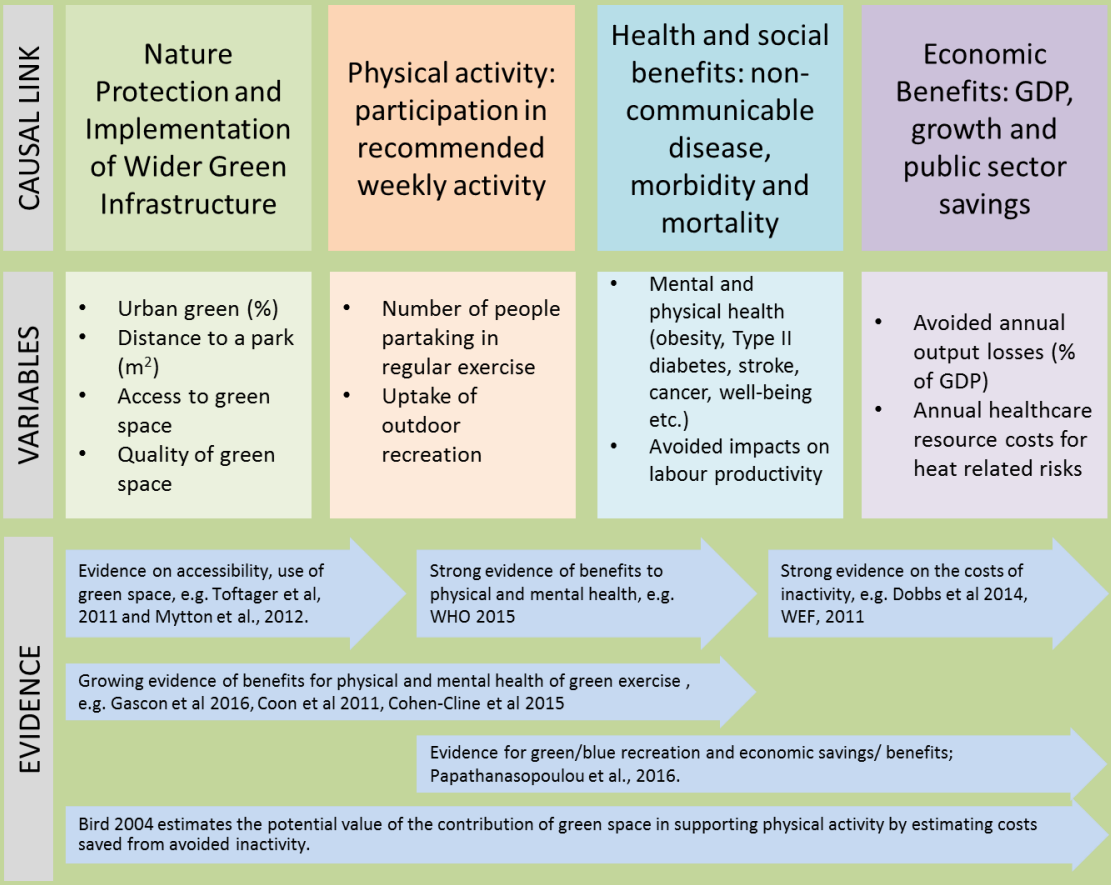
Green Exercise: Nature helps people to meet their recommended levels of regular physical activity, and providing additional health benefits in contrast to exercise not carried out in green spaces. In Europe more than 40% of physical recreation takes place outside (European Commission, 2010b). Reduced morbidity and mortality and increased physical activity have been linked to the access to green and blue space (Gascon et al., 2016; Coombes et al., 2010)**.** Evidence suggests that exercise in green spaces provides both physical and mental health benefits (Thompson Coon et al., 2011; Cohen-Cline et al., 2015; Grazuleviciene et al., 2015). A study by Cohen-Cline et al. found that green exercise increased self-esteem and mood irrespective of the duration, intensity, location, gender, age and health status (Cohen-Cline, et al., 2015). It has been found that exercising in green spaces or natural scenery has both mental and physical benefits in comparison to urban or synthetic environments (Pretty et al., 2005; Bowler et al., 2010; Coon et al., 2010; Gladwell, et al., 2013).

Access to nature: Access to quality nature for urban populations increases the likelihood that individuals to exercise regularly and more rigorously. In Bristol it was shown that respondents living closest to the type of green space classified as a Formal park were more likely to achieve the physical activity recommendation and less likely to be overweight or obese (Coombes et al., 2010), comparable results were found for the whole of England (Mytton, et al., 2012). In Denmark people living more than 1 km from green were more likely to be obese (BMI ≥ 30) and less to exercise rigorously than those living closer than 300m (Toftager et al., 2011). In cities access to nature is often determined by wealth (Lee & Maheswaran, 2011).

Quality of nature: the characteristics of natural spaces determine how they can be used for recreation: size, quality and type of green infrastructure can determine health benefits in terms of physical recreation (Paqueta et al., 2013). The presence of trees, water, large lawns can increase the use of green spaces for physical activities (Schipperijna et al., 2013).

Society (gender, age, and wealth): Human activity is statistically linked to gender (ISCA/Cebr, 2015), age (WHO Europe, 2015; ISCA/Cebr, 2015) and socio-economic status (European Commission, 2010; ISCA/Cebr, 2015). Poorer people tend to have less free time, limited access to facilities or live in environments that do not support recreation (WHO, 2010).

Jobs and growth (output losses and health care costs % of GDP): Inactivity costs the European economy ~€80 billion per year (ISCA/Cebr, 2015) – or 6.2% of all European health spending. Global estimates of the costs of inactivity to economic output €1.8 trillion, 2.8% of global GDP, comparable to armed conflict or smoking (Dobbs et al., 2014; WEF, 2011). In the UK it was estimated that in 2004 physical inactivity cost the economy GBP 8.2 billion, and that increasing access to one local green space in Portsmouth could save the economy GBP 4.4 million, including GBP 910,000 to the NHS (Bird, 2004). One UK study estimated that exercise in aquatic environments alone provided benefits of 24,853 QALYs, equivalent to GBP 176 million (Papathanasopouloua et al., 2016).



Step 2: Cases

Bottom up

Only one study was identified which directly linked nature conservation with monetised health and social benefits relating to physical activity. Bird (2004) shows for the UK the potential value of the contribution of green space in supporting physical activity by estimating costs saved from inactivity. This analysis is based on the amount of physical activity that two green spaces (a public park and a circular walk) can contribute to the total amount of physical activity taken. This analysis is based around exploring the following:

- How many visits are made to the park involving at least 30 minutes of moderate exercise?
- What the catchment area of the park is? What is the local population density?
- What is the cost of inactivity to the total and local population?

For the parks examined the analysis showed that a park in Portsmouth could save the economy GBP 4.4 million, including GBP 910,000 for the NHS. Similarly, a footpath in Norwich can save the economy GBP 1 million, including GBP 210,000 for the NHS.

The study by Bird (2004) focuses just on the role of green space in providing a space for physical activity for all parts of the population. The literature and cases explored in this chapter have also identified how nature based exercise may be prescribed as a treatment to vulnerable groups, such as the Moved by Nature project in Kuopio, Finland which targeted those at risk of type-2 diabetes. Such initiatives could amplify the benefits of green space for public health and expenditure. The economic

benefits of prescriptive use of green exercise would have to be measured against alternative treatments. The success of programmes such as Moved by Nature in Kuopio, or the Walkability project in Pembrokeshire is indicative that such initiatives can be successful and have the potential to be financially viable. In addition, wider benefits of nature based exercise, such as for mental health and self-esteem may also be considered in evaluations and research on nature based solutions.

Top down

With the EU wide economic burden of inactivity estimated €80 billion per year, even incremental increases in outdoor recreation can pay significant dividends to public budgets and the wider economy (ISCA/Cebr, 2015). Bird (2004) estimated that in the UK a single urban park of 20 ha could contribute on average GBP 5 million in value from physical activity, or 0.06% of the total nationwide cost of inactivity (in 2004). Considering the existing green space in the EU-28, including more than 25,000 Natura 2000 sites, without attempting to estimate the total monetary contribution, it is self-evident that these provide invaluable resources for public health. Without making considerable assumptions it is difficult to estimate the contribution of existing green space to physical activity in the EU. However, the evidence presented in this chapter suggests that the potential for benefits is considerable.

Step 3: Policy Implications and Research

Physical inactivity places considerable stress on health systems and the economy in all EU Member States. Assessing the contribution of green spaces to physical activity suggests that nature based exercise already contributes to maintaining levels of activity, but more can be done to promote improved levels of physical and mental well-being. The benefits of outdoor recreation for mental health needs also to be taken in consideration in valuations – these benefits are likely to further increase the value of nature based solutions in contrast to other approaches. Drawing on existing studies, it seems likely that investments in urban green can support a higher baseline of physical activity in urban populations in particular. Furthermore, targeted and prescriptive application of nature based exercise could increase potential benefits for vulnerable populations, including those less likely to be active. Policy options supporting nature based solutions need not just be interpreted as increasing green space. Other tools, such as educational programmes; nutrition; and the maintenance and protection of existing green space will all support the development of healthy communities. Future research into projecting how policy including greening strategies, or prescriptive nature based exercise, can increase levels of physical activity is needed. The exploratory analysis presented here strongly suggests that nature based solutions should be incorporated into approaches to addressing physical inactivity in Europe to the benefit of the economy.

What insights are there on Natura 2000 sites providing benefits – and to whom?

Nature project, Finland is a good example to illustrate how the Natura 2000 sites support the health and wellbeing of citizens. Parks & Wildlife Finland conducted Moved by Nature (Luonto liikuttamaan) in April 2013 - January 2015. It was an implementation project as part of the Parks & Wildlife's Healthy Parks Healthy People Finland programme. The project was mainly funded by the European Social Fund (75%) and by the public and private organisations (25%). The aim of the project was to promote health and wellbeing by embedding physical activity in the natural environment and urban green space into health and social services' practices. The project aimed to enhance the collaboration between nature and health and wellbeing sectors, and to increase the understanding of the health benefits of nature amongst target groups and the public. Most of the activities were conducted in Natura 2000 areas in Lieksa, Rautavaara and Kuopio. During the project, several pilot studies were conducted to develop and assess the best practices for targeting to hard-to-reach groups with an increased health risk (e.g. new immigrants, youth at risk of social exclusion, the long-term unemployed and obese working aged men at risk of type 2 diabetes). The hypothesis was that nature would motivate these groups to become physically and socially more active. Pilot studies were conducted in collaboration with several organisations from public, private and voluntary sectors. The main target groups included employees in the fields of health promotion, social care, education and natural resources and park management. To assess the efficacy of the nature-based health promotion activities, questionnaires, interviews and objective measures were used. In addition to pilot studies, the project included several seminars and work groups. Mass media and social media were actively utilised to inform professional and public audiences about the project and its results, as well as scientific evidence related to the health benefits of nature.

Unemployed people (unemployed > 500 days) were recruited to the pilot study conducted in collaboration with Lieksa social services. The aim was to improve the working abilities of the long term unemployed by offering weekly employment coaching that included group meetings in a national park, and regular employment support (e.g. CV writing, lectures). Nature activities lowered the participants' perceived barrier to participating in group meetings, enhanced their social skills and improved their mood and self-esteem significantly. By entering employment, costs to the City of Lieksa reduced significantly (€330/month/unemployed person). The model is now being adopted in the social services of Lieksa.

Pilot studies were also conducted to promote social integration of new immigrants. Interestingly, Somali women who had high rates of obesity were highly motivated to participate in nature walks organised by the immigrant services. Walks in nature were found to be relaxing and enjoyable, and it also offered a natural surrounding for immigrants and locals to socialise even without a common language.. Participation in nature walks was considered convenient for mothers staying at home with several small children. Both for Somali men and women, learning to know Finnish nature, berries and mushrooms, improves their chances of receiving income through forest products. The pilots were conducted in collaboration with immigrant services and voluntary organisations.

Nature activities were also embedded in vocational school curricula to prevent social exclusion. Four faculties organised 1-2 day nature trips three times during the programme, at the beginning and at the end of the study year, and at the beginning of the second study year (approximately 80 students participated). The aim was to increase cohesion amongst the group and to promote students' and teachers' physical, mental and social wellbeing by outdoor activities in nature. Both the teachers and students found the nature trips important for increasing group cohesion and feelings of belonging and self-efficacy, all of which are important determinants of social inclusion.

Moved by Nature – Kuopio, Finland

Moved by Nature's aim was to promote the collaboration between **nature** and **health sectors** in Finland to allow **vulnerable groups** to benefit from access to **physical activity in natural spaces across Finland.** Studies and pilots were carried out in a number of areas, working with different population groups.

The pilot study in Kuopio included men at risk of type 2 diabetes. The eight meetings in total covered different outdoor activities (e.g. canoeing, hiking, horse-riding, ice-fishing), lifestyle counselling, and healthy food preparation together in nature.

16 men at risk of type 2 diabetes were involved in the pilot and reduced their group weight by 60 kg in total. Positive changes were also observed with body mass index, activity level, body composition, visceral fat level, physical fitness classification, and oxygen uptake (Kaasalainen et al., 2015). The Moved by Nature program was Funded by **the European Union Social Fund** (75%) and **public and private organisations**, with a total budget of **€348,000.**

According to the program results, nature has great untapped potential in the promotion of physical activity, health and wellbeing of the groups usually considered as hard-to-reach population groups. Embedding nature in health and social services simultaneously produces physical, mental and social benefits. Mental health plays a major role in participation in social or physical activities. According to several studies, nature enhances mental health significantly. The results of Moved by Nature are encouraging. It is recommended that nature should be utilised more in the promotion of physical activity and health promotion. (see http://www.metsa.fi/sivustot/metsa/fi/hankkeet/rakennerahastohankkeet/luontoliikuttamaan/sivut/default.aspx)

Improving access for disabled people - "Green Routes without Obstacles", Latvia

The Nature Conservation Agency of Latvia has led a project "Green Routes without Obstacles", funded by the EU's cross-border cooperation programme. The project aimed to improve access and routes to Razna National Park, a relatively newly established park and Natura 2000 site in South-eastern Latvia, close to the border of Belarus. Through collaboration between NGOs and governmental partners from Latvia, Lithuania and Belarus, new routes were established and equipment for physical activity was set up to cater especially for people with disabilities. Training was also organised for nature tourism entrepreneurs on how to offer services using the park and the equipment. The project made several nature tourism sites accessible to disabled people in Latvia (Rāzna National Park, Ezernieki), Lithuania (Grazute Regional Park) and Belarus (Zaboriye) border regions. A tourism booklet called "Green Routes" was published and distributed to organisations representing disabled people that detailed all nature tourism attractions that were adapted for people with disabilities.

More information: http://www.enpi-cbc.eu/go.php/eng/1S_6_project_LLB_2_257/1093

What are the insights?

Most current research is linked to outdoor recreation areas or urban parks, because they are easily accessible and frequently used by citizens. The current research evidence suggests that exercise in nature areas provides not only physical health benefits but also psychological ones and therefore, physical activity in nature areas should be encouraged throughout Europe. The health benefits linked to physical activity are delivered through several mechanisms including a healthy environment for activities with less noise and cleaner air, but also through restorative effects of diverse and attractive nature environments.

Nature areas can be viewed as areas providing low threshold environments for persons starting to become more physically active. In nature areas, there are fewer demands for high physical performance, yet they encourage people to move and have exercise, with the main focus being on observation of the nature environment. For some user groups this may be the key motivating factor for participating in outdoor recreation.

Natura 2000 sites and other protected areas have great potential as places for physical activity given that they are accessible and have basic recreational infrastructure such as trails and guidance linked to specific areas. There is also a good collection of finished or ongoing practical projects that use well-located Natura 2000 sites or protected area for engaging people to increase their physical activity in everyday life. One of the ongoing projects in Finland includes collaboration with the Sipoo municipality healthcare centre, Natural Resources Institute Finland (Luke) and a local entrepreneur Luonnontie Ltd. which aims to engage depressed patients and those with type 2 diabetes to actively use Sipookorpi National Park as a support tool along with their current health treatment.

What insights are there on GI providing benefits? What type of GI provides what benefits and to whom?

Research on physical activity has previously focused on individual-level factors, showing how demographic factors such as age, sex, education, health status, self-efficacy and motivation are associated with physical activity. Ecological models have recently gained attention by taking a broader view of health behaviour causation. These models include the social and physical environment beyond the health sector as contributors to physical activity. Nature areas, parks and trails are examples of such environments (Bauman et al., 2012).

An extensive body of literature now suggests that the natural environment promotes physical activity and health in multiple ways. Therefore, the natural environment and green exercise can be utilised in encouraging physically inactive people to adopt a physically active lifestyle. A large part of society makes up these aforementioned target groups, but in particular those who suffer or an in danger of suffering from lifestyle-related diseases. Easily accessible green areas have a strong influence on the possibilities for physical activities amongst children and elderly people. Moreover, lower income groups that have limited access to other outdoor recreation services are largely dependent on the provision of public green areas. Therefore, in low-income housing areas, adequate provision of nature areas is needed as it contributes to reducing health-related inequalities in society. The extent of green areas in residential areas is typically linked to the socio-economic qualities of the area; better-off families live in green environments and low-income families live in areas with less green areas and the green areas themselves tend to be of lower quality..

This type of development needs enhanced collaboration between the agencies dealing with land-use planning, provision of sport and physical activity services and green area management. One of the key foci of this work is to pay attention to the environment in which physical activity takes place or is encouraged to, such as cycling and walking routes and playgrounds. More emphasis should be put on, for example, how the surroundings of the routes or specific sites could be improved by landscaping, or how cycling and walking routes can include as much health-promoting green environments as possible.

A study in the UK (Bird, 2004) estimated that if 20% of the population who live within 2km of a green space used it for 30 minutes of physical activity per day on five days per week, the saving to the National Health Service could be over £1.8 million (€2.7 million) per year. This noteworthy result suggests that city planners need to safeguard availability and access of green spaces for dense urban residential areas in particular. Furthermore, the result indicates that those citizens living within a close proximity of green areas are a target group with a high potential for nature-health interventions. Efforts are needed to facilitate both supply and demand of green space.

The Exercise Referral Scheme, Pembrokeshire National Park, Wales

The National Exercise Referral Scheme (NERS) is a Welsh Assembly Government (WAG) funded scheme which has been developed over the last 4 years to standardise exercise referral opportunities across all Local Authorities and Local Health Boards in Wales. The Scheme targets clients who have a chronic disease or are at risk of developing a chronic disease. The Exercise Referral Scheme is a program of activities designed for those who are currently not active or who exercise less than three times per week. It is also for those who suffer from one or more mild to moderate medical conditions, such as high blood pressure, arthritis, and depression, or who have been identified as being at risk of developing these conditions. As a 'health asset' to secure benefits for the community, the Pembrokeshire Coast National Park Authority hosted the Walkability Project, which sought to use walking as the basis for ameliorating or preventing a number of mild to moderate medical conditions. Demand has been high and the cost of this therapy has been less than other comparable medical interventions.

Source: http://www.wlga.gov.uk/ners

Slí na Sláinte – Path to Health, Ireland

The Irish Heart Foundation set up the Slí na Sláinte project in 1996 which aims to promote regular walking among the population as it has numerous health benefits, including cardiovascular, pulmonary and articular benefits. Local authorities and local communities are encouraged to work together and start a health path in their area. The project consists of two parts. Firstly, Slí na Sláinte walking routes were mapped, providing information for people on where to find the routes and details on their distance. Over 200 routes are situated all over Ireland and communities have the opportunity to propose new routes at new locations. Some of the walking paths involve Natura 2000 sites, for example the Mountmellick path (IE0002162, Habitats Directive). The paths have signs every kilometre so that people are aware of the distance they have walked. Secondly, training is provided for people who are interested in becoming 'walking leaders', and to guide walking groups in their own communities. The approach of Slí na Sláinte is unique as it involves a variety of stakeholders from different sectors and levels. It is initiated at the national level and implemented at the local level. Moreover, it is a project that is initiated by the health sector that involves stakeholders from the environmental sector and local communities itself.

More information: http://www.irishheart.ie/iopen24/-t-8_197_200_208.html

7.3 The role of supporting instruments and governance

With growing evidence that suggests that living near green areas increases physical activity and that physical activity in green environments has positive effects on human health, it implies that urban land-use planning has a pivotal role in providing a health-supporting environment for city residents. City planners and municipal decision-makers are important stakeholders for disseminating such evidence and related examples of good governance, such as the Nummela Gateway Wetland park (see Chapter 8). More generally, like section 13 points out, the role of local governments and authorities is pivotal when establishing a working cross-sectoral partnership in the nature-health-social nexus. When promoting benefits through physical activity in nature in particular, the collaboration calls for physical health professionals as well as sport trainers and those who know about nature.

Public-civic cross-border collaboration to support ecological integrity and recreation in the intersection of Austria and the Slovak Republic

The Alpine-Carpathian Corridor comes across as a successful example of bringing together several civil society organizations and public authorities to enhance the ecological value and integrity of green spaces in border regions. Alongside ecological benefits, the ERDF-funded project has contributed to outdoor sports opportunities including cycling, hiking and hunting. The participatory effort has included GIS modelling, strategic planning and conducting concrete action plans for the region. The project has involved awareness raising and education for school children. The active role of the lead partner, the Regional Government Body of Lower Austria and its well-functioning cross-border collaboration network has evidently been pivotal to its success.

More information: www.alpenkarpatenkorridor.at

With this broad body of evidence that the availability of attractive and stimulating green environments is especially relevant to the physical activity of children (one of vulnerable citizen segments in terms of health and well-being), local administrations throughout the EU should respond to the challenge of designing greener spaces next to day-care centers and schools. Another task for local administration is to **use public money to utilize urban green spaces in the provision of health care and social services to various special groups** such as immigrants, overweight people or those that suffer from poor mental health, in line with the examples from Finland and UK above. Such investments produce both physical and mental health benefits, as well as social benefits.

Variation in access regulation leads to contrasting governance challenges in different EU regions. While “everyman’s right” or “freedom to roam” allows wide access to private forests in the Nordic and Baltic countries, in many other countries, easy access is granted primarily to designated green infrastructure areas. Public information on access options is important in all countries, but those with more limited access opportunities need special attention from the government with regards to public transport, direction guidance and cycling and walking routes.

Promotion of health and wellbeing at Metsähallitus, Parks & Wildlife Finland

Metsähallitus, Parks & Wildlife Finland manages all the state owned protected areas, including 39 national parks. In their current strategy Parks & Wildlife Finland states the promotion of health and wellbeing through nature as one of their four key priorities. The health promotion activities of Parks & Wildlife Finland are guided by their Healthy Parks Healthy People Finland Program. The goal of the program is to improve public health by encouraging people to get out into natural settings, enjoy positive and genuine experiences, and improve their health through a wide range of outdoor activities. The program aims to make outdoor activities a more important aspect of Finnish lifestyle, thereby lengthening life expectancy, improving work capacity and health equality, and fostering positive attitudes towards national parks and nature protection.

The actions presented in Healthy Parks Healthy People Finland comprise (i) developing stronger collaboration and partnership between Parks & Wildlife Finland and the health and wellbeing sector at the local, national and international level, (ii) developing data collection methods to gather information on the health benefits of protected areas, outdoor activities, hunting, fishing, and other extractive activities, to be able to create services that best meet the visitor needs, (iii) improving the accessibility of protected areas e.g. by creating green networks linking urban nature to rural and remote protected areas, and (iv) promoting the development and preservation of favourable attitudes towards nature among people of all ages, in particular children.

Vitoria-Gasteiz shows the way to green inclusiveness

The European Green Capital Winner 2012, Vitoria-Gasteiz, situated in the Basque Country in northern Spain, demonstrates an impressive governance system that combines a strong green strategy by the city administration and a high level of commitment by the inhabitants. With a high proportion of green spaces, a surrounding “green belt”, as well as forests and mountains, the entire population of some 240,000 lives within 300 m of an open green space. The city has numerous projects and activities that invite people to live greener lifestyles, including the promotion of cycling, using green spaces for educational purposes, ecotourism etc. Vitoria-Gasteiz provides a future-oriented green version of a middle-sized European city, indicative of the size of city in which 80% of people in Europe now live in.

More information: http://ec.europa.eu/environment/europeangreencapital/winning-cities/2012-vitoria-gasteiz/index.html

7.4 Conclusions and recommendations

Increasing knowledge of the health benefits of contact with nature has yielded efforts to connect park managers and health sector worldwide. However, despite evidence suggesting that green space has a great potential in decreasing the health inequities within the population, nature has been underutilized as a health promotion setting thus far.. In urban societies, losing contact with nature may have negative consequences with regards to public health and wellbeing that are not yet fully understood.

Based on the evidence from research and best practices, the objectives should be:

- To promote health and wellbeing by encouraging physical activity in the natural environment.
- To enhance the role of the natural environment and healthy outdoor activities in the promotion of health and wellbeing by strengthening cross-sector partnership.
- To recognize that proximity and access to green areas needs special consideration in city planning and may be quantified, for example, by providing residents' average distance metrics to smaller and larger green areas for the basis of assessing alternative city plans.
- To improve access to nature by diversifying the supply of nature-based services and increasing the quality and availability of services within nature destinations such as national parks, national hiking areas, other protected areas, and urban green space.
- Physical activity in green areas and green exercise should be incorporated into rehabilitation and other health care services.

8 Wellbeing – living in an attractive location

8.1 Attractive location, wellbeing and public health

In this section, the focus is on nature's benefits to human health and wellbeing in terms of the importance of attractive living environment, landscape preferences and satisfaction with living environments. We observe the amount and quality of green areas in neighbourhoods and the importance of nature experiences. It has previously been demonstrated that urban nature areas have many health and wellbeing effects on urban inhabitants. Urban green settings help in establishing personal and community identity and can strengthen social participation and ecologically sustainable lifestyles (Irvine and Warber, 2002). This section will look at the evidence of positive effects on well-being from improved landscape quality, raised property values and increased satisfaction of living in specific housing areas.

8.2 Health benefits of nature areas and living in an attractive location

The importance of proximity of green areas in urban environments

In general, nature areas are associated with increased positive emotions, stress reduction, motivation to be more physically active, and better mental and physical health. The benefits of nature exposure have been investigated by various research designs. Experimental studies have focused on short-term nature exposure effects such as changes in mood, concentration, and stress relief (for example, Hartig et al., 2003; Lee et al., 2009; Pretty et al., 2005). The results show rather fast improvements in these measures. Experimental studies show that urban parks, in comparison to the built city environment, have positive effects on participants' mood, stress levels and attention restoration (e.g. Hartig et al., 2003; Tyrväinen et al., 2014a). However, the type of natural environment (urban green space vs. wilder areas) does not seem to moderate the effect (McMahan and Estes, 2015). The meta-analysis shows that differences in emotional state vary across countries and different cultural situations (e.g. highest effects on positive emotions are found in Japan, followed by United States, Canada and Sweden) (McMahan and Estes, 2015). However, the restorative feelings seem to be related to the amount of greenery. For example, the perceived restorativeness is higher when the built environment is observed through forest vegetation (Hauru et al., 2012).

The link between mental health and density of trees in urban environment, United Kingdom

Trees in urban areas may improve mental health. Doctors prescribe fewer antidepressants in urban areas with more trees on the street, according to recent UK research. The study examined the link between mental health and wellbeing and the presence of trees in London neighbourhoods. Its findings support the idea that maintaining a link to nature, even in an urban area, may help provide a healthy living environment. The average street tree density in London boroughs was 40.2 trees per kilometre, with figures ranging from 15.7 to 81.3. Antidepressant prescription rates per 1000 people varied between 357.9 and 577.8. Statistical analysis of the results found an increased tree density of one tree per kilometre was associated with 1.18 fewer antidepressant prescriptions per 1000 people.

Source: Taylor et al., 2015 and Science for Environmental Policy, April 2015

The evidence shows that urban green areas improve wellbeing and health. In order to gain health and wellbeing benefits, urban green areas should be easily accessible, especially taking account of more vulnerable groups (e.g. elderly people). Epidemiological studies, instead, have looked at longer-term impacts such as morbidity and longevity (Maas et al., 2009; Takano et al., 2002). The cross-sectional studies on the topic have found a positive relation between well-being and objective (or, at times subjective) measures related to neighbourhood greenery (van Dillen et al., 2012; Van Herzele and de Vries, 2012; de Jong et al., 2012; Stigsdotter et al., 2010; Ward Thompson and Aspinall, 2011).

People also report more positive benefits of a walk or run in a natural environment (Bowler et al., 2010). It seems that the closeness to green areas is especially important for older people. Older people report more positive benefits (positive affect) in a natural environment than younger age groups (McMahan and Estes, 2015). Childhood nature experiences may also influence adult relationships with natural environments (Korpela et al., 2008; Milligan and Bingley, 2007).

One longitudinal panel data explored how moving to greener or less green areas may affect mental health during five years. The samples were participants in the British Household Panel Survey. Moving to greener urban areas was associated with sustained mental health improvements. It was suggested that the increase in urban green space may have sustainable public health benefits (Alcock et al., 2014).

Improved landscape and property values

A large body of landscape research shows that natural environments are preferred over built landscapes (Kellert, 2005). Green areas also contribute to an attractive green townscape and can indirectly promote tourism and enhance economic development (Ridder et al., 2004; Tyrväinen et al., 2005). The mere presence of green areas near the residence may also improve health e.g. via calming window view. Natural views and easy access to nature are shown to be preferred also in nature-based tourism destinations (Tyrväinen et al., 2014b).

The health and well-being benefits are one important part of the social values that people derive from green areas, which are suggested to have important economic implications. At the local level, green areas improve to the quality of residential and working environments and their benefits are reflected in property values (Tyrväinen and Miettinen, 2000; Tyrväinen et al., 2005).

The results reflect the fact that green structures offer valuable aesthetic and recreational services to households. However, there is variation in the results caused by differences in consumer preferences, quality and the supply of the green areas.

The role of green infrastructure for property development, examples from the UK

Glasgow Green is the largest park in central Glasgow. The restoration of Glasgow Green into an attractive green space led to increases in residential property values by £3-4.5 million, increased council tax yields by 47% and increased land values from £100,000 to £300,000 per hectare.

The development of Canary Wharf included the £6 million development of Jubilee Park at its centre. The estate itself has 20 acres of open landscaped space both at ground level and as green roofs. This green space feature was then used to help persuade businesses, and their staff, to relocate to the area.

http://www.canarywharf.com/aboutus/Corporate--Social-Responsibility/Green-Canary-Wharf/

The evidence shows that green areas in cities improve the quality of residential and working environments, as reflected in property values. The accessibility of green living and working environments is a question of social equality. A study by Luttik (2000) in the Netherlands suggest that, for a local recreational site, the distance to green environment has a price effect as long as the areas are within walking distances from home, which means between 400 meters and 600 meters. Moreover, pleasant views alone lead to a considerable increase in house price (6-12%), particularly if a house overlooks water or open space. Powe et al (1997) used data from Southampton, UK and constructed so called forest access index. They found significant positive relationship between housing prices and the woodland index. Studies from the U.S. also show that even single trees have an effect on house prices. Although green areas are in general a positive externality, in some cases the areas may link with negative externalities such as roads, malls and other types of uses that have a negative effect on the experienced values of green areas.

Green Doors Programme links social and ecological connectivity, Spain

In Andalucía, Spain, better non-motorized access to neighbouring natural areas has been promoted since 2001 as part of the Green Doors Programme which aims to make green corridors for double use; ecological and social connectivity. The impact, through 374 km of green corridors connecting 46 urban settlements in Andalucía, has improved supply of access to natural areas, as well as better availability of outdoor sports, in addition to bringing coherence to the Natura 2000 network in the region.

Source: http://www.interreg4c.eu/good-practices/practice-details/?practice=381-green-doors-programme&

Utilising U.S. data sets, Irwin and Bockstael (2001), Irwin (2002) and Bolitzer and Netusil (2000) found significant positive effects resulting from the nearness of certain types of open space. Areas with conservation status had the strongest positive effect on housing prices. Local demand and supply conditions, however, affect implicit prices, as Rouwendal and van der Straaten (2006) showed by using data from Dutch cities.

Moreover, a natural view, especially a sea or lake view, is typically found to have a positive effect on housing prices. The positive effect of forest views on housing prices were proven by Tyrväinen and Miettinen (2000) who found that a forest view increases the price of a dwelling. Furthermore, proximity to a forested area increases the price of dwelling. In their model, an increase in distance of one kilometre from a forested area reduced the average price of a dwelling by 6 %. In addition, dwellings with a view onto forests were on average 5% more expensive than dwellings with otherwise similar characteristics.

Quality of the nature areas

From the residents' perspective, the relevant issue is not only the accessibility to nature, but also the environmental quality and diversity of nature experiences offered by the everyday living environment (Tyrväinen et al., 2007; Sipilä et al., 2009). Although studies indicate that certain types of nature spaces may differ in their restorative quality, the type of the effect and the whole variety of the place types have been investigated in only few studies (Herzog et al., 2003; Tyrväinen et al., 2007; Korpela et al., 2010).

The evidence shows that well designed urban parks and natural areas have health and wellbeing effects. There is more evidence needed about the type and quality of natural spaces on health and wellbeing benefits. For example, we do not know if small pocket parks just next to home are more, less or as beneficial for human health as larger recreation areas further from home. Green settings can also be perceived as threatening and alien places which may cause anxiety and uncertainty. These negative perceptions can also be linked to inadequate or inappropriate management of urban nature areas. Moreover, there is a lack of knowledge of the variety on well-being benefits that can be gained through being outdoors in nature in the vicinity, particularly emotional benefits alleviating experienced stress.

Region of Attica provides green public spaces for disabled, Greece

The program "Green Life in the City" seeks to provide solutions to problems such as lack of natural sites and open spaces and reduced accessibility to public spaces for disabled people. In general terms, the program aims to improve the quality of life of citizens who live in the Region of Attica and especially in deprived areas with relatively high population density and severe environmental problems.

Source: http://surfnature.ctfc.cat/det_project.php?id=35

Open Space Strategy advances green spaces beyond traditional meanings, Scotland

Edinburgh in Scotland applies Open Space Strategy (OSS) in developing urban green spaces as advised in governmental local planning advice in the frame of urban green infrastructure (UGI). The aim of OSS is to advance green space planning by acknowledging the importance of the human dimension of the enjoyment of urban nature. In practice, the Edinburgh OSS contains quality audits and (accessibility etc.) standards for different types of open space as well as action plans to improve green space quality. Edinburgh has 26 parks with a Green Flag Award, the national benchmark of high quality parks. The case also references local government support to grass-root level initiatives such as community woodland groups, funding from related Scottish donor funds as well as several NGOs that improve access to green spaces. Furthermore, some parks are in private ownership and businesses are increasingly recognizing the value of green spaces in building a strong and resilient corporate strategy. The Edinburgh case clearly has novel governance activities for urban green infrastructure, associated with attractiveness to citizens and participation by various actors.

Source: (GREENSURGE Case City Portraits; Hansen et al., 2015)

Little is known also about the effect of different types of nature on positive health benefits, and how nature areas such as woodlands should be managed to maximize the health benefits. A Finnish study recently showed that natural-like environments, typically woodlands, were more restorative than urban parks (Korpela et al., 2010), More information is needed on the effect of the social and cultural environment and personality on gaining the beneficial health effects.

Sanatory schools for children with health problems in Estonia

There are some historical examples of hospitals and schools situated in aesthetically beautiful natural areas using a holistic view of the importance of living environment on health. In 2010 there were five sanatorium schools in Estonia, situated to different regions. The schools are specialised to physical disabilities, chronic somatic diseases (e.g. asthma), cardiovascular diseases, lung diseases and allergies; and children with complex health problems. Four out of five are boarding schools. The owner of these schools is the state, and in one instance, the local municipality.

Children are provided with free accommodation and meals. The schools provide high level education so that children can continue to study at university or other higher education institutions. The number of students varies from 31-233 (in the year 2010), but the number of students is dropping. The problem is that these schools are in a regulation gap. Firstly, they belong under the authority of the Ministry of Education whose competence is not to regulate health and social affairs, and secondly, the children's family doctors are not obliged to share medical information with schools. Currently, the ministries and schools are making efforts to overcome these difficulties. It is noted that these schools are providing a healing and supportive environment, including trained specialists that are missing in ordinary schools. Children's medical conditions are under control and their special needs are taken into account.

A previous student of one of these schools writes: "This school provided the best support to physical and mental health. The hiking trips to nature, walking and skiing, sitting by the fire, picnics and many other activities was the best medicine."

(Statistical data and analysis driven from PRAXIS Center for Policy Studies, Political analysis nr 8, 2010)

Although the availability of accessible and attractive green spaces contributes to quality of life, the health benefits of green areas are still relatively poorly acknowledged in urban planning and decision-making (Sipilä et al., 2009; Tyrväinen and Korpela, 2009). Compact city planning policies do not fully take into account the potential of nature spaces to contribute to quality of living and housing environments or to the health and well-being of residents. More basic knowledge that would be applicable in land use planning both at regional and community level, housing design and management of nature spaces is needed. Practitioners need information about the optimal locations, sizes and types of nature spaces in living and housing environments as well as information about the differences among the residents in terms of their perceived benefits of green areas.

In the city of Lahti, Finland, an innovative Maptionnaire tool is used for participatory city-planning:

City planning with children, the case of Lahti, Finland

The City of Lahti Strategy 2025 declares child-friendly city development, which includes investments in day care, maternity and child health clinics, and comprehensive schools, as well as taking children into consideration in urban planning.

In Lahti, children in day care participate in city planning. Day care centres use city green areas for playing, physical activities and collecting berries and other nature products. Children can point at their important places and play areas using Maptionnaire tool, and this information is used for

child-friendly city-planning (Maptionnaire tool developed by Mapita Oy).

The same city-planning tool is also used with adolescents asking for the most favourable and unfavourable places in Lahti (using Maptionnaire for iPads). The tool allows residents to pin their ideas and concerns about future development on a map.

The tool is used widely In Helsinki where during one month almost 5000 people mapped 33 000 opinions and ideas including 9000 places for new residential areas.

Source: Happy World Cities Day 31.10.2014; www.urbanfinland.com, presentation by Timo Hämäläinen, Maptionnaire web page: https://maptionnaire.com/

Table 8.1: Causal links, hypothesis, measures and evidence – an overview

What Environmental and Health Pressures could Biodiversity help address and what indicators are useful?	**What specific benefits could in principle (and actually) be measured?** What quantitative indicators are used?	**What benefits can be measured in monetary terms?** (note that for some areas we do not expect much)	**Who are the main beneficiaries of biodiversity measures?** (note key stakeholders, esp. if minorities or vulnerable)	**What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?**
Trees in urban areas may improve mental health. A higher street tree density of one tree per kilometre was associated with 1.18 fewer antidepressant prescriptions per 1000 people.	Density of trees, medical prescriptions	Amount of prescribed antidepressants	Depressed people	Green corridors may both attract people and improve connectivity within the Natura 2000 network
The amount of greenery is related to higher satisfaction with living environment. (EU-SILC 2013, available in 2015)	Amount of greenery in living environment, satisfaction with living environment, satisfaction with recreational and green areas		Children with health problems, disabled people	Quality-assurance of peri-urban parks may improve access to green spaces and boost the impact of urban green infrastructure

There is little direct research information linked to the contribution of Nature 2000 sites to quality of the living environments. The studies conducted so far have, in general, identified a clear and significant contribution to the quality of living environments from various types of nature areas irrespective of their protection status.

The characteristics of nature areas that affect their use and consequently the delivered well-being benefits are their accessibility, usability and their recreational qualities such as the attractiveness of landscapes. Moreover, larger nature areas are often appreciated for recreation as they offer peaceful environments, clean air, various types of nature experiences and the possibility of recovery from stress. These qualities are often found in large size Nature 2000 sites given the necessary infrastructure for recreational use is available there.

What insights are there on GI providing benefits (living in attractive location) – what type of GI providing what type of benefits and to whom?

Green infrastructure is linked to income-related health inequality. Living in areas with green spaces is associated with significantly less income-related health inequality, weakening the effect of deprivation and health (Mitchell and Popham, 2008). In greener areas, all-cause mortality rates are only 43 per cent higher for deprived groups, compared to 93 per cent higher in less green areas. The European Quality of Life Survey 2012 provided data on 21,294 urban residents from 34 European nations. The study results showed that socioeconomic inequality in mental well-being was 40 per cent narrower among respondents who reported good access to green areas, compared with those with poorer access (Mitchell et al., 2015). Children in deprived areas are nine times less likely to have access to green space and places to play (National Children's Bureau, 2013).

Interventions designed to increase access to green and open spaces for disadvantaged groups requires a detailed knowledge of local needs, cultural contexts and attitudes, with clear objectives and strong targeting (Buck and Gregory, 2013).

It is recognised that disturbed ecosystems might negatively affect human well-being, but it is not clear how and if biodiversity promotes human health and well-being. A systematic review of health and well-being benefits of biodiverse environments showed that there is evidence that biodiverse natural environments promote better health and well-being through exposure to pleasant environments and encouraging physical activity. However, there is not enough evidence to show the specific role for biodiversity in the promotion of better health and a more reliable interdisciplinary evidence-base is needed (Lovell et al., 2014).

Nummela Gateway Wetland park, Finland

Nummela Gateway Wetland Park is part of TEEB Nordic. A network of wetlands (i.e. a zone for urban "green infrastructure") was established along 1.5 kilometres of the degraded stream within the suburb of Nummela, including a new 2 hectare wetland park by Enäjärvi lake, at the mouth of the stream. Benefits provided by ecosystem services were successfully integrated into urban planning and management processes. Monitoring of the Nummela Gateway Wetland Park over a period of three years shows that constructed wetlands rapidly self-establish, resulting in an increase in biodiversity and the establishment of several ecosystem services (e.g. erosion and flood control, and reduction of pollutants in runoff water). The constructed wetland also provides a range of other

benefits including opportunities for recreation and education.

The network of wetlands was also foreseen to provide a range of cultural services to the local public, including opportunities for environmental education and recreation and support to local identity. The wetland areas were made accessible to the public by establishing a network of nature trails. Information boards were created along the trail to provide visual and written information about the ecosystem services at the sites.

Source : Salminen et al., 2012 www.syke.fi/download/noname/%7B3CC3EE73-3794-46F0.../29843

The Green Life in the City, Attica case (Greece) is an example how different stakeholders work together to improve citizens' wellbeing. The most important actors are policy makers (mayors) and the general public (citizens, volunteers etc.). The program is addressed to local people and the goal is to improve the quality of life of citizens living and working in the Region of Attica. The European Regional Development Fund (ERDF) funding will be used mainly for recreation activities, which will directly promote ecotourism facilities in the urban areas located in the Region of Attica. As a result, through the implementation of the project, many benefits will arise concerning the quality of life in these areas. One measure to be mentioned is that through the implementation of the program, municipal centres for environmental information and awareness will be established. Moreover, according to the implementation guide of the program, many publicity and awareness raising activities for both public bodies and citizens will be funded..

Table 8.2 Key studies on health benefits (living in attractive location) of green infrastructure

Study (short reference)	**Country & region / city**	**Name of site**	**Type of green infrastructure**	**Location type (urban, peri-urban, rural)**	**Types of benefits and beneficiaries**
Michell et al., 2015	34 European nations, urban inhabitants	Cities	Neighbourhood characteristics, such as recreational and green areas		Socioeconomic inequality in mental well-being was 40 per cent narrower among respondents who reported good access to green areas
Lovell et al., 2014	Several	Effect analysis of 17 different studies	Specific consideration of biodiversity within the environment	Urban, suburban, rural	Biodiverse natural environments promote better health and well-being through exposure to pleasant environments and encouraging outdoor recreation and physical activity.

8.3 The role of supporting instruments and governance

The exemplary governance cases, such as Bristol and Utrecht below, as well as Padova in section 13.3.5, are characterized by a strong vision by city authorities which recognizes the connections between GI, attractiveness and human well-being impacts. Rather than "ordinary" city planning with parks included, exemplary governance pays particular attention to providing good access to green spaces and/or connections between those. Furthermore, forerunner cities tend to have all three sectors: public authorities, business actors and third sector (NGOs) participating in the efforts to improve the green spaces in and around the city.

The exemplary cities have been successful in engaging the inhabitants to make the city greener and thus more attractive as a place to live; Chrudim in Czech Republic is an example of this type of activity. Overall, cities have various reasons and potentials to be active and effective players in the health-social-nature nexus, particularly relating to attractive and accessible living locations (see section 13.3.5), a long tradition of projects, parks actively being used, active civil society.

Sometimes an enabling national regulation (e.g. planning act) may play a pivotal role, as is the case in Scotland and Edinburgh. But perhaps more relevant is the support of local government to grass-root level initiatives by environmental-social NGOs that acquire funding and promote higher quality green spaces, which in turn raises awareness among city dwellers and makes health and wellbeing benefits real. In general, the more decentralized forms of participation in city planning and GI development appear to create diverse activities that make use of green spaces for health and social benefits.

Opportunities vary however between regions; while the operational environment in western and northern Europe enables lively civic society and contains several active NGOs as well as donor funds that provide support to projects as well as a functioning participation culture, the transition countries in eastern Europe have had more limited opportunities to mobilize people and resources for developing green infrastructure for the benefit of people. In these countries, international initiatives (such as WHO's Healthy Cities programme in the case of Chrudim, Czech Republic, for example) have been important accelerators. It is therefore evident that no single magic bullet exists for good governance; reasonable policy implications need to be adapted according to the local circumstances.

What are the insights?

Business actors' contribution to the co-evolution of urban green infrastructure and human well-being seems to be increasing; in future more companies may be favouring locations with better access to green spaces or using green spaces as part of their corporate strategies. Public–private partnerships may play a stronger role in future in improving the impact of urban and peri-urban green infrastructure on people's wellbeing as residents.

Bristol: the innovative hub of inclusive view on urban green infrastructure

Bristol is a rapidly growing city with some 900,000 inhabitants. It is an exemplary hub of novel thinking connecting the development of urban green infrastructure and the enhancement of citizens' well-being. Bristol City Council acknowledges the role of green spaces in promoting healthy lifestyles and social inclusion. The city aims to provide diverse, accessible green spaces that support diverse recreational activities. Green infrastructure is applied to support sustainability and quality of life in and around Bristol. The Bristol Parks and Green Space Strategy is an official evidence base to feed into the Local Plan the aims and means to increase the provision of quality accessible green spaces. As an innovative governance mechanism, Bristol applies the Neighbourhood Planning approach, which allows local people to draw up Neighbourhood Plans and accept planning applications in line with their views of what the community should look like. The commitment of the local authority and various local stakeholders to making Bristol a healthier, more sustainable city with attractive, well-distributed and user-friendly green spaces has earned it the European Green Capital 2015 award (Hansen et al., 2015).

Utrecht: the city harnessing GI for the vehicle of improving attractiveness

Utrecht is the fourth largest city in the Netherlands with over 700,000 inhabitants in the larger urban zone. The Green Structure Plan of Utrecht emphasises the importance of green structure for the attractiveness of the city for (future) inhabitants and businesses to choose Utrecht as their base. Other objectives of the Green Structure Plan are to improve its role for recreation, social and psychological well-being, health, the environment and ecology. Connectivity of green infrastructure is important both for ecological coherence and the recreational network. The Green Structure Plan was compiled in a participatory manner. Local knowledge is used in developing the GI, citizens are allowed to inform about bottlenecks, and inhabitants have a role in maintaining and managing the green spaces (Hansen et al., 2015). The plan is accompanied by multi-annual green programmes that elaborate the plan in more detail. Co-financing and collaboration are emphasized in the latest programme. The province, the national government and the EU are seen as important for realising investments in green structure.

8.4 Conclusions and recommendations

Even short visits to nature increase positive emotions and subjective well-being. Nature should be easily accessible, so that visits to nature can be incorporated into daily routines. There is more research needed on the type of green areas. So far, most of the comparisons have been made between largely used and popular green spaces and built-up environments. We have little knowledge related to rural inhabitants. Most of the questionnaire studies and experimental studies in particular, have been carried out among urban inhabitants.

Despite growing evidence of public health benefits from urban green space there, has been little longitudinal analysis. One longitudinal study shows that moving to greener urban areas is associated with sustained mental health improvements, suggesting that environmental policies to increase urban green space may have sustainable public health benefits.

Property value studies confirm that green areas improve the quality of residential and working environments and their benefits are reflected in property values.

It is advised that attention must be paid to creating an operational environment where third sector associations and networks may flourish and contribute to the GI-health relationship with grassroots initiatives. Cross-sectoral learning may bring additional value to the governance mechanisms. For instance, community-engaging initiatives relating to climate change may be easily adapted to the initiatives promoting higher quality green spaces and related health and social benefits.

A particular attention to access to and connections between green spaces is recommended in city planning in order to improve the health and social impact of GI. Cities are advised to use local knowledge in a collaborative manner when running participatory city planning processes Social Benefits: Quality of Public Spaces, Reduced Tension

9 Social Benefits: Quality of Public Spaces, Reduced Tension

9.1 The role of nature for strengthening social cohesion

This section discusses the social benefits of publically accessible, good quality green spaces, both in urban and rural settings. The research explored the extent to which available evidence demonstrates the role that access to shared, green public spaces[5] can play in increased social cohesion and reduced social tension, particularly for minority groups (e.g. ethnic, religious) and the socially excluded[6] (e.g. immigrants, economically deprived).

Social tension may occur where particular social groups pursue their own values and preferences without consideration, or inclusion, of others. Social cohesion is a term used to cover a number of different but related concepts (Demireva, 2014; Hartig et al., 2014; OECD, 2011; Forrest and Kearns, 2001; Berger-Schmitt, 2000). Broadly, it can be divided into two core domains:

1) Social inclusion[7], social order and reductions in inequalities, and

2) Bonds of trust, shared social and cultural norms, social networks, social capital, social solidarity, place identity and attachment.

This section explores in particular social benefits to communities, rather than individual or personal benefits of having access to nature or green space. Individual benefits are covered in the sections above that consider indirect health benefits, in particular 'Healthier lifestyles – nature experience' and 'Outdoor recreation and physical activity'.

[5] One study defines public green space as including: parks and reserves; sporting fields; riparian areas like stream and river banks; greenways and trails; community gardens; street trees; and nature conservation areas; as well as less conventional spaces such as green walls; green alleyways; and cemeteries (Roy et al. (2012) cited in Wolch et al. (2014)).

[6] *"Social exclusion is a complex and multi-dimensional process. It involves the lack or denial of resources, rights, goods and services, and the inability to participate in the normal relationships and activities, available to the majority of people in a society, whether in economic, social, cultural or political arenas. It affects both the quality of life of individuals and the equity and cohesion of society as a whole"* http://www.poverty.ac.uk/definitions-poverty/social-exclusion Last accessed 13 May 2015

[7] Seeland et al. (2009) define social inclusion: *Social inclusion is achieved through slow but constant integration of the customs and patterns of cultural values that bring resident foreigners into the local social fabric*

9.2 What evidence is there for social benefits of engagement with nature?

A wide-reaching review by Keniger et al. (2013) into the benefits of interacting with nature identified social benefits as one type of benefit from interacting with nature, and cited the following examples of social benefits: facilitated social interaction; social empowerment; reduced crime rates; reduced violence; interracial interaction; social cohesion; and social support.

Social cohesion benefits from local walking groups

Pembrokeshire Coast National Park, Wales

The Walkability Project started in 2011 and is a partnership between Pembrokeshire Coast National Park, the Welsh Government and the Hywel Dda Local Health Board. The project has encouraged and supported local individuals with higher health risks to walk in and around the National Park. The project has resulted in self-reported physical and mental health benefits and created a sense of companionship for participants. There were also social cohesion benefits as participants reported greater companionship between participants.

Slí na Sláinte project, Ireland

The Irish Heart Foundation has set up the Slí na Sláinte project in 1996 which aims to promote regular walking among the population as it has numerous health benefits, including cardiovascular, pulmonary and particular benefits. Local authorities and local communities are encouraged to work together and start a health path in their area. Walking can also have social benefits as it provides a way to meet new people and maintain existing friendships. At some health paths, community walks are organised that promote walking with, for example, people from your community or from the workplace.

Research to understand how biodiversity and the natural environment can contribute to social cohesion and related issues is relatively limited (Hartig et al., 2014) although there has been work in environmental psychology that has focussed on the role of landscapes, settings and urban design on attitudes, preferences and behaviours for many years (Clayton, 2013). More recently, the rise of the ecosystem services concept – and its focus on the economic contribution of green spaces – as an established advocacy tool for the natural environment has increased interest in social benefits. As a result there is a growing body of evidence around these types of benefits and an emerging strand of research around the role of green spaces and green infrastructure in promoting social cohesion specifically in the urban and peri-urban context.

Social interaction in nature as a pathway to cohesion

The evidence indicates that greenspaces, parks and playgrounds can provide places in which people interact, and that this can strengthen communities and help people from minority groups or different cultural backgrounds become better integrated in and to identify with their community. Research suggests that seeing one's neighbour at the local park can help to build familiarity, a sense of commonality, and sets the groundwork for future engagement. Seeing neighbours interacting in the neighbourhood environment may also contribute to

social interaction by creating norms of social behaviour that promote yet more neighbourhood interaction (Bennet et al., 2012).

Other research has identified that parks, green spaces, playgrounds, and recreation areas can lead to formal and informal social interaction and contact among residents from different cultural backgrounds. See for example: Seeland et al., 2009 (Zurich, Switzerland), Bennet et al., 2012 (Ontario, Canada), Kuo and Sullivan, 2001 (Chicago, USA). These interactions may lead to increased social cohesion and inclusion (e.g. Hartig et al., 2014, New Economics Foundation, 2012, Ockenden, 2007, Ecominds, 2013, Sanwick et al., 2003)).

Constructing an eco-trail in Bulgaria: opportunities for engagement in nature and intercultural exchange

The construction of an eco-trail in the Natura 2000 site Zmeeva Dupka cave has helped different social groups to discover nature and develop a healthier lifestyle while deterring illegal and exploitative nature use. The local branch of the international NGO, SOS Children's Village Tryavna, constructed an eco-trail, barbecue area and information boards to improve accessibility of the track and to create opportunity for learning and physical exercise for the children supported by SOS Children's Village facilities, citizens of Tryavna, and for tourists visiting the region. The implementation of the project involved children of the village and a group of Hong Kong students, an intercultural exchange between different social groups that was much appreciated by both groups. Since the creation of the route in 2011, the cave has become one of the most popular nature destinations in the region.

In essence, the literature suggests that green infrastructure in the form of green public spaces, especially in urban areas, can act as 'green hubs' for communities. A study in the UK by Burrage (2011) describes a move from conventional ideas about green 'space' to the more nuanced idea of green 'hubs', as one way to enhance communities' well-being through genuine stakeholder engagement and social inclusion. By acting as green hubs, green spaces can provide places to come together, but also for 'celebration of cultures and communities' and to be used as 'living community notice boards' (Burrage, 2011).

Maas et al. (2008) found that the relationship between green space and social support was strongest for people with a low income or a low level of education, indicating that they may rely on (and hence benefit from) green space in their living environment for their social contacts.

Making friends in Zurich's urban forests and parks: The role of public green space for social inclusion of youths from different cultures

An empirical survey of pupils and teachers in selected schools of the city and metropolitan area of Zurich investigated leisure activities in urban forests and public green spaces for their potential to facilitate social interaction between Swiss and immigrant young people. The study concluded that for recent immigrant youths / children public parks and green spaces provided potential for cross-cultural social inclusion that other places do not offer:

"…to understand and come to respect unfamiliar gender roles and develop friendships that cross the boundaries of ethnicity, nationality and creed, youths must meet their peers in surroundings that are accessible to members of all communities, without formal, financial or symbolic restrictions … there is more potential for social inclusion to occur in public green spaces than anywhere else" (Seeland et al. 2009, p.11).

Community gardens and allotments can also be an important platform for social cohesion through intercultural communication and sharing experience/build understanding, helping to bring people out of isolation, and serve as a starting point for broader discussions of community issues (Wakefield et al., 2007). This is supported by Leikkilä et al (2013) who conducted a qualitative study in Helsinki metropolitan area, with the aim of identifying the role of urban nature in social integration, in particular of immigrants and ethnic minorities. Through thematic interviews and group sessions of immigrants, they found that the use of urban nature by immigrants facilitates their identification with their current living environment and communities. Additionally, Leikkilä et al identified the importance of intercultural interaction for the enhancement of social cohesion concluding:

> "By fostering intercultural interaction, collaborative planning [of community gardens] can enhance mutual understanding and knowledge-sharing between diverse population groups, authorities and other actors" (p.188).

The role of allotment gardens in inducing individuals' personal attachment to green space and their community was also explored by Hawkes and Acott (2013). Many plot-holders revealed how allotmenting evoked deeply personal connections to people and places, particularly the local. This was emphasised through a quotation from one of the residents included in Hawkes and Acott:

> "it doesn't matter who you are or where you come from, everyone up here is part of the same group ... everyone up here is welcome" (p.1125).

Neighbourhood gardens, Vienna, Austria

The Neighbourhood Gardens project was started in May 2013 and now comprises three gardens at social facilities of Caritas in Vienna. In the gardens, the residents work together with volunteers and do everything from the planning of the garden and maintaining of the plants to harvesting the crops, which are shared equally between volunteers and residents. The cooperative gardening season starts with a kick-off workshop, where participants get to know each other and start making plans for the garden. During the gardening season, they collaborate at least once a week for about 2-4 hours. Setbacks and successes in the garden help participants to form relationships. The plants used in the garden are mostly donations from businesses and companies which makes the project relatively inexpensive with an annual budget of 5,000€ overall.

Much evidence in this area is based on the outcomes of specific studies focussed on relatively small groups of people in defined areas, using ethnographic or qualitative survey based techniques. Although the literature supports the idea that there are wider benefits of green

spaces, Konijnendijk et al. (2013) expressed that while there are indications that parks promote social cohesion the strength of the evidence is weak due to the relatively small amount of research undertaken to date and the limited nature of those studies.

"Prove It!" – quantifying community benefits

A report by English Nature (2003) Biodiversity's contribution to the quality of life includes a case study "Prove It!" that has been established to help quantify the community benefits of the SiteSavers scheme. This study was undertaken by the New Economics Foundation. The SiteSavers project promotes environmental improvements in economically deprived areas through offering grants and awards to community groups to transform areas of derelict or redundant land.

This study included 17 sites, from a skateboard park to a nature trail, and two surveys of around 2,000 people were included. Key findings of the evaluation were:

- Diverse connections: 80% of project participants had enjoyed a conversation with a new person of a different background in the last six months;
- New friendships: Those involved as project participants gained an average of five new friends each by the end of the project;
- Community know how: Those in the wider community who definitely knew who to contact in the neighbourhood to effect change grew threefold to 35%;
- Knock on effect 1 – Community safety: Of the wider community, 86% now felt safe out and about in the local area in the day compared to 55% before the project had been carried out;
- Knock on effect 2 – Things don't go back to normal: Those involved in Barclays SiteSavers go on to be active in different ways locally, e.g. two participants became Parish Councillors.

More information: http://publications.naturalengland.org.uk/file/128018 and http://www.neweconomics.org/publications/entry/prove-it Last accessed 13 May 2015

Greenspace as a factor in enhancing social capital

The evidence suggests that green spaces, particularly in urban areas can act as a 'third place' in which people can come together and engage in shared social activities, thus generating social capital. Community gardens and allotments can also act as 'social capital multipliers' whereby motivated individuals and groups can lead to wider involvement and enhanced social benefits. A qualitative review of literature completed in 2010 concludes that the potential impact of green space on community building is well-established in the literature (Brook et al., 2010)). As Sullivan (cited in Brook et al., 2010) summarises:

> "Individuals who live adjacent to green spaces consistently report more social activities and more visitors, knew more of their neighbours, felt their neighbours were more concerned with helping and supporting one another and had stronger feelings of belonging." (p.300)

Green spaces have also been described as a 'third place' in which people can meet and seek community, thereby indirectly being a driver of social capital (Porter and McIlvaine-Newsad, 2013). Porter and McIlvaine-Newsad particularly emphasise the links between community gardens and social capital. Although much evidence suggests (urban) greenspace can generate social cohesion / inclusion, it may also require existing social cohesion to kick-start this process. The evidence indicates the importance of 'community activists' to start a gardening programme (e.g. individuals who can deal with access issues, ensure permits are in order, motivate others to participate etc.) so that this process can snowball into formal and informal networks within communities. Once a process or initiative has been started green space can act as a social capital multiplier, and this may particularly be the case for community gardens (Porter and McIlvaine-Newsad, 2013).

Social wellbeing from visiting protected areas in Finland

Protected areas have also been linked with social wellbeing: a case study developed for Europarc (2015) on the health benefits experienced by visitors to protected areas in Finland included a survey of visitors in which 83% (of 2,011) respondents agreed that their visit had benefitted their social wellbeing.

More information: http://www.europarc.org/wp-content/uploads/2015/01/Health-and-Protected-Areas_Case-Studies-in-Europe.pdf Last accessed 24 April 2015

The potential for increases in wider social capital across a whole community resulting from engagement with green space (e.g. through volunteering, or community gardening) cannot always be assumed, as some studies indicate the social benefits do not extend beyond an enclosed community group e.g. those involved in a community garden (see Keniger et al., 2013).

Community involvement in creating and managing 'pocket parks' in Amsterdam, NL

"Stamp parks" (Postzegelparken) is a foundation that establishes tiny parks on abandoned sites, which are then maintained by surrounding inhabitants and organisations. The park initiators claim that the main benefits of such parks are the increased social cohesion and well-being resulting from building these parks in collaboration. Postzegelparken design the tiny parks, raise funds for their establishment and advise during the process of establishment. From the start the involvement of surrounding inhabitants is encouraged and facilitated. Funding comes from different governments and from the involved entrepreneurs. Citizens help in the maintenance and design of the stamp parks.

Community attachment and ownership of greenspaces

The evidence suggests that greenspaces, including urban parks, community gardens and forests are an important factor in community identity, and can strengthen people's attachment to their communities and the extent to which they identify with it. Accessible public green space and trees can foster community attachment to a specific area. Attachment is also affected by the use of green space and the 'community experience' (Arnberger et al., 2012). A study explored community gardens in St. Louis USA as likely drivers of interracial

contact between African Americans and Americans of Caucasian descent. For this study, Shinew et al (2004) selected random gardeners from a gardening community to conduct a telephone survey to evaluate respondents' psychological attachment to a group and sense of community. Their findings suggest that interracial contact was present in many of the community gardens and both racial groups expressed similar sense of community stating that their neighbourhoods were "good places to live", and they expect to remain in the community for near future. Another benefit reported by Shinew was a sense of belonging expressed by the respondents who confirmed that they felt connected to their neighbourhoods.

A study using spatial modelling and urban area analysis to determine the amount of and types of forests in Ljubljana, Slovenia identified the importance of urban forests in supporting community identity (Hladnik and Pirnat, 2011). The literature supports the idea that green infrastructure and green space is an important factor in individuals and communities establishing a 'sense of place' and 'ownership' of the landscape (Maas et al., 2009, English Nature, 2003, Hladnik and Pirnat, 2011)). The importance of green space in providing this benefit is recognised in the Maas et al. study with their results suggesting that:

> "… the relation between green space and social contacts has more to do with the fact that green spaces can strengthen sense of community via place attachment and place identity of its residents, than with actual contacts with neighbours." (p.593)

As well as broader social and community benefits, research in the field of environmental psychology has examined place and identity (for reviews see: Fresque-Baxter and Armitage, 2012; Twigger-Ross et al., 2003) providing theoretical frameworks for the role of the physical environment in the creation and maintenance of personal identity.

Existence of and access to (urban) greenspace as a factor in crime and perception / fear of crime

The evidence shows that there can be a positive correlation between green spaces and vegetation in urban areas and reduced crime, aggressive behaviour and fear of crime. Exploring literature around the wellbeing and social benefits of the natural environment Brook (2010) cites the Kaplans' (2003) 'reasonable person model', which relates access to the natural environment with 'more reasonable' behaviour (i.e. positive actions and understandings). Other studies show that green spaces can help to reduce aggression, as demonstrated by Kuo and Sullivan (2001a) in their seminal study on communities accommodating public housing buildings in Chicago. Based on interviews with local residents, they demonstrated that individuals living in public housing facilities barren of greenery experience significantly higher incidences of aggression than those in areas with more greenery. Similar trends were found in London where case study evidence has shown a correlation between the use of green space and a decrease in vandalism (Faculty of Public Health, 2010). The reduced incidence of vandalism behaviour was seen to be a result of green spaces becoming more valued by members of that community.

Trees for Cities – Growing Skills training programme

The Growing Skills project had been running or three years in Tower Hamlets and with the help of Ecominds grant programme the funding was used for horticulture therapy, soft skills development and accredited training of people with mental distress.

According to the report: "The project runs from 9–4pm on Monday to Thursday, and provides training for people who may not necessarily have diagnosed mental health problems, but have been out of work for six months. Volunteers are usually referred by advisors at Jobcentre Plus (although some are self-referrals), and may face multiple barriers to employment, such as family breakdown or substance abuse. Attendees of the group work over a 13-week period towards a qualification in horticulture, giving them the skills and knowledge that will help them towards finding long-term employment" (page 11).

The success of the project has been linked to physical activity and the involvement of local people. The project manager has concluded that because green spaces are designed and maintained by local people they are valued by members of that community. A decrease in vandalism and an increase in people using local parks have been observed as a result of this project.

Faculty of Public Health (2010) report on The Growing Skills training programme run by Trees for Cities in London.

More information: http://www.treesforcities.org/about-us/ Last accessed 13 May 2015 and www.mind.org.uk/media/1393800/ecotherapy-growing-skills-traning.pdf

To provide a better understanding on the mechanisms behind reduced aggression, Keniger et al (2013) explains that the reason could be:

> "urban vegetation restoring attentional function [mental fatigue], which reduces the occurrence of violence and aggression in urban public housing, indirectly contributing social benefits to the broader community" (p.926).

The link between access to green space and reduced criminal activity is explored in a study that used police crime reports to examine the correlation between vegetation and crime in an inner-city neighbourhood in Chicago, USA. The presence of trees had a correlation with reduced criminal activity in the neighbourhood (Kuo and Sullivan, 2001b). In conclusion Kuo and Sullivan propose that

> "vegetation can deter crime in poor urban neighbourhoods in any or all of the following ways: by increasing residents' informal surveillance of neighbourhood spaces, by increasing the implied surveillance of these spaces, and by mitigating residents' mental fatigue, thereby reducing the potential for violence" (p.348).

These findings are supported by a multiple literature reviews in this area included those by Keniger et al (2013), Faculty of Public Health (2010), Forest Research (2010), Hartig et al (2014) and New Economics Foundation (2012).

Shared experiences, learning and environmental knowledge

The evidence shows that the natural environment provides opportunities for learning and this can enhance people's personal development and self-esteem resulting in improved social interactions and connections. Research has demonstrated that there are considerable educational benefits from intentional (e.g. learning about nature in nature such as pond-dipping and forest surveys) and incidental (e.g. learning any subject in a natural environment, such as historical re-enactments and poetry festivals).

The use of the natural environment as a learning environment has been shown to reduce pupil truancy and indirectly benefit the community by reducing associated anti-social behaviour (Dickie et al., 2011). The New Economics Foundation (2012) brought together research and evidence relating to nature's role in delivering well-being and key policy goals including relating to learning and personal development from engagement and activities (including playing) in the natural environment. For example for children: improved natural environment around schools can improve behaviour, aid overall development and learning; and explorative play and experiential learning outdoors have been found to improve attention and achievement, physical and mental health, social interaction and personal concept/esteem (p.11).

Examples of education activities

Education activities carried out by volunteers include community activities, preparing publications, working with schools, leading walks and training others. A few examples include:

- Duppini Art Group in Bulgaria[8] works with different social groups to create land art. They organize workshops related to nature and the knowledge of species and the environment in harmony with the natural materials available in the environment, focusing on the aesthetics of the place and on the characteristics of the plant and animal species that live there.

- An NGO project[9] in Latvia carries out environmental education activities for youth in the city of Valmiera, including hikes in nature with environmental guides, nature photography workshops with a professional nature photographer, river and coastal clean-ups, and debates on nature conservation issues.

Natural England (2013) have also identified that the Access to Nature[10] initiative in the UK has helped children to engage with learning and has boosted their confidence and self-esteem.

[8] http://duppini.blogspot.co.uk/
[9] http://www.baltadaba.lv/
[10] Access to Nature is a grant funded scheme in the UK which was created to help communities enjoy and improve their natural environments.

Green Gym initiative, UK

Green Gym initiative, established in 1998 by The Conservation Volunteers charity, seeks to involve people in guided practical activities in nature, such as planting trees, sowing meadows and establishing wildlife ponds. Green gyms exist across the UK and have provided local residents with the opportunities to meet new people, connect with their community and nature, and co-create high quality and sustainable green spaces.

The latest evaluation of the national Green Gym initiative (2008) stated that (in March 2008) the Green Gym initiative had:

- Involved approximately 10,000 volunteers in improving over 2,500 green spaces.
- Established 95 Green Gyms across the UK, with 20 run entirely by the volunteers themselves.

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- Involved approximately 10,000 volunteers in improving over 2,500 green spaces.
- Established 95 Green Gyms across the UK, with 20 run entirely by the volunteers themselves.

A study of public-access community gardens (PAC-gardens) in Berlin (Germany) by Bendt et al. (2013) used in-depth interviews to help understand perceptions of gardening practices and community dynamics, to identify explicit and implicit learning experiences, and to map out interactions with external actors. Bendt et al. found that PAC-gardens that combine collective gardening with, for example, art, political activity, back-to-work programs, or business development may be particularly promising for countering “extinction-of-experience” in cities.

Cockney Sparrow project, London

This initiative by Peabody Trust (a housing provider) in partnership with London Wildlife Trust and funded by the UK Big Lottery Fund aimed to re-introduce the sparrow and other native birds back into the local area while engaging residents in activities in the nature of their neighbourhood. The project focused on improving landscapes of local housing estates, to benefit sparrows and other wildlife, and in doing so, help overcome barriers between cultures and generations as people would connect through the project.

The resulting activities enabled residents to enjoy and learn about London's wildlife through a range of wildlife activities. Through the project, local residents from all age groups learned new skills and established new relationships and became more connected to their community. Being involved in the project activities allowed local residents to change their perception on their local area.

Spiritual benefits: awe and wonder

The evidence suggests that interaction with the natural environment can engender feelings of spiritual meaning and enhanced sense of stewardship to the environment and inter-generational equity. In a long-term perspective such feelings may strengthen attachment to and respect for community. Interactions with the natural environment have spiritual benefits and create a sense of awe and wonder (O'Brien and Morris, 2013). Specific interactions can facilitate spiritual growth and may have particular spiritual meaning associated with religious beliefs (Burls, 2007, O'Brien and Morris, 2013)), for example the belief of environmental stewardship and inter-generational equality. O'Brien et al. (2008) found that volunteers involved in a conservation activity spoke of a spiritual connection to nature and reflections on reasons for connection with nature. This is an area that although potentially important currently yet lacks clarity of definition and approaches to its research (Keniger et al., 2013).

Realising the social benefits of greenspace and nature: accessibility and quality of design

Whilst there is good emerging evidence for the benefits of greenspace and nature in terms of improving social cohesion etc. as discussed in previous paragraphs, there are two fundamental issues that need consideration in order for those benefits to be realised: access and quality of design.

Access to greenspace and nature

The evidence suggests that accessibility depends on multiple factors, such as gender, age, relative income, and education, and that physical access to green space in itself does not necessarily imply that social benefits will be realised by all sectors of society / communities. Accessibility of nature, in the form of protected areas or wider green infrastructure, can be seen as a precondition to associated social benefits. There are multiple social benefits that are facilitated by having access and interaction with nature that ultimately result in increased social cohesion, including community attachment; social interaction; social capital; social inclusion; and reduced social tension/violence (Keniger et al., 2013).

However, it is necessary to consider what factors may influence accessibility in order to explore the role of natural green spaces and green infrastructure in providing social benefits.

An investigation by the WHO (Marmot, 2013) of health inequalities across Europe found that [emphasis added]:

> "**People who live in areas with high levels of deprivation** are more likely to…live close to hazardous waste sites, in locations where public places feel unsafe, unwelcoming and uncongenial, **have less access to green spaces and fewer opportunities for healthy activities**."

Analysis completed in 2014 of urban green space in Greater Manchester in the UK used spatial data on green space area and levels of socio-economic deprivation to compare levels of deprivation with access to green space (Drayson, 2014). This study showed that people in the richest 25 per cent of areas enjoyed, on average, 2.7 times as much green space per head as the most deprived 25 per cent. This finding was supported by another study in the UK (CABE, 2010) which concluded that the most affluent 20 per cent of wards (administrative areas in England) have five times the amount of parks or general green space (excluding gardens) per person than the most deprived 10 per cent of wards.

Access standards: physical measures of accessibility

In some countries access to nature standards have been proposed, either in the context of spatial planning or by organisations seeking to promote and encourage wider access to nature for all.

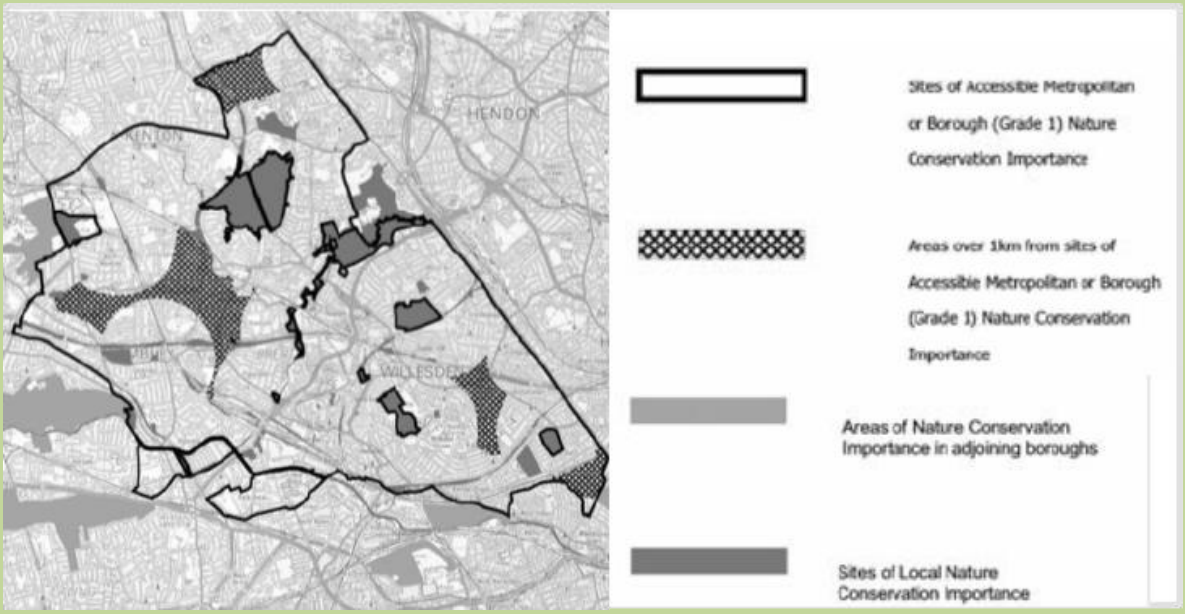
One of the predominant examples is from the UK, where English Nature (now Natural England) adopted an Accessible Natural Greenspace Standard (ANGSt) in 1996. These have been reviewed and updated since, and the latest Natural England (2010) ANGst model proposes that everyone, wherever they live, should have an accessible natural greenspace:

- of at least 2 hectares in size, no more than 300 metres (5 minutes' walk) from home;
- at least one accessible 20 hectare site within two kilometres of home;
- one accessible 100 hectare site within five kilometres of home; and
- one accessible 500 hectare site within ten kilometres of home; plus
- a minimum of one hectare of statutory Local Nature Reserves per thousand population.

More information: http://publications.naturalengland.org.uk/publication/40004 Last accessed 22 April 2015

Such standards can be used to model (for example using GIS mapping) existing levels of access, and also to help plan the provision of green infrastructure, particularly in urban areas, to ensure access levels for all people.

An example of the use of access standards can be seen in the Strategic Environmental Assessment for an English Local Authority (London Borough of Brent, 2005). The hatched areas in the figure below are areas over 1km from sites of Accessible Metropolitan or Borough Nature Conservation. This



assessment was used to understand the likely significance of changes to green space in the authority.

While physical proximity is an important factor in accessibility, other factors are also important. Drayson (2014) identifies existing evidence from the UK that indicates that those with long-term illnesses or disability are much less likely to visit green spaces than people without such conditions. Those with a disability or long-term illness are more than twice as likely to only visit green spaces three or fewer times per year (Burt et al 2013, cited in Drayson 2014). She also reports that people from ethnic minority groups are more likely to have reduced access to green spaces, and make less use of green spaces where they are available. More than a quarter (26 per cent) of the black and minority ethnic population in England only visit the natural environment three times or fewer per year (compared to 15 per cent of the rest of the population) (Burt et al. (2013) cited in Drayson, 2014).

A hierarchical cluster analysis of Berlin districts identified distributional inequality of urban green space / green infrastructure. This study identified that even if most districts have sufficient access to green space there are differences in access rates – these being lower for communities with high percentages of immigrants and high population density (Kabisch et al., 2014). A study in Kansas City USA applied spatial analyses to explore the relation between criminal offence frequency and proximity to urban parks. This study concluded that the level of deprivation [in a neighbourhood] has an influence on whether or not parks function as beneficial urban green spaces (DeMotto et al., 2006).

The literature also considers how access to green spaces can, in some cases, have undesirable impacts on communities, especially those that are economically most vulnerable. The economic impact that green space accessibility may present can be reflected in increased

property values that could affect adversely existing community dynamics (Van Herzele et al., 2005).

Van Herzele (2005) conclude that "accessibility should not be approached merely in terms of a person's capacity to move from the dwelling place to the woodland (on foot or using forms of private and public transport), but also in terms of residential mobility" (p.186).

A study of protected areas in the UK found that social attributes can act as a factor in different perceptions of accessibility. The study used on-site surveys to explore the distribution of benefits from these areas, and found that minorities and socially excluded groups were "starkly underrepresented" as were younger people (16 – 25 years old), and that the social / demographic groups most likely to be accessing protected areas were older people and men (Booth et al., 2010).

Other studies support this notion of social factors playing a role in accessibility with access to transport and cost being important factors, perhaps in particular in relation to accessing protected areas that may be more distant from urban centres. For example, a literature review by Kabisch et al. (2015) noted "people who can easily access distant green spaces belong to either the middle- or upper-middle-income groups. People from low-income groups struggle to meet the cost of these services and prefer to visit areas within the city that are accessible by public transport" (p.30).

A survey of a random sample of people in Switzerland used questionnaires to identify the reasons for accessing green infrastructure. It found that respondents with higher education qualifications were more likely to be motivated by the desire to learn something about nature and to socialise with others, and that age was considered a factor in the differences in motivation of accessing green infrastructure (Home et al., 2012).

Similar conclusions are drawn in a quantitative and qualitative data analysis of existing studies on benefits and accessibility of woodlands in Britain (O'Brien and Morris, 2013). This analysis concludes that the benefits of woodlands are unequally distributed across society in Britain and that protected areas in the UK do not appear to be directly benefiting much of society, suggesting that just one third of adults visit the countryside in England (Natural England (2006) cited in O'Brien and Morris, 2013).

Quality of greenspace

The evidence indicates that the quality and design of green spaces, particularly in urban settings, plays an important role in people's perceptions of access and safety (e.g. fear of crime), and thus influence the extent to which greenspaces may enhance community cohesion and result in social benefits. As well as access, the quality of green spaces and green infrastructure is a factor in realising social benefits. A survey based study of local residents in the Vienna region sought to identify the extent of community attachment and perception of public green space. It concluded that the quality of the green space environment could be a positive predictor of community attachment and that "the perception of many attractive, less crowded, nearby public green spaces is related to higher community attachment" (Arnberger et al., 2012, p.48). Perceptions of quality and attachment to green space also differ between urban and suburban residents:

> "Compared to the urban sample, the suburban residents were less attached and scored lower on the quality of life of their community, the green-space quality and safety conditions. Although the suburban community is less affected by urban sprawl, has a better green-space supply and more home garden owners, this sample agreed less on the green space quality in their community. In fact, most suburban areas are fields and meadows, which are not very attractive for recreation, and very few designated recreation areas exist in the community" (Arnberger et al., p.48).

A study on playgrounds and accessibility observed that visitor density, infrastructure and spatial planning of a green space has an effect on the benefits including social interaction, with greenspace aspects such as the availability of seating and 'shady areas' influencing the extent of social interaction (Bennet et al., 2012).

The quality and make-up of green infrastructure can impact on a community's perception and fear of crime as evidence by Kuo et al. (2001) who found that in an inner-city neighbourhood certain vegetation patterns (widely spaced, high-canopy trees and grassy areas) retain visibility. This was considered an important factor in perceived security of the park and the likelihood of crime. This research fed into existing literature on landscape design, landscape overview and control, vegetation density and character, which are all recognised to have an effect on perceptions of personal safety (e.g. Jansson et al., 2013, O'Brien., 2005, Tucker and Matthews, 2001).

The quality, design and maintenance of green spaces are also important. Poorly maintained green spaces have been associated with vandalism, verbal and physical abuse, household waste dumping and social conflicts (O'Brien, 2005, Tucker and Matthews, 2001). Different green space landscapes have different perceived safety levels, and key factors influencing perceptions of safety include: possibility for overview and control; vegetation density; and vegetation character and maintenance (Jansson et al., 2013). A study based on a spatial analysis of the relationship between proximity to parks and criminal activity in Kansas City, USA, concluded that, in urban areas with high levels of deprivation parks can become the location of a "criminal marketplace" (De Motto et al., 2006, p.156) and that in such neighbourhoods an increased number of criminal offensive are seen in close proximity to parks. This study only considered proximity however and did not consider the quality of any of the parks included.

A large-scale survey in the Netherlands explored the relationship between the extent of green space, social contact and health through a multilevel regression analysis that controlled for socio-economic and demographic characteristics and urbanity. This study concluded that perceptions of the quality of green spaces are more likely to motivate behaviours than the actual levels of available green space (Maas et al., 2009).

The role of Natura 2000 and wider green infrastructure

The literature and **evidence reviewed in this chapter provide very strong support for access to good quality green infrastructure, in particular in the form of parks, play areas and other publically accessible open and green spaces, playing a role in social cohesion and reduced social exclusion**. This is particularly the case in urban areas, where sufficient provision of accessible (geographically and economically) green infrastructure can provide spaces for

communities to meet and share experiences (the concept of 'green hubs'). However, research also shows that access by all should not be taken for granted, as economically and socially excluded groups may find it harder to access green infrastructure and it is important to ensure, and perhaps even facilitate, equitable access and provision.

There is relatively limited research identified that explicitly explores the social benefits of Natura 2000 and other protected areas. However the **evidence related to wider green infrastructure suggests that Natura 2000 sites within or close to urban areas are very likely to result in similar benefits**, and those case examples that do exist indicate that **Natura 2000 and wider nature / protected areas can provide opportunities for social interaction and related social benefits**. At the same time, natural areas, such as forests, can play a role in community identity and sense of place

Table 9.1: Causal links, hypothesis, measures and evidence – an overview – Promoting social benefits: Accessible, quality green spaces as shared public space

Benefits types		**What environmental pressures could biodiversity help address?**	**What specific benefits could in principle (and actually) be measured?**	**What benefits can be measured in monetary terms?**	**Who are main beneficiaries of biodiversity measures?**	**What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?**
Promoting social benefits	**Quality of shared green public spaces**, reduced **social tension,** improved access by minorities and hence improve social cohesion and reduced social exclusion (e.g. accessibility (average distance to green space) and use of opportunity by communities… and hence feeling of inclusion/reduced exclusion)	Principle: Social exclusion and isolation (within and between groups of people).	Principle: Monitoring of visitor numbers and demographics would be a useful indicator of potential interactions	Principle: Reductions in crime rates could be monitored.	Principle: The socially excluded, economically deprived and/or minority groups (e.g. national, ethnic).	Principle: Management (which differs in N2K / GI areas) determines, in part, the sorts of users and their experiences.
		What does the data say: • Public spaces provide areas for those without access to outdoor private spaces (esp. lower socio-economic groups) to gather. • Green spaces can foster a 'sense of place' and community ownership • Good quality greenspace in urban settings may reduce crime / anti-social behaviour.	What does the data say: • Demographics of green space users. • Accessibility standards relating to public green space (e.g. using GIS). • Quality of green space (e.g. based on agreed criteria). • Levels of social tension / conflict (e.g. complaints about neighbours, crime rates).	What does the data say: • No attempts to monetise social cohesion benefits of greenspace were identified.	What does the data say: • The existence or provision of (good quality) greenspaces benefits all, and people from deprived communities may benefit most as they may rely on public spaces (due to lack of access to private communal spaces). • Available research suggests that members of minority and deprived communities are less likely to visit protected area.	What does the data say: • Accessibility, management and active facilitation are all likely to increase the use and hence social benefits of green spaces.

9.3 The role of supporting instruments and governance

The literature reviewed in this chapter indicates a few areas in which policy instruments are, or could, be an important factor in encouraging or maximising access to green space and the natural environment, thereby helping to realise the social benefits identified:

- The use of accessible green space standards, such as those in use in the UK (note, these are guidelines rather than statutory requirements) to help integrate recommended levels of access to greenspace for all through urban planning and development (Natural England, 2010). Although such standards generally focus on the provision of green space in urban settings, Booth et al (2012) suggest developing location based strategies in relation to ensuring proximity of protected areas to communities, and that such strategies should consider social diversity indices.

- In the context of access standards, GIS mapping and assessment can be used to visualise, measure and monitor change in the size, distribution and accessibility of green infrastructure. This can be used for modelling provision for social / community purposes, but also in relation to habitat fragmentation and environmental benefits, such as climate change adaptation, noise abatement and air pollution mitigation.

- Efforts to enhance green (and blue) infrastructure can also help increase accessibility for exercise and amenity, as well as better health and social conditions (European Commission, 2013).

Green routes without obstacles in the Razna National Park (Latvia)

The project "Green routes without obstacles" (2014) by Nature Conservation Agency of Latvia[11] (funded by European Commission, European Neighbourhood and Partnership Instrument, 2007-2013 Cross Border Cooperation Programme[12]) aimed to increase availability of nature tourism for disabled people by adapting infrastructure and educating tourism service providers. Resulting outputs for visitors with special needs included the creation of new and adaption of existing nature tourism infrastructure elements; two-three day travel routes in the border regions with information available in four different languages; recommendations and practical advice on working with people with special needs for tourism service providers.

Other important factors that need to be considered in the provision and management of green spaces and the natural environment for social benefits include:

- The need for proactive intervention to improve either real or perceived accessibility to greenspaces is highlighted by the study by Wang et al. (2015) which suggests that residents in more deprived neighbourhoods perceive access to parks as more

[11] See http://www.daba.gov.lv/public/lat/projekti/lat_lit_bel/zalie_marsruti/ [in Latvian] Last accessed 24 April 2015

[12] See http://www.enpi-cbc.eu/ Last accessed 13 May 2015

difficult than in relatively wealthy neighbourhoods with very similar levels of park provision.

- The need for bottom up approaches when seeking to maximise social inclusion outcomes from greenspaces, for example involving stakeholders from deprived / minority social groups in designing access and facilities within parks and protected areas to ensure that needs are met (Colding et al., 2013, Wolch et al., 2014).

Using urban green infrastructure to enhance social cohesion, the case of Almada, Portugal

A case study in the city of Almada in Portugal acknowledged that managing urban green spaces involves participation of local citizen groups in the maintenance of public green spaces in the form of multi-urban parks and gardens. These spaces should provide opportunities for performing different cultural and sport activities and should contribute towards actively promoting environmental education and awareness. Attention was also given to stimulating social integration of different ethnic and cultural groups in green spaces, e.g., by providing a varied infrastructure for different recreational activities such as biking, jogging, or practicing yoga or Tai-chi.

A network of community allotment gardens has also been established, in part to promote local production and small-scale commerce, as well as social cohesion by fostering social relationships and helping families budget (by growing their own produce).

More information: http://greensurge.eu/products/case-studies/Case_Study_Portrait_Almada.pdf

- While greenspace and parks are associated in the literature with social benefits there is also a risk of 'eco-gentrification'. Wolch et al. (2014) suggest that urban neighbourhoods should be 'just green enough' as urban green space strategies may be paradoxical: while the creation of new green space to address environmental justice problems can make neighbourhoods healthier and more aesthetically attractive, it also can increase housing costs and property values. Ultimately, this can lead to the displacement of the very residents the green space strategies were designed to benefit.

- A number of studies highlight that, while vegetation and green spaces can help reduce aggressive behaviour and crime, the design and maintenance of such spaces is a crucial factor. Poorly designed or quality open and green spaces, especially in urban areas can have the opposite effect: increasing fear or crime. For example Hartig et al (2014) suggest that local parks / green spaces must be well maintained and provide attractive recreational facilities to realise their full potential in developing social ties. In the UK, a government endorsed scheme assesses and awards parks and open spaces a Green Flag Award, recognising the park's quality and contribution to local communities. Eight criteria are used to assess parks: a

welcoming place; healthy, safe and secure; clean and well maintained; sustainable; conservation and heritage; community involvement; marketing; and management[13].

9.4 Conclusions and recommendations

The working conclusion from the research and evidence reviewed to date in relation to quality of green spaces and social benefits are that:

- Green spaces, including urban parks, community gardens and forests are an important factor in community identity, and can strengthen people's attachment to their communities and the extent to which they identify with it.

- Green spaces, parks and playgrounds can provide places in which people interact, and that this can strengthen communities and help people from minority groups or different cultural backgrounds become better integrated in and to identify with their community.

- Green spaces, particularly in urban areas can act as a 'third place' in which people can come together and engage in shared social activities, thus generating social capital. Community gardens and allotments can also act as 'social capital multipliers' whereby motivated individuals and groups can lead to wider involvement and enhanced social benefits.

- However, accessibility depends on multiple factors, such as gender, age, relative income, and education, and that physical access to green space in itself does not necessarily imply that social benefits will be realised by all sectors of society / communities. Proactive schemes are needed to enable people from all sectors of society to engage with nature and green spaces.

- The quality and design of green spaces, particularly in urban settings, plays an important role in people's perceptions of access and safety, and thus influence the extent to which green spaces may enhance community cohesion and result in social benefits.

- There can be a positive correlation between green spaces and vegetation in urban areas and reduced crime, aggressive behaviour and fear of crime. However, the design and quality of green spaces is important in this context, and poorly maintained parks may have the opposite effect, leading to higher perceived risk and fear of crime.

[13] See: http://greenflagaward.org/judges/judging-criteria/ Last accessed 23 April 2015

10 Social Benefits: Volunteering, employment, management

10.1 Engagement in the natural environment

This section explores opportunities for engagement in the natural environment such as green spaces, community gardens and protected areas that are likely to lead to the types of social benefits discussed in the previous chapter. This section focusses on opportunities to engage in the natural environment that are beyond recreation and 'incidental' engagement (e.g. walking or cycling through a park on the way to school or work), and are linked to volunteering and employment.

This section refers to social benefits to communities, rather than individual or personal benefits of engaging in activities in the natural environment or public green spaces. Individual benefits are covered in the sections that consider indirect health benefits, in particular 'Healthier lifestyles – nature experience' and 'Outdoor recreation and physical activity'.

10.2 Opportunities for engagement in the natural environment

Engagement in the natural environment such as urban green spaces, woodlands or protected areas can take various forms, including volunteering, community gardening / allotments or organised eco-therapeutic activities (see e.g. Mind, 2013) such as group walks. Such engagement typically takes place in a range of green and natural spaces, which can include protected areas and Natura 2000 sites.

Volunteering

The evidence suggests that volunteering in the natural environment can lead to social and community benefits, by enabling people to meet new people, develop social relationships and build a sense of community. However, in practice the diversity of volunteers is often limited. Wider social cohesion benefits such as social inclusion, reduced inequalities, and the fostering of trust or shared cultural norms between different socio-economic or ethnic groups require active facilitation to encourage diverse participation.

The Council of the European Union considers voluntary activities to include all kinds of voluntary engagement that are open to all, unpaid, undertaken under the individual's own free will, educational (non-formal learning aspect) and offer added social value (GHK, 2010). Definitions of volunteering vary between countries, as do approaches to it. While western countries have longstanding traditions of volunteering and a positive attitude towards it, in post-communist countries, attitudes are mostly negative, but slowly changing (GHK, 2010). Nature volunteering, also referred to as environmental or conservation volunteering, has the additional aspect of the context in which it is undertaken (O'Brien et al., 2008), and is distinguished from other types of volunteering by its focus on practical environmental action (Volunteer Development Scotland, 2006).

Volunteering activities may be undertaken for personal reasons and lead to personal benefit, but can also have wider social and community benefits.

Recent research into flood and coastal risk management volunteering by the UK Environment Agency and Forest Research (2015a) collected evidence from volunteers (including those doing outdoor activities such as habitat management and river catchment surveys) using an online survey and found that volunteers were motivated by altruistic concerns such as to 'do something to reduce flooding' or to 'help the community as a consequence of flooding experiences' (Environment Agency and Forest Research, 2015a, p.17). Benefits reported by volunteers were both personal (e.g. 'knowledge of who to turn to in a flood emergency') but also social, including: 'sense of belonging in my community'; 'trust in other people in the community'; 'meeting new people in the community'; and 'fostering a sense of pride and care in the area' (see Environment Agency and Forest Research, 2015a, Figure 4.11, p.21). Environment Agency and Forest Research (2015c) also classified the types of activities that flood volunteers do into four areas which are relevant to other areas of volunteering in the natural environment:

1. Knowledge: Encompassing activities such as surveying a river in a catchment walkover, checking river gauges, monitoring water quality, pollution monitoring, collecting data as part of a citizen science project.

2. Campaign: For example raising awareness of flooding, taking part in flood planning, educational work with schools, and promoting the uptake of local flood warden services.

3. Physical: Embankment building, habitat management, opening and closing sea gates, clearing drainage ditches and water courses etc.

4. Virtual: For instance, remote monitoring or web-related action such as documenting the group's activities and providing information on web pages.

As the evidence in the box below suggests, much of the volunteering in nature parks is "physical focused", or practical management.

Volunteering in European Protected Areas

Thomson (2013) under the wider project "Volunteer Management in European Parks", gathered data about volunteering in European protected areas. The research was developed on the basis of a literature review, a set of questionnaires circulated by e-mail and online to a wide range of volunteers, volunteer co-ordinators and community representatives across the protected areas in the EUROPARC network and a series of interviews with individuals. In total 182 volunteers, 42 volunteer co-ordinators and 6 community representatives submitted responses to their respective questionnaires. Key findings of the study were that:

- Tasks most often assigned for volunteers were: practical management (140 out of 182), less than half of them were engaging visitors and 40 did awareness-raising and communication.

- Most of the interviewers had volunteered more than five times, whereas fewer than 10% of all participated only on a single occasion.
- Almost 40% of volunteers were aged 60 and over, very few were under 20, other age groups were represented equally. The overall balance between the sexes was 60% male to 40% female.
- The main benefits for volunteers were social contact and sense of belonging (nearly 80%). Secondly was fitness and wellbeing (77%), then 62% saw it as making a major contribution to their overall motivation and little under half of respondents saw their work as a way to improve their self-confidence.
- Benefits for Protected Areas from having volunteers according to their co-ordinators were: help in practical management (85% of major benefit), visitor engagement (61%), wider awareness-raising and communication (50%). Whereas only 11% helped with administration and fund-raising.
- The concept of volunteering rooted in protected areas as a way of rising available resources for its management is prevalent in north and west Europe, with an increasing role in southern and eastern countries.

Opportunities for volunteering in nature: Chrudim, Czech Republic

As part of its status as a healthy city, Chrudim has run a programme of greening to deliver health benefits to its citizens and visitors. Notable activities include investing in arborists to care for city trees, developing new public parks, greening housing estates, and providing new opportunities for outdoor recreation. A number of voluntary activities support the work, for example the replanting of 500 trees that were lost following heavy storms in 2008. Around 1000 people participate in voluntary projects organised by the city each year. The residents of Chrudim are actively involved in decision-making processes concerning the planning and development of the town: around 20 meetings take place each year, during which citizens, including young people and senior citizens, gather to discuss planning proposals.

Assuming volunteers work together in groups, a factor in fostering social inclusion or cohesion from volunteering in nature is that it enables volunteers to meet new people (although this would also be true of other forms of volunteering). A literature review of volunteering in the natural outdoors in the UK by Ockenden (2007) cites a survey of volunteers completed for the National Trust (UK) in 2004 that found that 92% of National Trust volunteers agreed that it allowed them to meet new people. At the individual level, interactions with the natural environment, through participation in conservation groups, have been found to increase social capital by creating social networking opportunities and a sense of belonging (New Economics Foundation, 2012).

However, there are some good examples of “knowledge focused” volunteering such as Coastwatch and Clean Coasts volunteering in Ireland, together with The Blue Patrol (Błękitny Patrol) led by WWF Poland.

Citizen Science: Coastwatch Survey, Ireland

The Coastwatch Survey (http://coastwatch.org/europe/survey/) started in Ireland in 1987 and spread to other countries with EC aid. It is a systematic shore eco-audit done by volunteers who walk their chosen 500m of shore around low tide each autumn. They record their observations while in the field and report back. The project uses a standardised shore coding, questionnaire and feedback system which was initially paper based and is now mainly online GIS and social media based.

Volunteers are typically not scientists so they are given basic training and learning materials beforehand where possible. Surveyors come from all social classes and educational levels. They include families who want to care for their local environment, clubs, scouts and university students who want to practice their fieldwork and do something useful. It also includes whistle-blowers who want to flag a local issue or danger and communities who want to collect data on their local area.

The aims of the Coastwatch network are: training and education of volunteers in fieldwork, gathering baseline data and expertise about European coasts, raising awareness about rich biodiversity of coastal zones, policy enforcement (e.g. changes in Natura 2000 sites boundaries), safeguarding the natural environment and reacting in case of damage, and increasing public participation in nature conservation.

The literature suggests that volunteering allows individuals to create new social relationships and strengthen existing ones, which can lead to an increase in social support and a reduction in social isolation (Reynolds, 2000). It can also bring together people from different organisations and subsequently lead to expanded social networks with wider pools of resources (Environment Agency and Forest Research, 2015a).

Engagement with nature is a potentially effective way of enabling some marginalized people to reintegrate into society by facilitating skills development, improving self-esteem and confidence, enabling people to feel part of a small social network, providing meaningful activity, and aiding the development of feelings of responsibility (O'Brien et al., 2011). In this study, O'Brien et al. gathered ethnographic[14] and interview data from volunteers in the UK. The first considered general environmental volunteering primarily in northern England and southern Scotland, and the second focused on mental health participants at Meanwhile Wildlife Garden in London[15] (also see box below). The aim was to explore the role of active, hands-on contact with the environment to understand the benefits that participants gained from their voluntary involvement. A study by Brook (2010) into an allotment community health inclusion project in Edinburgh, Scotland, had similar findings to the O'Brien et al. (2011) research.

[14] The UK Government user research service describes ethnographic research as usually involving observing target users in their natural, real-world setting, rather than in the artificial environment of a lab or focus group. The aim is to gather insight into how people live; what they do; how they use things; or what they need in their everyday or professional lives. See: https://www.gov.uk/service-manual/user-centred-design/user-research/ethnographic-research.html [accessed 27 March 2015]

[15] See: http://meanwhile-gardens.org.uk/ [accessed 26 March 2015]

Enabling people to reintegrate into society through volunteering in a wildlife garden in London

O'Brien et al. (2011) gathered ethnographic and interview data over a year (2004) from participants in an eco-therapeutic project involving volunteering in the Meanwhile Wildlife Garden in London to understand the benefits they gained from their voluntary involvement. The volunteering was coordinated by the local office of Mind[16] , a UK based mental health charity. and participants were referred to the project by their health or social care practitioner or general practitioner, or they could refer themselves if they were interested in this type of therapeutic approach. This is a small garden site in London, and approximately 6 participants would be on site at Meanwhile per day and 30–35 participants with mental health issues would be on the Meanwhile books at any one time.

Key findings of this study were that:

- Participants reported that their involvement encouraged wider community involvement in respecting nature and taking care of the environment; helped develop a sense of pride, a sense of self and sense of place; derived personal social benefits from meeting other people, joining in the activities and working as part of a team; and led to direct involvement in the community.

- Participants gradually developed bridging links with their diverse community and cultivated a self-directed effort towards becoming stewards for the environment and agents of change. This aided recovery from ill health, rehabilitation in the context of personal health and inclusion into the local community.

Employment in the natural environment

Another way that people can be engaged in and benefit from the natural environment and protected areas is through employment and skills development for employment. For example, in response to the Scottish Government's priority to tackle youth unemployment, in 2011 the Forestry Commission introduced a work experience and skills development initiative for young unemployed people (Forestry Commission, 2013). Opportunities available through the initiative range from a few hours of volunteering per week to full-time apprenticeships working in the National Forest estate, to enable young people to gain skills, training and experience within woodland environments. As well as benefits for individuals (new skills, employment opportunities), the initiative has reported a number of community benefits:

- Enabling participants to get to know their peers and learn to cooperate with each other.

- Providing opportunities for joint working towards shared objectives, helping to establish 'communities of interest'.

- Bringing benefits to the wider communities near the sites involved.

[16] See: http://www.kcmind.org.uk/index.asp#.VVRltpOrMXA [accessed 14 May 2015]

Increasing social cohesion through engagement in forests in Scotland

On the basis of case study research in the Loch Ness and Glasgow and Clyde Valley regions of Scotland, Edwards et al (2009) identified a range of community and social benefits from engagement in forestry for people in Scotland, and in particular those from socially and economically deprived inner-city areas. These included:

- Increased human capital and hence employability of individuals who participate in forest-related initiatives and activities, through educational learning, training and skills development, and life skills such as teamwork and leadership.
- Positive reinforcement of good behaviour among young people and associated increases in capacity for learning.
- Increased social inclusion and community cohesion associated with shared experiences of forests through visits, volunteering and employment associated with forests.
- Increased community capacity to achieve shared goals, through increased 'bonding' social capital (i.e. within communities), and 'bridging' social capital (i.e. between members of communities and external partners).

The research also found that (in 2006 – 2007):

- The total employment resulting from first-round (direct) spending from tourism and recreation attributable to woodland, where woodland was the primary reason for the visit, is estimated to be around 17,900 FTE jobs, while the total Gross Value Added (GVA) associated with tourism and recreation is around GBP 209 million.
- In 2006–2007, around 7,500 volunteers carried out forest-related work, representing a total of 47,400 volunteer days.
- 138 active community woodland groups with around 13,500 members were identified, who together manage around 250 woodlands covering a total of 18,275 hectares, or 1.4% of the woodland area in Scotland. The total income was around GBP 4.5 million in 2006/2007, of which 50% was grants from public bodies

Employment and disabled access opportunities through regeneration of a former coal mining area, Hoge Kempen National Park, Belgium

Hoge Kempen National Park contributes to the social cohesion and regeneration of a former coal mining region that was at risk of economic decline. Innovative approaches to developing the park's infrastructure have helped balance economic and biodiversity objectives, providing 400 jobs and direct annual economic benefits of €20 million (Schops, 2011). Today, a heightened sense of public ownership and political appreciation of the value of the park represent the success of the project. Special attention is given to people with disabilities, for whom specific activities and itineraries have been created. For example, Vakantiehuis Fabiola, a nursing home located close to the Mechelse Heide getaway, cites the benefits of the calm and relaxing surroundings for its patients. At this location a special and highly appreciated path was developed ("zandloper pad") to give access to disabled people and to provide them with a new and direct experience with nature.

Protecting traditional agricultural products and unique ecosystems: Slow food Presidia Project

The Slow Food movement was established in Italy in 1986 as a challenge to fast food and a perceived degradation of the relationship between food and nutrition, the planet, people, politics and culture. The Presidia Project, which started in 2000 in Italy, brings together communities of producers who are interested in collaborating to protect traditional products, production practices or rural landscapes or ecosystems at risk of extinction. It has helped hundreds of small-scale producers continue using local traditional techniques, preserving cultural links between food, society and nature. Each product that belongs to a Slow Food Presidium is regularly evaluated based on over 50 indicators, to assess the sustainability of the product on the socio-cultural, agro-environmental and economic levels.

Employment opportunities and preservation of cultural heritage: Secovlje Salina Nature Park (SSNP), Slovenia

Sečovlje Salina Nature Park (SSNP) is comprised of state owned and privately managed saltpans. The site is an important source of employment and social cohesion for the region as well as providing proven health benefits as a natural spa. SSNP contributes to the local economy and is an important socio-cultural landmark. The park has approximately 50,000 annual visitors, increasing from 8,000 in 2002, and employs about 90 local staff for nature management, up from 16 in 2002. Around 80% of visitors go to the Museum of Salt, with 20% attending the guided tours. As the largest local employer, the park is appreciated by the community and promoted in local media. Economic spillovers outside the park include restaurants and hotels, which provide further indirect employment and revenue.

Other organised engagement

The evidence indicates that participation in led and organised activities (such as conservation activities or skills development initiatives related to woodlands) can lead to social development and new connections, enhanced life-skills, social inclusion through shared experiences, and building of community capacity. Such benefits may depend on specific programmes that target marginalised and excluded groups.

In relation to the benefits of involvement in a range of led and organised activities in woodlands, O'Brien and Morris (2014) drew on 31 studies carried out since 2001 and undertook a meta-analysis of quantitative data and a meta-synthesis of qualitative data to explore the social distribution of wellbeing benefits from woodlands and forests in Britain. Social development and connections was one of the key wellbeing 'categories' identified:

"… social development and connections includes benefits associated with strengthening existing social relationships, for example with family and friends, and the creation of new relationships. These benefits can be realised through a range of activities in woodlands. Participation and capacity building gained through involvement in led and organised

activities in woodlands are also viewed as beneficial" (O'Brien and Morris, 2014, Table 4, p.374).

Reflecting the findings of O'Brien et al. (2011), a review of literature by Burls (2007) identified that marginalised people reported finding empowerment in caring for the environment, which can reawaken a sense of possibility, relief from struggles and the opening of new social opportunities.

Living Roots Open Spaces Project, Warwickshire ,UK

The Living Roots Open Spaces Project[17] launched in 2011 (with a grant of approximately GBP 30,000 (circa €41,000) from the North Solihull Regeneration Partnership) has engaged young people from North Solihull in activities that provide them with new skills and access to green spaces, whilst instilling in them a desire to care more for these areas. Through experiences relating to conservation, art, photography, film making and youth work, the project aimed to challenge young people to engage more with the natural world and their surrounding communities.

Community gardening and allotments[18]

The evidence suggests that participation in community gardening and allotments can benefit individuals and their communities by providing opportunities to break down barriers and have shared experiences across economic, occupational, age and educational backgrounds. Such spaces can also become 'places that matter' and enhance community attachment. Some evidence suggests that benefits may be limited to those directly engaged in a specific garden or allotment.

A key way in which people can engage with each other and nature is through gardening and horticulture. There is considerable research into community and allotment gardening and how such activities benefit people and communities. Examples identified come from the UK (e.g. Hawkes and Acott, 2013, Brook, 2010, O'Brien et al., 2011), Finland (Leikkilä et al., 2013) and USA (e.g. Flachs, 2010, Hynes and Howe, 2004, Porter and McIlvaine-Newsad, 2013).

Transition and Education for a Resilient and Regenerative Agriculture (TERRA), Luxembourg

Set up in 2014, TERRA (Transition and Education for a Resilient and Regenerative Agriculture) is Luxembourg's first Community Supported Agriculture (CSA) project. This grass roots initiative was the vision of three friends who were critical of intensive and environmentally harmful agribusinesses and were searching for alternatives for producing, distributing and consuming food locally. On a 1.5 hectare site just 3 km from the centre of Luxembourg city centre, they grow food for 150 families

[17] See: http://www.warwickshirewildlifetrust.org.uk/living-roots-open-spaces Last accessed 24 April 2015

[18] Allotments refer to areas of land that have been formally allocated (typically by a local planning authority) explicitly for the use of local residents to grow food. Community gardens on the other hand refer to spaces on often derelict or abandoned land that a group of people from within a community have gained (legal) access to for the purposes of creating a garden for their community, which may either be for growing food or to provide an attractive and accessible open space. (project author's own definition)

and provide opportunities for employment, volunteering and participatory learning. Participation and volunteering on the farm is open to anyone, and members are encouraged to take part. The project was set up without financial support, and is dependent on membership fees and volunteers, who themselves benefit from food baskets and collaborating in this thriving community.

From Plot to Pot

'From Plot to Pot'[19] is a project run by Teesdale Conservation Volunteers (TCV) in County Durham, UK. The project aimed to encourage local residents to grow their own food, both for their own consumption as well as sharing with neighbours. A summary of the project concluded that one of "the most significant outcome(s) of this project has been building a sense of community, which has resulted from the combination of people attending events and working on pieces of land together".

From construction site to community garden, a case from Ljubljana, Slovenia

In collaboration with neighbourhood residents and other interested people, locals have been transforming a previously derelict site in Ljubljana into a community space for urban gardening, socialising, education, and culture. The project shows the potential of degraded urban areas and the possibility of creating new value through temporary use and community - based interventions. The project promotes urban gardening as well as more active inclusion of inhabitants in decision-making about planning, development, and management of urban spaces.

The plot owner is the Municipality of Ljubljana and it has allowed free usage of the land. The project is coordinated by two local NGOs (Obrat Culture and Art Association and Bunker). The European Regional Development Fund, the Municipality of Ljubljana and the Ministry of Culture are the main supporters of the project.

More information: http://greensurge.eu/products/case-studies/Case_Study_Portrait_Ljubljana.pdf

Ethnographic 'sketches' of four community gardens in the city of Cleveland (Ohio, USA) show that community gardens can act as centres for socialising or networking and "foster personal and communal growth by providing a framework within which a community can participate in a shared experience, interact in an atypical environment, and contribute to a body of shared knowledge" (Flachs, 2010, p.7). These benefits expressed by gardeners were found to exist within 'the unique framework' of each garden rather than necessarily being shared across the gardens (Flachs, 2010).

[19] See http://www.localfoodgrants.org/public/press/morethanjusttheveg.pdf Last accessed 24 April 2015

The Ecominds scheme (UK)

The Ecominds scheme funded 130 projects across England over 4 years – between 2009 and 2013, to provide access to a range of nature-based activities that improve physical and mental wellbeing. The scheme allowed more than 12,000 people with mental health problems to be involved with gardening, farming and food growing, environmental conservation, arts and crafts and green exercise.

Among the multiple health and well-being benefits identified by the participants, an important aspect that was highlighted was increased inclusion in their local community, and reduced social isolation. A participant of the Ecominds project said: "The project has brought people from various backgrounds together and the group works extremely well as a team. All the participants have commented that the project has enriched their lives in so many ways. I feel truly alive again."

Source: http://www.mind.org.uk/ecominds

In a small rural town in Illinois, USA, ethnographic approaches including participant observation, attendance of community gardening events, a review of journals kept by community gardeners, focus groups and interviews were used to help understand participants' perceived benefits of participation in community gardens (Porter and McIlvaine-Newsad, 2013). Community gardens were identified as places where people of various economic, occupational and educational backgrounds came together with a desire to garden and that:

"…the act of gardening was a larger experience that provided leisure opportunities such as relaxation, friendships and connectedness with family. When these benefits were realized, they, in turn, resulted in the creation of internal social capital which facilitated previously unrealized relationships. These relationships evolved into connections that resulted in the alleviation of many individual and social constraints that a lack of access to environmental goods had previously thwarted" (Porter and McIlvaine-Newsad, 2013, p.391).

Porter and McIlvaine-Newsad (2013) also found that gardening broke down barriers between generations e.g. older gardeners passing recipes and horticultural knowledge and skills to younger people.

Encouraging food growing on a regenerated brownfield site, Le Parc des Hautes Bruyères, Villejuif, France

South of Paris, the Council of Val de Marne converted a brownfield site into 23 hectares of public park with the purpose of reducing noise from a motorway, as well as providing a valuable community resource. The park houses a number of public allotments, spaces for recreation, education and biodiversity. The park includes 85 allotment plots, each with a small shelter designed by Renzo Piano. These vegetable gardens are reserved for residents of the communes. Two of the plots are kept as spaces for educational programmes run by the local council. The park also includes a medicinal garden, consisting of around 900 plants of 85 different species. In 2014, a canal in the park was restored to in order to increase the biodiversity of the site.

Sitric Compost Community Garden, Republic of Ireland

Sitric Compost Community Garden is a small patch in Stoneybatter, Dublin. The land was transformed from a small composting site into a garden that now grows vegetables, herbs and fruit. The initiative was started by people who did not have access to gardens and these activities have resulted in the garden becoming a focal point for the community where social interaction is facilitated. Activities include a monthly event where the participants meet in the garden to work together and afterwards share tea and cake. The democratic way the community garden is managed is reported to have empowered local residents to be active in their community and become drivers in making it a better place.

A review of literature related to Urban Horticulture in the United States by Hynes and Howe (2004) concluded that:

"…community gardens re-create a sense of "place" for those dispossessed of place by slum clearance and ghettos and for immigrants arriving from agrarian cultures. Offering physical, existential, and community support, they become 'places that matter'" (p.10), and that "the give-and-take of working in gardens attaches gardeners to a particular place through physical and social engagement" (p.2).

An observation and interview-based qualitative study of participation in an allotment in England found that it:

"evoked deeply personal connections to people and places, particularly the local. Their common interest in gardening was seen as a great equaliser: irrespective of their background and by virtue of residing locally, plot-holders could discuss local concerns on an equal footing with their neighbours" (Hawkes and Acott, 2013, p.1125).

Leikkilä et al. (2013) conducted interviews and discussion groups with immigrants in Finland, seeking to understand the role of urban nature in promoting inter-culturalism. Their findings suggested that "in some cases using nature collectively creates opportunities to meet other people, as is the case with allotment gardening". However they also state that they did not find "support for social integration through actually making friends in nature". Leikkilä et al. do note however that this may be at least in part due to cultural norms in Finland: "the Finnish preference for less interaction" (p.188).

As well as being a potential source of and factor in social cohesion and individual social capital, Ockenden (2007) suggests that community gardens may also often emerge as a community's response to social exclusion and lack of local facilities.

Volunteering and employment in Quinta do Pisao, Sintra-Cascais Natural Park, Portugal

Quinta do Pisão is part of the Sintra-Cascais Natural Park, which belongs to the Natura 2000 network. The Quinta do Pisão is the redevelopment of abandoned agricultural land into a working farm and large public park that offers walking and cycling paths, as well as a range of events based around sustainable tourism. Since the changes were made to Quinta do Pisão, local biodiversity has increased, and local people as well as visitors, primarily from Lisbon, increasingly use the space for recreation. Visitors can pick and purchase home grown seasonal organic produce in the park's farm, with the aim of encouraging people to eat more healthily and to raise their awareness of the value of food. Since 2007 the park has been supported by over 1,750 volunteers – who have aided with vigilance against forest fires, control of invasive plants, seed collection and maintenance of walking routes. The park also promotes green jobs for local people without work. This project involved 55 unemployed people organized into brigades, one forestry and two agricultural ones which support the management of the Park.

10.3 Facilitating engagement for all sectors of society

Ockenden (2007) considered evidence about the 'diversity of volunteers' (Ockenden, 2007, chapter 8.1) and found a significant amount of literature supporting volunteering in the natural environment being socially inclusive and helping address the symptoms and causes of social exclusion. Ockenden further suggests that volunteering can build social capital, trust and reciprocity between cultures, and that nature-based volunteering activities such as tree planting or woodland management help to build social networks and subsequently social cohesion.

However Ockenden (2007) also identified 'considerable evidence' to show that in practise, those that volunteer outdoors demonstrate a lack of diversity in terms of age and ethnicity and that other authors have observed wider problems of participation and equality in volunteering in conservation.

Surveys carried out in the UK and examined by Ockenden indicated that conversation volunteers are predominantly older people (over 65 years or retired) and lacked ethnic diversity, with one volunteer surveys showing 99% of volunteers being white (see Ockenden, 2007, chapter 8.1). Equally, a project to assess the involvement of volunteers in achieving flood and coastal risk management outcomes in the UK found that, of volunteers surveyed, they were predominantly male (72%), aged over 54 years (84%), retired (68%) and living in rural areas (63%) (Environment Agency and Forest Research, 2015a). The research by Environment Agency and Forest Research (2015b) also reported that there was "…very little ethnic diversity and probably few volunteers from lower socioeconomic backgrounds" (p.16).

Social benefits such as social interaction, social empowerment, reduced crime rates, social cohesion, and social support are all associated with engagement in nature, but such outcomes may not be inevitable and should be seen in the context of a general lack of diversity amongst people that are engaged with nature. Thus, facilitated programmes of

engagement or initiatives that explicitly aim to achieve wide participation and / or specific minority or excluded groups, may offer the greatest social benefits. Such programmes require coordination, expertise and funding.

Natura 2000 and green infrastructure relevance

The evidence reviewed in this chapter indicates that **there are various ways in which people can become engaged in green infrastructure and that this can have a range of social benefits**. In particular, opportunities to participate in group activities, such as conservation volunteering, can bring different social groups together in shared activities, thus helping to increase understanding and communication as well as build trust and a shared sense of place and belonging. Structured activities like allotment gardening have been widely researched in Europe and elsewhere and are seen to have wide-ranging beneficial social effects.

While there is relatively limited research explicitly focussing on Natura 2000 and protected areas, **many of the benefits of involvement in green infrastructure could be expected to be realised from involvement in Natura 2000 and other protected areas**. At the same time Natura 2000 sites and protected areas may help focus community activity and volunteering by connecting with the idea of place and a sense of community identity. Equally, the wider natural environment provides an array of opportunities for employment, volunteering, skills development and community participation (e.g. community forest management groups), which can lead to personal and social benefits.

Table 10.1: Causal links, hypothesis, measures and evidence – an overview – Promoting social benefits: Engagement in green spaces, community gardens and protected areas

Types of benefits		**What environmental pressures could biodiversity help address and what indicators are useful?**	**What specific benefits could in principle (and actually) be measured?** What quantitative indicators are used?	**What benefits can be measured in monetary terms?**	**Who are the main beneficiaries of biodiversity measures?**	**What can one say about the role of Natura 2000 and wider GI measures and their contribution to the benefits?**
Promoting social benefits	Green areas, community gardens and protected areas are place –based, localities that provide significant opportunities for involvement from all sectors of society – volunteers, employment, management. (e.g. numbers of volunteers and jobs engaged in different activities*)	Principle: Lack of integration of minority or excluded groups into wider society.	Principle: Participation in natural environment based activities by different social / ethnic groups	Principle: • Number of volunteers	Principle: The socially excluded, economically deprived and / or minority groups	Principle: Management plans including activities to increase participation and encourage engagement.
		What does the data say: Engaging in the natural environment has benefits including: • Facilitating integration of communities and individuals • Developing relationships with people from different backgrounds • Breaking down barriers • Enhancing sense of community, feelings of trust and community identity.	What does the data say: The number and type of people, and types of engagement can be measured quantitatively. Assessment of the effects on communities / social cohesion could be measured through surveys. Where standard questions are used, self-reported perceptions of cohesion could be quantified.	What does the data say: In principle, the monetary value of volunteering could be calculated (e.g. using agreed values for different types of volunteering).	What does the data say: The evidence suggests that people from deprived / minority groups are less likely to engage in the natural environment and related activities such as volunteering and community gardening.	What does the data say: For social benefits to reach those most in need (the excluded, socially and economically deprived, minority groups etc.), there is a need to actively encourage and facilitate participation, including addressing barriers such as cost, perceived (and real) lack of access (e.g. for transport reasons).

The role of supporting instruments and governance

The evidence suggests that achieving social benefits from engagement in the natural environment, be it through volunteering, employment or other organised activities, is improved through facilitation and coordination at some level. This can take the form of bottom-up community-led initiatives such as those behind many community gardening schemes. Indeed some research suggests that community-led initiatives may offer opportunities to maximise social inclusion outcomes and engagement of people from diverse backgrounds (see e.g. Colding et al., 2013, Wolch et al., 2014).

Who coordinates nature volunteering in Europe?

- **NGOs:** For example, in the UK the RSPB mobilised more than 13,500 volunteers in 2015, representing a gift of time of 1,004,307 hours, equivalent to an extra 587 full-time staff working for nature conservation[20]. In Germany, NABU[21] registered 37,000 volunteers with 3,024,000 hours in 2010. NABU estimates that about 150,000 volunteers' hours each year is devoted to designation and caretaking of protected areas, which sums up to a monetary value of €2,250,000. NGOs such as Greenpeace, WWF, and Friends of the Earth rely heavily on volunteers for fundraising, campaigning and other kinds of support.

- **Protected area managers**: See the box 'Volunteering in European Protected Areas' above.

- **Scientists and researchers**: the benefits of using volunteers for science purposes is that it can enable a larger geographical scale of research (O'Brien, 2008, van der Wal et al., 2015)

- **EU and globally funded programmes**: The European Voluntary Service (EVS) (part of the EU-funded Erasmus+ programme) supports people between 18 and 30 years of age to carry out voluntary work abroad for up to 12 months[22]. The Grundtvig programme promotes the participation of European citizens in volunteering projects in a European country other than their own, allowing them to learn and share their knowledge and experience across borders (COM, 2011).The United Nations volunteer programme[23] had more than 6,000 people in 2014 globally.

More common engagement of minority groups and socially and economically deprived people will require active intervention from organisations with resources (monetary / expertise) and the authority to facilitate, coordinate and encourage wide participation and engagement, examples include initiatives run by Wildlife Trusts[24] and Natural England[25] in the UK.

[20] http://www.rspb.org.uk/about/run/annualreview/2015/index.html
[21] www.nabu.de/wir-ueber-uns/transparenz/jahresbericht
[22] https://www.erasmusplus.org.uk/
[23] http://www.unv.org/
[24] See for example http://www.wildlifetrusts.org/making-nature-more-accessible Last accessed 24 April 2015
[25] See https://www.biglotteryfund.org.uk/funding/big-stories/access-to-nature Last accessed 24 April 2015

Engaging the Roma community in forest management in Slovakia

A case study on Slovensky Raj National Park , of which part is a Natura 2000 site and UNESCO World Heritage Site, explored the involvement and means of participation of the Roma community in sustaining multifunctional forest management (Bizikova et al. (2011)). Through workshops and interviews with members of the Roma community, the study looked at factors affecting participation in stakeholder decision-making. The study concluded that local institutions have a critical role to achieve this aim. Criteria for successful participation of local minorities included: learning, repeated stakeholder interaction, trust building and cooperation between and within multi-ethnic local communities.

Targeted interventions with specific social and community objectives are likely to be required to help realise community and social benefits, examples include projects aimed at tackling youth unemployment in Scotland (Forestry Commission, 2013), or eco-therapeutic programmes aimed at re-integrating marginalised people into their local communities (see for example O'Brien et al., 2011).

Research in the USA has explored the changing governance arrangements of public spaces and in particular, in the context of economic austerity measures, the emergence of a greater role for the private sector in environmental and social provision, including parks and open spaces (Perkins, 2009). The intervention of private sector (neoliberal) models into the governance of parks, exemplified by the development of coffee-houses as an integral part of park infrastructure, can lead to disproportionate provision of quality parks in neighbourhoods that provide economic support for such models and thus leading to neglect of parks and open spaces in deprived areas. The author concludes that this can have the effect of:

"…rearticulating parks governance into atomistic regimes profitable to a few communities of self-interest" (p.2629).

This may become an increasingly relevant economic reality for open spaces in urban areas, for example Hynes and Howe (2004) conclude that:

"Community gardens, and more recently urban agriculture, cannot compete with market-based land uses, such as housing and retail, if they are evaluated solely by their tax generating and other economic potential. We need, therefore, to demonstrate and document the health, education, and social welfare benefits of community gardens, urban agriculture, and access to nearby greenspace for city dwellers in order to assess and validate their full value as natural assets that contribute to social, human, and financial well-being" (p.174).

10.4 Conclusions and recommendations

The working conclusion from the research and evidence reviewed to date in relation to quality of green spaces and social benefits is that:

- Volunteering in the natural environment can lead to social and community benefits, by enabling people to meet new people, develop social relationships and build a sense of community. In practice, the diversity of volunteers is often limited. Wider social cohesion benefits such as social inclusion, reducing inequalities, and building bonds of trust or shared cultural norms between different socio-economic or ethnic groups require active facilitation to encourage diverse participation.

- Participation in organised activities (such as conservation activities or skills development initiatives related to woodlands) can lead to social development and new connections, enhanced life-skills, social inclusion through shared experiences, and building of community capacity by having shared goals. Such benefits may depend on specific programmes that target marginalised and excluded groups.

- The natural environment provides opportunities for learning and this can enhance people's personal development and self-esteem resulting in improved social interactions and connections.

- Interaction with the natural environment can engender feelings of spiritual meaning and enhanced sense of stewardship to the environment and inter-generational equity. In a long-term perspective such feelings may strengthen attachment to and respect for community.

While the project has identified a large number of studies suggesting that a range of social benefits are associated with engagement in the natural environment, the majority of this evidence relates to studies conducted in urban and peri-urban settings and focuses on relatively specific sites or interventions. Although there are examples of studies that have explored the social benefits of engagement in wider nature (e.g. forests and national parks), there is limited evidence that specifically considers the social benefits of protected areas or Natura 2000 sites. This reflects the research undertaken to date rather than suggesting such benefits do not exist.

Further evidence (e.g. a review by Keniger et al., 2013), suggests that while natural settings, such as community gardens, "can be important for facilitating social contact … it is unclear whether collaborative activities in these natural settings can actually increase social capital in the wider community" (p.925). This review also found that although many types of benefits of interacting with nature have been studied, benefits to physical health, cognitive performance and psychological well-being have received much more attention than the social or spiritual benefits, despite the potential for important consequences arising from the latter. Furthermore Keniger notes that the vast majority of research into the human (including social) benefits of nature has been undertaken by social scientists, with a "noticeable lack of contribution from the environmental and biological sciences" (p.928). This is considered important as it means that little is known about which specific ecological

features of the environment might be important for delivering a beneficial response, with much literature referring instead to “an often ill-defined ‘nature’.

This suggests the need for additional research to better understand and articulate the types of social benefits and the mechanisms that lead to them.

11 Role of Policy Instruments for Natura 2000 and Wider Green Infrastructure

11.1 Supporting Health and Social Objectives through Policy Frameworks

In the European Union, the Birds Directive and the Habitats Directive form the main legal framework for the protection of nature and biodiversity. Together they establish the EU-wide Natura 2000 network of protected areas. Currently, the network comprises of 26,000 sites, covering almost 18 per cent of the EU territory (around 790,000 km^2) and includes a growing number of marine protected areas (MPAs) of over 3,000 sites covering over 318,000 km^2. The Natura 2000 network is designed to protect habitats and species of European importance. However, while its primary purpose is biodiversity conservation and sustainable development of activities, the network also provides a range of ecosystem services as co-benefits of biodiversity protection. A range of these benefits are related to health and social wellbeing (see Figure 11.1). As such, the network is a core element of the wider EU green infrastructure and forms the backbone of European living natural capital.

The EU Biodiversity Strategy (Target II) commits to the better protection of ecosystems, and more use of green infrastructure (including a 15% restoration target for 2020). Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, green infrastructure is established both in rural and urban settings. While biodiversity conservation plays an integral part in green infrastructure, the focus is on the provision of multiple ecosystem services, including a range of benefits to health and social wellbeing.

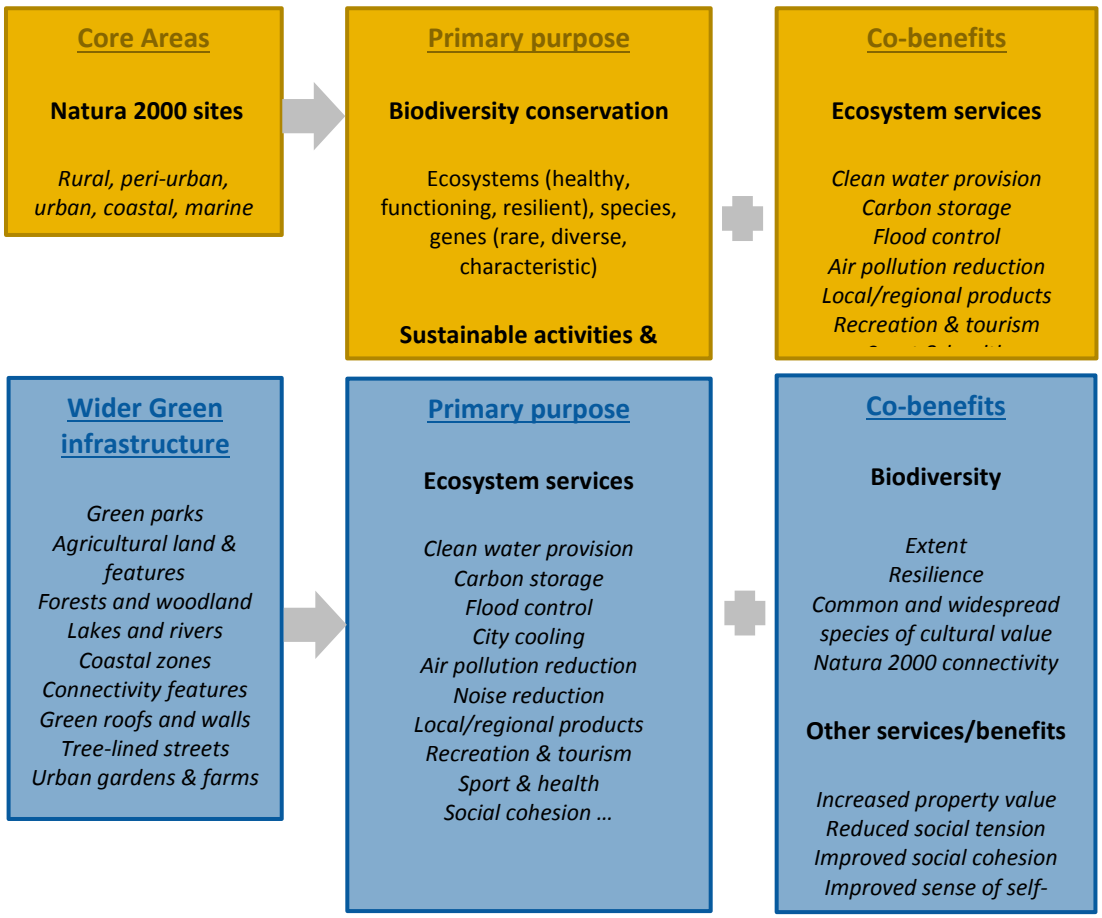


Figure 11.1: Aims of Natura 2000 network and wider green infrastructure and relation to health and social benefits

Source: Own representation

11.2 Health and social benefits associated with Natura 2000 and wider GI

The review of different health and social related benefits carried out in the context of this study reveals a clear and undisputable link between green areas and health and social benefits. Green areas known to deliver such benefits range from small scale urban infrastructure (green roofs and walls, tree belts, green noise barriers etc.) to wider natural and semi-natural areas (urban green areas and parks, nature conservation areas in the vicinity of cities, wider forest areas etc.), making the existing evidence base directly applicable and supportive of the development of EU Green Infrastructure that embraces a range of natural and semi-natural areas and green environmental features aimed at delivering benefits to both people and biodiversity[26].

[26] Green Infrastructure can be broadly defined as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings. See: http://ec.europa.eu/environment/nature/ecosystems/index_en.htm

In terms of protected areas and the Natura 2000 network, the review indicates that there is a clear synergetic relationship between Natura 2000 sites and health and wellbeing benefits, in particularly when it comes to the management of green areas to deliver health and social benefits (see below and Table 12.1). While protected area status is not an absolute precondition for an area to deliver health and social benefits, Natura 2000 sites and other protected areas, especially the ones located within or close to urban areas, are a very useful mechanism for maintaining and promoting such benefits. This is in particular due to the physical infrastructure (network of trails, campsites etc.) and governance frameworks in place that help to facilitate the delivery of benefits (see below). However, the review also reveals that there is a limited amount of information currently available that attempts to link Natura 2000 and other protected areas directly with the delivery of health and social benefits.

Furthermore, several studies point to certain attributes inherently linked to the delivery of health and social benefits that are common to protected areas (e.g. Natura 2000 sites), indirectly providing evidence on the importance of these areas for health and social wellbeing. Such attributes include the following:

Infrastructure: The review highlights the importance of infrastructure in lowering the barrier to access and enjoyment of nature, of encouraging healthier lifestyle and in supporting the delivery of physical, mental and wider societal benefits. Establishing and maintaining infrastructure is a common characteristic of Natura 2000 sites, enabling easy access to stakeholders. Nature 2000 sites and other protected areas have great potential for increased used for physical activity given that they are accessible and have basic recreational infrastructure such as trails and guidance linked to specific areas.

Location: The existing evidence also shows that the location of green areas is a key to capitalising on the nature-related health and social benefits. Accessibility to an area is essential for nature to play a role in encouraging healthier lifestyle and enhancing physical and mental wellbeing (see thematic chapters above). This suggests that protected areas in the vicinity of human settlements play the most important role in delivering such benefits. While remote and unique areas (e.g. wilderness areas) can trigger interest in nature related activities, easily accessible and well-recognised nature areas in close vicinity of human settlements; such as Nature 2000 sites and other protected areas; encourage repeated use and therefore are the most efficient in delivering nature-related health benefits (physical activity, lower stress, improve mental health, lower risk of allergies). The same applies also to wellbeing benefits associated with air, noise and climate regulation as the importance of these natural regulative functions increases in the vicinity of urban areas (e.g. increased concentration of air pollutants).

Size: Some evidence suggests that large green areas, mainly forests and other extensively managed areas, are preferred for outdoor activities (Tyrväinen et al. 2007). This can indicate that Natura 2000 sites and other protected would offer an attractive destination to users, increasing related health and social benefits. Furthermore, size is also the determining factor for the capacity of green areas to capture pollutants and maintain air quality (e.g. EEA 2009, IBGE 2012, Chaparro & Terradas, 2009). Consequently, larger (peri) urban parks and forests, including Natura 2000 sites, play a proportionately larger role in controlling air quality, in comparison to smaller green areas.

Status and information base: Natura 2000 sites and other protected areas are recognised locations with known ecological values and related information. This makes such areas desirable destinations for educational and other social purposes, linking to cognitive and social cohesion benefits. Similarly, building on their status and information base, Natura 2000 sites and protected areas may help focus community activity and volunteering by connecting with the idea of place and a sense of community identity.

Species diversity, habitat structure and management requirements: Little information is available that explores the connection between biodiversity (i.e. diversity of species and habitats) and health and social benefits. Variable landscapes, scenery and habitats and/or presence of certain species may be important triggers for people's enjoyment of green areas, increasing their repeated use and related benefits to physical and mental health. There is new research suggesting that reduced actual contact with nature and biodiversity affects the human commensal microbiota and its immunomodulatory capacity, meaning that the loss of biodiversity is related to non-communicable diseases (Hanski et al. 2012). Furthermore, some evidence even suggests that biodiversity rich environments enhance senses (Rappe et al. 2008). Some management requirements, such as the conservation of certain species, may require low levels of noise and air pollution, linking to the delivery of related health and wellbeing benefits. Similarly, old and large trees play an important role in air quality management (FAA 2014). Several of these attributes are commonly associated with protected areas.

11.3 Enhancing benefits through investment, management and stakeholder involvement

In the earlier chapters a range of measures essential to the management of both Natura 2000 sites and wider green infrastructure were identified to improve the delivery of nature-related health and social benefits. Such measures include, for example, mapping and zoning, management planning, establishing frameworks for monitoring, and adopting dedicated measures for awareness raising and stakeholders engagement. Furthermore, investment in facilitating the access and upkeep of areas plays a key role in capitalising on the role nature can play in delivering health and wellbeing benefits.

Planning with due understanding of ecology and causal links

The review of all different health and social benefits points to the same direction: planning with due understanding of the underlying causal links between nature and human wellbeing play a key role in increasing the delivery of health and social benefits.

Several European cities (e.g. Stuttgart, Barcelona, Nantes, Rome and London) already integrate green areas as a natural control for air quality in their city plans. For example, a city-centre Natura 2000 site is an integral part of the air quality strategy for the city of Nantes, France (City of Nantes, 2013). Similarly, it is acknowledged that the Natura 2000 network and other protected areas can contribute to noise mitigation through the development of quiet areas, for example because the conservation of certain species requires low levels of noise pollution. Reviews of the determination of quiet areas in the context of EU's Environmental Noise Directive have identified overlaps with quite areas and

natural protected areas in several countries (e.g. Germany, the Netherlands, Romania, Slovenia) (Milieu et al. 2010).

As regards to physical and mental health, integrating health and social considerations into the management plans for Natura 2000 sites and wider green infrastructure networks can help to achieve conservation and wellbeing goals. For example, combining existing trail networks with restoration-enhancing therapeutic forest trails, with possible financial support from regional health budgets, can support both objectives (e.g. see example from Finland above). Similarly, integrated planning that links the location of business centres with proximity to green spaces which are easily accessible as part of the daily commute or during lunch breaks, can help employers to benefit from healthier and more productive employees. This kind of holistic planning requires cooperation between managers of protected sites and other green areas, city planners, as well as traffic management and the construction industry.

It is also considered that good understanding of ecological and broader environmental and social characteristics of the area (local climate, air quality and noise dynamics, vegetation structure and characteristics etc.) generate the most appropriate approaches to generating health benefits from nature. For example, rather than simply increasing the proportion of green areas, successful nature-based solutions for managing air quality in a city need to factor in a range of interrelationships between location, structure and type of vegetation, generation and movement of air pollutants within the city, and the use of the city by people. In recognition of this, the air quality strategies in Barcelona and London, for example, link the use of green areas with the development of local climate and air quality models for the city (see examples from Barcelona and London in Chapter 3). Similarly, while nature-based solutions cannot replace anti-noise measures taken at source, holistic strategies and planning approaches based on the understanding of interlinkages between vegetation and noise can both increase the effectiveness of traditional noise barriers and reduce inhabitants' noise-related annoyance.

Dedicated management plans for green areas, including Natura 2000 sites, can provide a useful starting point for planning on how to capitalise on nature-based health and social benefits. Alternatively, such plans can complement thematic planning for air quality, noise mitigation and/or health at local or regional level. For example, in cooperation with relevant health professionals or urban planners, one can explore how the different characteristics that influence nature-related health and social benefits can be taken into consideration, or even maximised, in conservation planning.

Investment

Equally important to evidence-based planning, the availability of funding has been recognised as a key factor enabling the development and uptake of pioneering nature-based solutions for health and social wellbeing. Furthermore, instead of identifying one single funding source, the ability to access different sources seems to play a key role in facilitating the development.

An increasing amount of funding is available at the EU level for nature-based solutions, particularly green infrastructure projects. These opportunities include, for example, EU

Structural and Cohesion Funds, LIFE+, Horizon 2020 and innovative new tools like the Natural Capital Financing Facility (NCFF) (Kettunen et al. 2015, Vella 2015). The European Green Capital Award and the new Green Leaf Award also give opportunities to cities and small towns to actively gain European support. National and city level investment is also required to supplement EU funds and in many cases this EU and local level public funding can be used to mobilise further private investments. For example, London's Clean Air Fund, City Trees for Berlin, Ikaalinen therapeutic forest trail (Finland) and Nordic hiking trails in the Białowieża National Park (Poland) (below) are examples of air quality and mental health-related green infrastructure projects that attempt to use funding from different sources to achieve their overall goals.

The establishment and management of the Natura 2000 network is eligible for EU support. These activities have been financed in an integrated manner from the EU budget since 2007, i.e. financial support to the management of sites has originated from several different EU funding sources, ranging from dedicated environmental funding to agro-environment schemes and finance for regional development (Kettunen et al. 2015). While there are still several difficulties and barriers to implementing this integrated financing model in practice, it has increased the awareness and experience of different stakeholders to use multiple funds in an innovative manner, including linking the delivery of conservation objectives with wider aspects of human wellbeing. Consequently, the framework for financing the Natura 2000 network; supported by dedicated national strategies for prioritising action (Prioritised Action Plans - PAFs); can offer an existing platform for further exploring nature-based solutions for enhancing health and social wellbeing. In this context, dissemination of scientific evidence and promising examples from different EU countries can be used to raise the profile of nature-based solutions for healthier lifestyles and improved wellbeing on development programmes such as EU funds for regional and rural development. For example, a pioneering initiative of Nordic hiking trails in the Białowieża National Park, Poland has been developed thanks to a collaborative effort by multiple stakeholders involved in the national park management, as well as finance from EU and national sources that support the national park. The key aim of this initiative has been to promote health through outdoor physical activity while increasing environmental awareness.

Broader framework conditions: legislation, target setting and monitoring

The existing information also highlights the importance of underpinning legislation, target setting and subsequent monitoring as a basis for successful delivery of health and social benefits from nature. For example, EU and national legislation with clear targets for air pollution reductions, combined with monitoring programmes, create an overarching framework and incentive for addressing air and noise pollution (see thematic chapters above). Similarly, the legislative basis also often creates clear obligations for securing the appropriate management for areas, backed up by financing (e.g. Natura 2000 areas).

Role of stakeholder cooperation and awareness

As chapter 13 shows, taking advantage of the health and social benefits related to nature conservation is relevant to and/or requires the participation of a range of stakeholder groups. Consequently, dedicated measures to increase the awareness and involvement of stakeholders are essential to further the uptake of existing and future opportunities.

Management plans with a clear stakeholder component are commonly cited as a useful tool for facilitating awareness and engagement. Plans for managing natural and semi-natural areas (e.g. Natura 2000 sites and other protected areas), together with thematic strategies for air quality, noise mitigation, climate regulation and public health, create an overall framework for the identification and strategic involvement of stakeholders across different groups. This can help, for example, to identify and engage with minority groups and socially and economically deprived people who, based on existing studies, are known to require active intervention to facilitate, coordinate and encourage wide participation and engagement. For example, the Walkability Project in Pembrokeshire, UK aims to improve the health and well-being of local people by encouraging and supporting them to use walking routes in the Pembrokeshire Coast National Park. The project is co-hosted by the national park authorities and the local health board. The cooperation of these two organisations - and the prominent role of the national park managers - is considered as one of the key success factors for the initiative, as generally leisure activities led by leisure services tend to have a limited focus on indoor exercise only.

Furthermore, the existing evidence highlights the role of stakeholder awareness in taking advantage of and proactively using different nature-based health and social benefits (see previous chapters). This need for increased awareness ranges from people benefiting from nature's wellbeing impacts to people playing a crucial role in facilitating the realisation of such benefits; from city planners and protected area managers to health care professionals, and from groups of stakeholders to individuals. For example, both health care professionals and the general public alike are still commonly unaware of the research pointing out the multiple benefits of regular visits to nature. Similarly, possible opportunities of using green areas as noise-free zones or shelter from heat waves are not commonly known to city planners or citizens. Consequently, dedicated measures for awareness raising are required to facilitate the mainstreaming of nature-based health and social benefits.

Dedicated management plans already exist for a range of green areas – and Natura 2000 sites in particular – and they often include activities to increase stakeholder awareness and participation. These plans could be updated and extended to address a range of different groups and increase the delivery of nature-based health and social benefits. As in the context of financing, Natura 2000 site managers have a long track record in engaging with a range of different stakeholders and therefore often have an existing mind-set and some capacity and means to extend their engagement to a new group of stakeholders.

11.4 Conclusions

There are clear synergies between measures associated with, on one hand, managing Natura 2000 sites and wider green infrastructure areas and, on the other hand, increasing the delivery of nature-related health and social benefits. Such measures include in particular a need for stakeholder engagement and infrastructure to facilitate access to and (safe) use of an area. Consequently, it seems suitable – and even cost-effective - to strive towards an increased co-management of these areas for both biodiversity and health and social wellbeing in the future.

While the management of Natura 2000 sites with health and social benefits in mind is not yet a mainstream practice, the earlier chapters of this report document several pioneering examples, summarised in Table 12.1, that already aim at capitalising on these synergies. These examples illustrate the diversity of approaches, for example, with respect to scale (e.g. local initiatives of citizens or municipalities, national approaches), the stakeholders involved or funding sources. In some cases, financing instruments of the European Union have been involved; in other cases, the initiatives rely on local and voluntary actions of citizens and civil society. In many cases, Natura 2000 sites are an integral part of the initiative, both in rural settings, as well as in urban and peri-urban areas. The examples range from integrating Natura 2000 sites into local air quality strategies to using them as integral elements for improving physical health, mental wellbeing and social inclusion.

The existing evidence indicates that the health and social benefits are most commonly related to easy access to and regular use of nature. This indicates that urban or semi-urban Natura 2000 sites and other green areas would have the highest potential for delivering health and social benefits. Consequently, promoting the access to and use of these areas; with due consideration of their conservation objectives; could be considered as a key for enhancing nature-related health and social benefits in the future.

Finally, the development of an EU green infrastructure network, comprising a wide variety of different green elements including Natura 2000 sites, can play an important role in maintaining and enhancing the health and social benefits provided by nature. Furthermore, a strategically planned network of green areas at the EU level can help to bring added value, for example, by catalysing political and financial support, sharing knowledge and good practise, supporting transnational initiatives, and ensuring an equitable sharing of such benefits.

Table 11.1: Collection of key examples from the report showing synergies between the management of Natura 2000 sites and/or wider green infrastructure and the delivery of health and social benefits. See thematic chapters for further information.

Country	Case	Description	Natura 2000/GI
Belgium	Hoge Kempen National Park	Hoge Kempen National Park is Belgium's only national park. It contributes to the social cohesion and regeneration of a former coal mining region that was at risk of economic decline.	Natura 2000
Bulgaria	Zmeeva Dupka Eco-Trail	The construction of an eco-trail in the Natura 2000 site Zmeeva Dupka cave has helped different social groups to discover nature and develop a healthier lifestyle while deterring illegal and exploitative nature use.	Natura 2000
Czech Republic	Chrudim, Zdrave mesto (Healthy City)	In 2001, the city of Chrudim joined the WHO Healthy Cities Project. Since then, the city has implemented a "Plan of Municipal Greenery Maintenance" and has invested in new areas of green infrastructure.	GI
Denmark	Copenhagen, Increasing Well-being through Climate Change Adaptation	The City of Copenhagen is implementing ambitious climate change adaptation plans using green and blue approaches to increase the quality of life for its citizens. Copenhagen's waterways are now safe for public bathing and new green spaces provide new opportunities for recreation, tourism and biodiversity.	GI
Germany	Stuttgart, StadtKlima and Nature Conservation for Clean Air	In Germany, the City of Stuttgart has implemented GIS mapping, zoning legislation, and investment in green infrastructure to facilitate air exchange and control air pollution in the city, in addition to controlling emissions at their source. Since 2004, the city has recorded significant reductions in PM_{10} and NO_2 measurements.	Natura 2000
Ireland	Slí na Sláinte – Path to Health	The Irish Heart Foundation set up the Slí na Sláinte project in 1996 that aims to promote regular walking among the population as it has numerous health benefits, including cardiovascular, pulmonary and articular benefits. Local authorities and communities are encouraged to work together and start a health path in their area.	Natura 2000
Spain	Barcelona Green Infrastructure and Biodiversity Plan 2020	The "Barcelona Green Infrastructure and Biodiversity Plan 2020", launched in early 2013, sets the environmental goals that the municipality intends to achieve by 2020 in order to become a city where natural and urban spaces interact and enhance one another. Collserola Natural Park, a Natura 2000 site, acts as the biggest sink for pollutants in the city.	Natura 2000
France	Villejuif, Le Parc des Hautes Bruyères	South of Paris, the Council of Val de Marne converted a brownfield site into 23 hectares of public park with the purpose of reducing noise from a motorway, as well as providing a valuable community resource. The park houses a number of public allotments, spaces for recreation, education and biodiversity.	GI
Croatia	Zagreb, Medvednica Nature Park	Nature Park Medvednica is a protected area on the border of the city of Zagreb and offers residents and an increasing number of tourists a chance to escape the urban environment and enjoy nature through activities such as winter sports, walking and hiking, as well as educational programs. The area is has improved air quality and a significant temperature difference compared to the city of Zagreb.	Natura 2000
Italy	Slow Food	The Slow Food Presidia project aims to sustain traditional agricultural products and processing methods at risk of extinction, and to protect unique regions and ecosystems. Presidia projects are important for biodiversity; they contribute to local/regional culture and identity.	Natura 2000

Latvia	Rāzna National Park, Green Routes without Obstacles	The aim of "Green Routes without Obstacles" is to increase the availability of nature-based tourism for disabled people at three protected areas in Latvia, Lithuania and Belarus. At the Rāzna National Park in Latvia, efforts have been made to provide equal opportunities and access to this protected area.	Natura 2000
Luxemburg	Eicherfeld, Terra, Community Supported Agriculture	Started in 2014, TERRA (Transition and Education for a Resilient and Regenerative Agriculture) is Luxembourg's first Community Supported Agriculture initiative. This locally based, grass roots, and community orientated model for the production of food provides opportunities for employment, volunteering, and participatory learning.	GI
Hungary	Lake Hévíz, Hungary's Unique Thermal and Medicinal Lake	Lake Hévíz is a peat bottom thermal lake located in West Hungary within the Lake Hévíz Nature Protection Area. Its healing effects, which are primarily linked to its sulphur content and sulphur bacteria living in the water, are used for the treatment of rheumatic and locomotor diseases.	Natura 2000
Austria	Vienna, Neighbourhood gardens	Caritas Austria has initiated 3 neighbourhood gardens where residents of their care homes work together with volunteers. The residents are elderly people that need care, disabled people and underage refugees separated from their parents. Gardening brings these people closer together; the garden provides a common ground that enables new social interactions and learning from each other.	GI
Poland	Hajnówka, The Land of the Bison and Primeval Forest Nordic Walking Park	In 2011, a network of Nordic walking trails opened in Hajnówka county in Eastern Poland. The trails spread across the Białowieża Forest, a UNESCO World Heritage site fully covered by Natura 2000 protected areas. It is a pioneering initiative that aims to engage the local rural community, promote health through outdoor physical activity, and increase environmental awareness.	Natura 2000
Portugal	Cascais, Quinta do Pisão - Sintra-Cascais Natural Park	Quinta do Pisão is part of the Sintra-Cascais Natural Park, which belongs to the Natura 2000 network. The Quinta do Pisão is the redevelopment of abandoned agricultural land into a working farm and large public park offering walking and cycling paths, as well as a range of events based around sustainable tourism.	Natura 2000
Slovenia	Secovlje Salina Nature Park and Lepa Vida Spa	The Salina Nature Park Natura 2000 area generates 90 local jobs in the tourism and health sectors while maintaining biodiversity values of the area. A public-private concession programme has supported the improved conservation status of this habitat for migratory birds as well as providing public access for 50,000 visitors per year.	Natura 2000
Finland	Kuopio, Moved by Nature Programme	Moved by Nature's primary aim was to promote the collaboration between nature and health sectors to allow vulnerable groups to benefit from access to physical activity in green spaces. Case studies and pilots were carried out in a number of areas, working with different population groups.	Natura 2000
Sweden	Alnarp, Rehabilitation Garden	The Alnarp Rehabilitation Garden was established as a research and development project involving nature-based rehabilitation (NBR), with a special focus on the role of nature in improving the mental health of patients. Based on the preliminary evaluation results, NBR is being integrated as a form of treatment in local health care provision.	GI
United Kingdom	Pembrokeshire Walkability and Exercise Referral in National Park	The Walkability Project started in 2011 and is a partnership between Pembrokeshire Coast National Park, the Welsh Government and the Hywel Dda Local Health Board. The project has encouraged and supported local individuals with higher health risks to walk in and around the National Park.	Natura 2000

12 Role of Governance and Stakeholder Engagement

12.1 Who are the nature stakeholders and what types of initiatives are they running?

Stakeholders and governments from the public health, social and nature sectors can benefit greatly from collaboration across policy areas when the aim is to address biodiversity and nature protection. However, such cross-sectoral initiatives and structures are often not considered or put in practice. Reasons for a lack of cross-sectoral collaboration include a lack of awareness of the opportunities, lack of institutional procedures to support collaboration, and diversity in the theory and concepts applied by sectors and disciplines. However, in recent decades, a move towards integration can be observed in the different sectors, including in EU legislation. For example, the EU's 7th Environmental Action Programme seeks to safeguard the health and well-being of EU citizens.

Within the health sector, the idea of working across sectors has been around since the 1970s. Concepts such as 'Healthy Public Policy' and 'Health in All Policies' are increasingly used by public health stakeholders as well as in EU policy documents, such as the EU 2007 health strategy "Together for Health". Yet these and other concepts are not being translated into action in a systematic way, as there is still uncertainty among officials and stakeholders on how to do so.

The primary aim of this chapter is to identify how different stakeholder groups from the health, social and nature sectors could work better together for nature and biodiversity protection. The objective is to identify and understand which stakeholder constellations and activities have been implemented and put in practice across the EU, and what lessons can be drawn from them. This chapter draws on a literature review, the findings of the previous chapter, and a stakeholder survey with over 100 respondents, as well as the outcomes of the project workshop. More information on the methods can be found in the Annex.

Stakeholders involved in nature and the environment, such as managers of protected areas and researchers, are the most actively involved in initiatives that relate to the scope of this report. For example, most survey responses came from nature stakeholders working for national and regional NGOs, such as Shared Assets (UK), West Pannon (Hungary) and the Kemeri National Park Foundation (Latvia).

Shared Assets, UK

Shared Assets supports the development of new models of management for the governance of land and natural resources such as parks, green spaces, woodlands and coastal areas. Shared Assets has supported practitioners and landowners in working together to develop new, social enterprise models of land management. These often include the active consideration of health and social outcomes. These land-based social enterprises work together to create environmental, economic and social benefits.

Shared Assets is currently working directly with local authorities who manage parks and open countryside, supporting woodland social enterprises as well as running a wide-ranging policy

programme.

Source: http://www.sharedassets.org.uk/

Kemeri National Park Foundation – Natura 2000, Latvia

The Kemeri National Park Foundation is an NGO that manages natural meadows, repurchases land for nature conservation, attracts project financing for various topics concerning national park problems, and provides information about the Kemeri National Park. They work together on common projects with the Environmental Protection and Regional Development Ministry, and the Nature Conservation Agency. The Foundation also acknowledges that it is important to work with society as a whole to maintain the national park. The cooperation's success is due to the NGO's financial tools that are used for protected areas. Thus, mutual support is important for cooperation between different stakeholders.

Source: http://www.daba.gov.lv/public/eng/visiting/zemgale/kemeri_national_park1/

Nature researchers often work together with nature departments from authorities to set up nature programmes and campaigns or develop management plans for green spaces. Forest Research (UK) for example is the research agency of the Forestry Commission in Great Britain. They have conducted several studies on the health and social benefits of. In addition, university departments study the health and social benefits of nature, such as the Swedish University of Agricultural (SLU) in Sweden (see Chapter 6).

A specific group of environmental stakeholders are Natura 2000 site managers, who are involved in projects that are implemented in or focus on Natura 2000 sites. Natura 2000 managers are beginning to have an established record of accomplishment in engaging with a range of different health and social sector stakeholders.

Walkability project, Wales, UK

Coordinated by: Nature/health sector

The Walkability Project started in July 2011 and aims to improve the health and well-being of local people, particularly those with a higher risk of poor health, by encouraging and supporting them to use walking routes in the Pembrokeshire Coast National Park, including a number of Natura 2000 sites. The project and project coordinator are hosted by Pembrokeshire Coast National Park and the Hywel Dda Local Health Board who support the Project by providing access to capital grant funding for access improvements, as well as promoting the Project with clinicians. The cooperation of these two organisations and the prominent role of the national park managers are considered as one of the key success factors for the initiative, as generally leisure activities led by the leisure services tend to focus primarily on indoor exercise.

Source: http://www.pembrokeshirecoast.org.uk/default.asp?PID=660

Green spaces play an important role for all nature stakeholders. The main aims of nature stakeholders are to protect, maintain, and create the existing green areas. The added health and social values of nature help to create more awareness among other sectors and the community in general. The willingness of the nature sector to cooperate with other sectors is evident as many of the identified cases are led by stakeholders from the nature sector.

Who are the health stakeholders and what types of initiatives are they running?

This study indicates that health stakeholders have been, to date, the least proactive player in initiating nature-based health/social activities in comparison with social and environmental stakeholders. This is related to the fact that the health sector traditionally relies on strong evidence from medical sciences and controlled health treatment experiments. In various cases, research has been used as a tool – by, for example, the nature sector - to convince health stakeholders to join cross-sectoral initiatives.

As the scientific information and evidence produced by research institutes and universities concerning the health benefits of nature has considerably increased during the past few years, the interest among the public health sector actors has also increased. The involvement of health stakeholders in projects, where nature is seen as part of a treatment of lifestyle diseases, such as type 2 Diabetes and mental health illnesses, has increased. Also concerning health promotion and disease prevention, the scientific evidence of the health benefits of nature seems to be adequate, but not solid enough for using nature more widely in the rehabilitation sector. There is also very little information about the economic benefits of using nature actively as a tool in the public health sector, which probably further prevents the health sector from working in a wider field. An example of a global organisation that is studying the links between health and nature is HEAL: Health & Ecosystems: Analysis of Linkages (see box below).

Health & Ecosystems: analysis of linkages (HEAL)

HEAL is a global collaboration between public health and environmental conservation institutions and measures the health effects of changes in ecosystems worldwide. They focus on four different areas: nutrition, infectious diseases and mental/physical activity. An example of a project they are currently conducting is a study of the relationship between green space and happiness and stress.

HEAL works together with different stakeholders such as public health professionals, physicians, ecologists, ministries, local NGOs, communities and policy makers. They mainly receive funding from private foundations and research streams.

Source: www.wcs-heal.org

Recognition and interest by health stakeholders in nature-based health/social activities is also observed at the EU level. Organisations such as the Health and Environment Alliance, the Standing Committee of European Doctors, the European Federation of Allergy and Airways Diseases Patients' Associations and the European Lung Foundation are involved in a range of relevant initiatives. However, as highlighted by the Health and Environment Alliance: "there is certainly not enough cooperation between the different sectors yet; at

the EU level there is no institutionalised forum and no regular dialogue, which could contribute to more cross-sectoral cooperation".

The Standing Committee of European Doctors (CPME)

CPME is a European organisation composed of national medical associations from across Europe. CMPE's action on environmental health addresses the health impact of factors such as air, noise or water pollution and works towards containment and rollback of damage to the environment. They also contributed to the debate on climate change, in particular on global warming and the loss of biodiversity to highlight the implications for health.

CPME has adopted various policies related to environmental health, such as CPME's Statement on Consultation on the EU environment policy priorities for 2020 and CPME's recommendation to national medical associations on health and the environment.

Source: http://www.cpme.eu/policy-areas/environmental-health/

Raising awareness of the health benefits of nature-based projects, as well as promoting collaboration with actors outside the health sector, is something that Health Care without Harm Europe actively focuses on. They inform healthcare professionals about the important role that the environment plays in public health and they stimulate the health sector to advocate for broader societal policies and change.

Health Care without Harm Europe (HCWH)

Health Care without Harm helps to bring the healthcare perspective into political debates around key issues such as climate change and health, green building, and sustainable procurement. The coalition consists of a wide range of health actors such as hospitals, healthcare systems and healthcare professionals; moreover, local authorities, research/academic institutions and environmental organisations are also partners. HCWH is present on the global scale, and the European members come from 26 countries of the WHO European Region, of which 17 are European Member States.

Source: https://noharm-europe.org

Looking at some of the EU Member States, particularly in countries such as Finland, Sweden and Denmark, the research sector has played an active role in involving the health sector in projects operating at the nexus. In these countries, scientific results have been widely discussed and acknowledged in the media and by the general public, and researchers have been actively putting the research evidence into practice through personal engagement in practical implementation projects.

Green Care Finland

Green Care Finland (GCF) is an association focusing on rural nature-based health services in Finland. GCF coordinates the networking activities for its 200 members, promotes public recognition of green care services, works for better regulation, organises seminars and runs development projects.

Source: http://www.gcfinland.fi/

Citizen-driven public health NGOs have also played an active role in participating in projects and networks that aim towards health benefits derived from using nature as a resource. These NGOs particularly strengthen the perspective of public health impacts in their networking activities, and they may act as resource integrators, i.e. by initiating new relationships and contacts with professional health players in public and private sectors. SMEs focusing on health treatments in nature are relevant stakeholders in the sense that they are innovative and flexible enough to be among the forerunners for initiating nature-based health services and development projects. These entrepreneurs and small companies are the ones whose experiences are then communicated to a wider health sector audience, yielding potential augmentation of similar activities.

Who are the social stakeholders and what types of initiatives are they running?

Within this chapter, 'social stakeholders' are defined as those who look to improve links between the environment and communities as well as promoting social inclusion and cohesion. Under this definition, the evidence collected across the project identifies two general types of social stakeholders and related initiatives:

- Primarily environmental – i.e. those from environmental sectors (e.g. conservation charities, forest organisations), who work with communities through environmental activities and which have indirect impacts on improving social networks etc.

- Primarily social – i.e. those from social sectors (e.g. prison services, social services) who use environmental activities to actively improve social inclusion and cohesion.

PE "Prisons Production", Natura 2000, Bulgaria

PE is focused on the socialisation and qualification of prisoners by involving them in different projects, many of which are related to renewable energies, biodiversity and environmental issues. Apart from the work in nature parks ("Vitosha" nature park) that receive modest funding from the state, PE helps prisoners to deliver some of their projects cost-free. They also work on improving the natural environment in the prisons.

Source: http://www.dpfzd.com/

Although there are social inclusion and social cohesion benefits from engaging communities in environmental and biodiversity improvement activities, these benefits are only captured where stakeholders are proactive in designing and managing projects to deliver social

outcomes. In practice, what is delivered is rarely clear-cut with stakeholders, particularly those from the environmental NGO sector looking to deliver an ambitiously broad range of social and environmental objectives.

Social Forest, Spain

Social Forest is a Barcelona based organisation that provides training in forestry services to youngsters at risk of social exclusion. It promotes sustainable forest management and the use of renewable energy, in particular local forest biomass. Through sustainable forest management, the Social Forest intends to tackle youth unemployment and exclusion and to raise awareness of the health benefits of nature. They are based in the Collserola Park (which is a Natura 2000 site) and work with the whole province of Barcelona.

Source: http://socialforest.org/trabajos-forestales-barcelona/

The results of our study suggest that activities combining biodiversity improvements with social cohesion and inclusion benefits primarily occur within the NGO sector (often funded by local or national authorities) and at the local level. Moreover, while social stakeholders working at the nexus are rare at the European and national levels, there are various environmental stakeholders promoting the social benefits of biodiversity and nature protection at those levels. Environmental stakeholders engaging in social activities across the private, government and NGO sectors commonly work with communities to deliver a number of objectives.

The majority of environmental stakeholders who responded to the survey indicated that they undertake some form of community engagement and that this work supports their environmental objectives. Examples of these initiatives include 'Heritage Keepers' by Õuesõpe in Estonia and OPAL in the UK (see boxes).

Open Lottery Air Laboratory (OPAL), UK

Coordinated by: Nature sector

Funded by the UK's Big Lottery and based at Imperial College London, OPAL has developed free and easy to use citizen science materials. These included surveys and other resources that allow all citizens to get out and monitor nature in their local area. The objectives of the project are to enhance knowledge and awareness about nature and to create stronger partnership between the community, voluntary and statutory sectors.

Source: http://www.opalexplorenature.org/

Heritage Keepers, Estonia

Coordinated by: Social/nature sector

Õuesõpe has set up a pilot project called "Heritage Keepers" which aims to raise awareness of the local heritage sites among schoolchildren and youngsters aged 7-19. This project is based on a project in Norway that has the same aim and has already existed for more than 15 years. The project actively involves children in their local heritage by cleaning and taking care of small-scale landmarks in forests, fields, parks and other rural areas. Eventually, the aim of the project is to raise awareness of national heritage in the whole society. It is expected that social cohesion will increase due to the programme because children will be part of a community that protects heritage.

Source: http://ouesope.ee/

Finally, our research suggests that although environment-focussed initiatives will have some social inclusion and cohesion benefits; the fact that these benefits are not explicitly designed into the initiatives reduces the scale of these benefits. This represents a substantial missed opportunity.

12.2 Governance levels working on health-social-nature synergies

Local level action

The majority of responses to our request for information came from actors working at the local level. Communities may have particular reasons for the implementation of such initiatives, or factors facilitate certain processes. For example, local communities may be well-advanced in their understanding of the value of nature and have a long-standing tradition for carrying out relevant initiatives and projects due to an active civil society (e.g. Local Agenda 21[27] or Transition town initiatives[28]). Another factor that facilitates cross-sectoral initiatives is a health-related policy strategy that ties in closely with reaching health and social benefit objectives from biodiversity and nature protection initiatives.

City of Padova, Italy

Several years ago, the city of Padova started to diversify their green area management through the participation of citizens, sponsors, and associations. Since 2008, they have used the Agenda 21 to plan new green areas, such as Basso Isonzo, Milcovich Park extension and Willows Park.

A success factor for the active participation of stakeholders was the realisation of workshops, linked

[27] Local Agenda 21 supports Agenda 21, which is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development. Local Agenda 21 is a local-government-led, community-wide, and participatory effort to establish a comprehensive action strategy for environmental protection, economic prosperity and community well-being in the local jurisdiction or area. Key elements are full community participation, assessment of current conditions, target setting for achieving specific goals, monitoring and reporting. Source: http://www.gdrc.org/uem/la21/la21.html.

[28] https://www.transitionnetwork.org/

to the 'Local Agenda 21', on the issues of the future development of parks and their management.

Source: http://www.padovanet.it/informazione/agenda-21-locale

Most of the local level initiatives identified through our research were implemented in urban areas. A large number of initiatives support community involvement in the maintenance of urban green areas, while others promote growing fruits and vegetables in public gardens. Other types of initiatives identified were those that involve the local community in maintaining biodiversity. This is the case in the city of Bucharest in Romania, which works with a local action groups on a biodiversity project that supports urban gardens, including on roofs and terraces. Another example is the 'I have a bee' project in Bulgaria, described below.

Urban Gardens Community, Bucharest, Romania

Coordinated by: Local authority

A project on biodiversity, led by the General Direction for Social Assistance of the Municipality of Bucharest, is "Gradini Urbane Comunitare", where a local action group has turned open spaces into urban gardens in which different vegetable and plant species are grown. These open places include roofs and terraces of buildings in Bucharest. The General Direction for Social Assistance of the Municipality of Bucharest is the main public organ in Bucharest that works with social groups at risk and with social groups in unfavourable conditions. A success factor for good collaboration between stakeholders is the will or motivation for participation in the actions of a project.

Source: http://gradiniurbanecomunitare.intranzitie.org/

"I have a Bee", Bulgaria

Coordinated by: Nature sector

A local organisation started popularising beehives in urban areas with the aim of addressing the decline in bee populations (50% over the last five years) and to preserve biodiversity values in local cities. The general goal is to inspire a large number of people to keep bees in the urban areas that, despite pollution, often provide better living conditions and habitats for bees than are available in the countryside due to pesticide use. A recent initiative includes installation of beehives on the roof of the National Palace of Culture in Sofia. Other initiatives by similar organisations take place in London, Berlin and Tokyo.

Source: http://www.ihaveabee.com/

Depending on the type of initiative implemented, different stakeholder groups are involved in the development and realisation of relevant projects. In many cases, local volunteer groups and NGOs are strong drivers of, for example, the management of green spaces such

as parks and community gardening. These actions often involve the improvement of neglected or poorly maintained local areas. The projects therefore often have goals that are of a social nature: improving local communities and addressing the social issues for vulnerable groups such as the elderly or minorities.

Park Work project, Bristol, UK – Natura 2000

Coordinated by: Local authority

Bristol City Council works on different nature-related projects, such as the Park Work project, which looks at the costs and benefits of involving volunteers and placement workers in the management of parks and public open spaces. This project offers training and skills' development for people who need additional support to secure permanent employment.

The projects of the City range from parks, school grounds, river corridors and green spaces to Sites of Nature Conservation Interest (which are designated Local Wildlife Sites) and nationally designated Sites of Special Scientific Interest (SSSIs) and European Wildlife Sites. The Avon Gorge & Downs Wildlife Project is a project that takes place in a Natura 2000 site (Avon Gorge Woodlands, UK0012734). This project aims to protect the wildlife in the area and to raise awareness and understanding about the importance of the nature area.

Bristol has a long tradition of green activities and active community involvement in parks, green spaces and areas recognised and/or designated for their wildlife interest.

Source: http://ways2work.org.uk/jobs-skills-south-west/parkwork-work-experience-bristol-parks/

Green Neighbourhoods, The Netherlands

Coordinated by: Nature/social sector

In 2012, a Dutch project was set up to support green neighbourhood initiatives, which aim to improve and support social cohesion and green spaces in neighbourhoods. The project was initiated by the National Institute for Environment Education and Sustainability (IVN), a national organisation that supports social initiatives (Oranje fonds), a website that presents neighbourhood initiatives (Buurtlink.nl), and an advisory organisation that helps set up sustainable development projects (SME Advies).

Source: http://edepot.wur.nl/319468

In some towns, the 'silos' between environmental, health and social sectors may be easier to break down when stakeholders work in a broader context: e.g. local sustainable development to improve the quality of life. Nonetheless, in many locations, further work is needed to catalyse action. Finally, some of the local initiatives evolved in response to action taken by citizens, who believed that changes were required in their town or municipality ('grass roots activism'). The following box provides an example of a grass roots initiative in Ghent.

The Spindle Pig (Het Spilvarken), Belgium

Coordinated by: Social/nature sector

The Spindle Pig was an idea of a few citizens who aim to raise awareness about the food chain and food waste. The project created a place for three pigs in the city of Ghent. Neighbours are involved in feeding and looking after the pigs. The ambition is to expand by keeping more pigs and chickens in several neighbourhoods in Ghent (in places such as urban parks and private gardens) with the aim of processing more than five tons of food waste.

The social and ecological impacts of the project are being researched by academic partners and universities. Furthermore, the project involves local restaurants, supermarkets, local partners in food production (e.g. a brewery, a cheesemaker, and a bakery), schools, social and cultural organisations.

To improve cross-sectoral collaboration and facilitate cost-effective projects, it is believed that new governance procedures and new roles in which responsibilities are designated, are needed.

Source: http://www.hetspilvarken.be/

City-wide and regional initiatives

Governance structures at the city and regional level can facilitate and strengthen cross-sectoral collaborations between health, nature and social stakeholders. Such structures can concern municipal working groups or advisory committees that involve a range of partners from different sectors with the aim of protecting nature or enhancing biodiversity across a city or region. An example of a local governance structure is the Environmental Department of the Basque country, which has already worked for more than ten years closely together with municipalities for project planning and development in the area of nature and health. Additionally, in the region of Tuscany, Italy, as part of the Regional Environmental and Energy Plan (PAER) an initiative was launched that sponsors educational nature events. This initiative has become part of the integrated regional strategy "Tuscany of the kids", which enables collaboration between the environmental department and the health department.

In Botkyrka, Sweden, a working group was established as part of the "green values programme", involving forest, leisure, environmental and health departments. The programme aims to create conditions for richer biodiversity, encourage outdoor life, promote good health, and ensure access to nature. Two other relevant examples from Scottish Natural Heritage and the City Council of Aberdeen are presented below in boxes.

Scottish Natural Heritage, UK – Natura 2000

Coordinated by: Nature sector

Scottish Natural Heritage (SNH) manages cultural and natural heritage. The work conducted on the links between green space and health has evolved over the years, and a strong link has been made between natural heritage and the Scottish Government's Health agenda.

SNH is part of the Green Exercise Partnership that raises awareness of the links between health and environment. This partnership also includes the National Health Service and the Forestry

Commission. The Partnership promotes, for example, more and better use of green spaces around healthcare facilities and outdoor activities.

Source: http://www.snh.gov.uk/

Aberdeen City Council, Scotland, UK

The City Council of Aberdeen has set up a health and well-being group under the Single Outcome Agreement. This group includes partners from the National Health Service, local authorities, education, fire and rescue, business, voluntary sector, police and communities.

Different thematic groups are set up with a desire and need to work with communities to meet future challenges and deliver better outcomes to reduce health, social, and environmental inequalities.

Source: http://www.aberdeencity.gov.uk/home/home.asp

An example of how a regional governance strategy is successfully being implemented to regenerate a region for economic and environmental benefits is the case of the Emscher Landscape Park in the Ruhr Area in Germany (see box below).

Emscher Landscape Park, Ruhr Region, Germany

Coordinated by: Local/Regional Authorities

The Emscher Landscape Park in the Ruhr Area provides a clear example of a multi-stakeholder approach to applying green infrastructure to regenerate a region in industrial decline. The area has a particular history as Germany's steel and coal mining heartland, but the last mines are anticipated to close in 2018. The region, however, has applied innovative GI approaches to regenerate the vast brownfield sites over the course of several decades. The overarching strategy within this is the Emscher Landscape Park (ELP) representing a regional park in the Emscher valley covering over 456 km^2 which is composed of 20 towns and 400 GI projects. The ambition is to develop attractive urban landscapes and a vitalised blue river system as the new basis for structural change and economic development (Mühlenfeld, 2015).

From a governance perspective, the regeneration of the Ruhr Region represents the successful coordination of polycentric stakeholders, including a number of city mayors, designers and engineers, as well as widespread public support.

Source: http://www.emscherkunst.de/riverscape-emscher/emscher-landscape-park.html?L=1

Responsibilities and structures within local institutions largely remain sectoral, aligned with the respective sectoral plan 'carrying' the green space project or parts thereof. This might include departments such as planning, green space and parks, sports or even roads and transport as the coordinating offices. Survey results showed that a 'booster' of initiative seems to be associated with an ambitious political target on green spaces (e.g. Aarhus in

Denmark has a target to secure near access to green recreational spaces for all citizens: 'the 500 meter objective').

The integration of the different demands of user groups and planners can be challenging; a local project can help to focus discussion and identify common objectives. The survey and examples have shown that "shared" spaces can bring different stakeholders together and form new alliances of stakeholders and social groups that did not exist before. This can also happen in participatory processes with local authorities, when residents and key stakeholders are invited to contribute to the planning of a green space.

Air Quality Plan 2011-2017, Berlin, Germany

Coordinated by: Local Authority

Berlin's Air Quality Plan 2011-2017 has supported macro and micro scale greening programmes to reduce air pollution in the city. One of the objectives within the Air Quality Plan is to plant 10,000 new street trees in the city by 2017. The cost of a street tree in Berlin is €1,200 for planting and the first three years of maintenance. In the Berlin tree-planting programme, the city government promises to make up the remaining costs from each €500 donated by citizens or private bodies. Berlin's streets have over 440,000 trees, and it boosts one of the best air quality records for a city in Europe.

Citizen engagement in Berlin has also been an important issue around preserving the open green space of the former Tempelhof Airport, a large airfield centrally located. The airport area has been the subject of two referendums, rejecting first keeping the airport open for operations and later rejecting property development on the site. Today, the open space provides important recreational opportunities for city inhabitants, generates benefits to air quality and microclimate while also being an important habitat for species – furthermore the preservation of this space is a matter of great pride to many of the citizens of the city.

Source: http://www.berlin.de/en/

Another example includes the city and county of Tatabanya in Hungary, which supports the expansion of green areas, including parks and Natura 2000 sites. The aim of this initiative is to promote health benefits among the citizens of Tatabanya by increasing access to green areas.

In the district of Freiburg in Germany, the city government involves citizen groups, Local Agenda 21 groups, sports associations, hospitals, businesses and other stakeholders in the protection and use of the area. Nearly half of the district of Freiburg consists of protected areas, including Natura 2000 sites.

City of Freiburg, Germany – Natura 2000

The city of Freiburg is working in many different fields to enhance and promote the cultural ecosystem services of nature and green spaces. The overall objective of those activities is to increase social cohesion and stewardship of nature, to strengthen the links between nature and citizens' well-being, and to raise awareness of the value of green spaces and natural sites.

All sorts of green spaces are involved in the different activities of the City of Freiburg. In total, around 50% of the district areas of the city are protected areas in different IUCN categories. In the Natura 2000 sites, and the other strictly protected areas, activities are only allowed if they do not threaten the main protection goals, while in less strictly protected areas or in the un-protected countryside, activities that are more intensive are possible. Urban parks and private gardens play a main role in the provision of urban gardening, recreation and sports' activities.

Many different stakeholders are involved: citizens' associations, nature conservation groups/NGOs (BUND, NABU etc.), trekking and sports' associations, Local Agenda 21 groups, university and research institutions, schools and environmental education organisations, hospitals and business developers.

Source: http://www.freiburg.de/pb/,Lde/232045.html

Governance structures at the national level

In a range of EU Member States, examples were identified of cross-sectoral governance structures at the national level. For example, in Finland, the health and social benefits of nature and green spaces have been acknowledged since the 1990s and relevant national governance structures have been put in place accordingly. Recently, as part of the preparation of the National Forest Programme, a working group was established on quality of life, which also addressed recreational uses of forests and their effect on the well-being of people. In addition, a recent study on ecosystem services and human health by the Finnish Environment Institute and the Finnish Forest Research Institute has proposed a new, ten-year national development programme on "Nature for Health and Well-being in Finland". The proposal consists of a national action plan and a multidisciplinary five-year research programme focusing on the key information needs within the sector.

Sport Northern Ireland is a cross-sectoral government department which created a national forum for stakeholders from the outdoor sport sector and the environment sector to address key issues concerning recreation in natural areas.

The Belgian Biodiversity Platform

The Belgian Biodiversity Platform is funded by the federal government of Belgium and provides services to the biodiversity segment of the Belgian scientific community. The Platform builds up networks and helps the Belgian government to be more involved in biodiversity activities at the international level. Biodiversity and health is one of the themes of the Platform.

They work together with scientific experts, policy experts, practice experts, lay people, NGOs and citizens.

Source: http://www.biodiversity.be/

Green Development Planning, Germany

Coordinated by: Local/Regional Authorities

In Germany, landscape planning aims to reconcile competing land use and at the same time protect natural resources and conservation areas. Landscape plans comprise a green development plan (Grünordnungsplan) at the local level, which specifies ecological requirements on land use. In most states in Germany, these plans become binding, and integrate many tasks that arise from nature conservation law. In cities such as Stuttgart, landscape plans have integrated the health objectives of the city, for example preserving a certain level of green space and restricting the removal of ancient trees in order to promote airflow and improve air quality in the city.

Source: http://www.gesetze-im-internet.de/bnatschg_2009/index.html

In Germany, the Federal Agency for Nature Protection has brought together municipalities, including health and environment departments, on actions to use green spaces for public health benefits. Indeed, work at the nexus can also help to break down existing 'silos' within local authorities, thus improving governance (for more information see section 13.4).

German Federal Agency for Nature Conservation (Bundesamt für Naturschutz)

he German Federal Agency for Nature Conservation is the German government's scientific authority that reports to the Ministry of Environment. It is responsible for national and international nature conservation and works on several research projects, such as:

- "Nature conservation and Health protection: identification of joint areas of action". It is especially important to create synergies for the promotion of nature conservation in urban areas;

- "Green, natural, healthy: The potentials of multifunctional urban spaces". A team of environmental health scientists and landscape planners looked for synergies and challenges between nature conservation and health promotion in urban areas. The idea was to demonstrate the benefits of nature conservation for human wellbeing and by doing so to increase appreciation of nature conservation by society as a whole (more information: http://bfn.de/fileadmin/MDB/documents/service/Skript371.pdf);

- A project with the overall goal of supporting blind and visually handicapped persons to experience nature

- A project with the aim of introducing socially disadvantaged children to forest ecosystems .

The various stakeholders with whom the Agency works on projects include health scientists, clinics, administration of protected areas, environmental psychologists, teachers, social workers, educational researchers, social scientists, environmentalists, and urban planners. In the research project on nature conservation and public health in urban areas, several cities participated as project partners. Workshops were organised bringing together the municipal administrations for nature conservation and health, often for the first time.

Source: https://www.bfn.de/

Examples of further relevant national cross-sectoral policy programmes and strategies that have been identified are:

- The **Belgian National Climate Change Adaptation Strategy**[29] (2010), developed by the National Climate Committee, highlights the impacts climate change may have, particularly in the domains of heat and water and the interaction of the two. Although heat waves are still relatively uncommon in Belgium, they are anticipated to be a feature of every summer by the end of the century[30]. Additional health concerns mentioned in the policy document relate to diseases such as botulism and vector borne disease (e.g. tick-borne encephalitis (TBE), Lyme disease, and visceral leishmaniosis). Protecting natural ecosystems is identified as one of the five key strategies required for climate change adaptation.

[29] Source: http://www.lne.be/themas/klimaatverandering/adaptatie/bestandenmap/NASpublicatieweb.pdf

[30] IPCC AR5. (2014). Fifth Assessment Report: Climate Change 2014 - Synthesis Report Summary for Policy Makers. Cambridge: Cambridge University Press.

- Parks and Wildlife Finland is a national agency that manages all Finnish national parks and other state-owned protected areas. They have developed the **Finnish Healthy Parks Health People**[31] programme and integrated it in their overall strategy. The programme initially started in Melbourne, Australia, and aims at improving public health by motivating people to get out into natural settings to enjoy positive and genuine experiences and to improve their physical health through a wide range of outdoor activities. The evaluation of the policy showed that most participants indeed show improved social, psychological and physical well-being since the introduction of the programme.

- The **Dutch National Prevention Programme 'Everything is Health'**[32] runs between 2014 and 2016 and acknowledges that there is an active role for the national government to create a healthy environment. This environment involves the surroundings where people live, work and go to school. The programme makes the links between health and nature, and acknowledges that health should be a core part during the design of public spaces. A platform has been established to support collaboration between health professionals and urban planners and designers. Moreover, the Ministry of Health and the Ministry of Economics stimulate and fund initiatives and research on the link between health and nature. For example, the National Institute for Public Health and the Environment (RIVM) works together with Alterra (a research institute focusing on green living environments) to study the relation between greenery in urban areas and health.

Governance aspects involving the Natura 2000 Network

Protected area managers, including managers of individual Natura 2000 sites, can play a proactive role in promoting health and social benefits of nature. The framework(s) for protected area governance – including existing links to a range of different stakeholders - provide a good basis for collaborative initiatives and projects around the nature protection/health/social inclusion nexus.

Existing examples show that individual initiatives linked to the health and social sector are often initiated by site managers, with policies and funding supporting such initiatives playing an important role in supporting the development process (see above). For example, Scottish National Heritage (SNH), the key stakeholder managing Natura 2000 sites and other protected areas in Scotland, states that successful cooperation between the nature conservation and health sectors in Scotland is supported by these issues being mainstreamed in the policy of the national health services (Annex IV). Similarly, in Finland the national 'Healthy parks, healthy people' programme, plays an important role in promoting the cooperation between the nature and health sectors (Annex IV).

[31] Source: http://www.metsa.fi/

[32] Source: https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2013/10/11/alles-is-gezondheid-het-nationaal-programma-preventie-2014-2016-deel-1-en-deel-2/alles-is-gezondheid-nationaal-programma-preventie-2014-2016.pdf

Examples of a range of partners collaborating with Natura 2000 managers can be identified including, for example, representatives of research and academia, regional and urban planners, public health sector, youth sector, organisations engaged with sports and outdoor activities, businesses linked to health and well-being (see boxes below) and stakeholders working in the context of social inclusion (e.g. special needs groups, groups working with immigrants and correctional facilities) (Annex IV). For example, in the cities of Lieksa, Rautavaara and Kuopio in Finland pilot studies are being conducted to promote social integration of new Somali immigrants through visits to nature and/or protected areas. The results show that nature walks are considered convenient for immigrant mothers staying at home with several small children to participate in activities outside the house. Furthermore, getting to know Finnish nature, by picking berries and mushrooms, has improved the newcomers' chances of receiving income through forest products. In Bulgaria, a dedicated national initiative has been established to support the socialisation and qualification of prisoners by involving them in different nature-related projects, including supporting nature conservation in the context of protected areas such as the Vitosha Nature Park (see box above).

EU level policy context

Also at the EU level, the importance of nature and biodiversity for health and social inclusion has been recognised, although arguably not widely implemented. For example, Green Week, which is the biggest annual conference on EU Environment policy, focused in 2015 on nature and biodiversity and its impact on health and wealth. Protecting nature and maintaining Europe's competitiveness must go hand-in-hand as nature and biodiversity policy can play a key role in creating jobs and stimulating investment.

Another EU policy example is the Europe 2020 flagship initiative "New Skills for New Jobs agenda", which aims to address skills gaps and so make it easier for people to find jobs and for employers to get the workers they require. The New Skills agenda will be able to support the transition to a low carbon economy by helping Europe anticipate its future labour market needs in this area. It will also strengthen the role of Public Employment Services that can provide people with information on training so that they can better exploit green job opportunities as they arise. This EU flagship initiative thus has the potential to make use of the social benefits that nature and biodiversity have to offer.

Two EU studies were identified, that carried out a mapping of policy typologies per EU Member State in response to two other issues: health inequalities and ageing of the EU population. While these issues are not (directly) related to biodiversity and nature protection, the three topics all require cross-sectoral action and the two identified studies could therefore provide us with indications of where good cooperation across sectors is happening.

Firstly, a report commissioned by DG SANTE[33] assessed the type of policy responses that have been put in place by EU Member States concerning health inequalities. Countries were

[33] European Commission, DG SANTE (2013): Health inequalities in the EU. Available at: http://ec.europa.eu/health/social_determinants/docs/healthinequalitiesineu_2013_en.pdf.

clustered according to the type of response, including a cluster of countries that considered "health inequalities to be a shared responsibility across government". These countries were considered to have implemented explicit strategies and cross-sectoral mechanisms to address health inequalities. The Member States that belong to this cluster are Denmark, Finland, Ireland, the Netherlands, Norway, Slovenia and the United Kingdom.

Another study, commissioned by the European Agency on Occupational Health and Safety (EU-OSHA)[34] is currently studying how Member States are addressing ageing of the (working) population, as well as rehabilitation of people after a long-term injury or illness. Again, the study assessed the type of policy responses put in place by European countries and categorised them accordingly. This project found, that those countries that address workforce ageing as well as rehabilitation in a holistic and cross-sectoral manner are Denmark, Finland, Germany, the Netherlands, Norway and Sweden.

The EU also plays an important role in funding collaborative initiatives. It appears that – as with Natura 2000 management in general - public funding (e.g. EU funds) is the most common source of funding. Although a range of projects examined in the context of this study indicated that they receive funding from the state budget. EU LIFE funding and occasionally also the European Structural Funds (e.g. Social Fund - ESF) have been used to develop pilot projects that use protected areas (e.g. Natura 2000 sites) as a means to deliver health and social benefits.

Wider international governance

The international policy context can greatly support and promote stakeholder engagement across sectors for the promotion of biodiversity and protection of nature. For example, the WHO European Healthy Cities Network consists of cities around the WHO European Region that are committed to health and sustainable development. The Network aims to:

- Promote policies and action for health and sustainable development at the local level and across the WHO European Region, with an emphasis on the determinants of health, people living in poverty and the needs of vulnerable groups;

- Strengthen the national standing of Healthy Cities in the context of policies for health development, public health and urban regeneration with emphasis on national–local cooperation;

- Generate policy and practice expertise, good evidence, knowledge and methods that can be used to promote health in all cities in the Region;

- Promote solidarity, cooperation and working links between European cities and networks and with cities and networks participating in the Healthy Cities movement;

[34] Pilot project: Safer and healthier work at any age – occupational safety and health in the context of an ageing workforce. Available at: https://osha.europa.eu/en/themes/osh-management-context-ageing-workforce/ep-osh-project.

- Play an active role in advocating for health at the European and global levels through partnerships with other agencies concerned with urban issues and networks of local authorities; and

- Increase the accessibility of the WHO European Network to all Member States in the European Region.

12.3 Catalysts for change and triggers for collaboration

A number of factors can catalyse stakeholders to undertake collaboration with others, and explain why organisations started working on addressing the health and social benefits of protected areas and green spaces. From the survey and the interviews with stakeholders, several factors were identified.

Developing the appropriate evidence of the benefits

Evidence of benefits can trigger action at the nature/health/social nexus. This is directly linked to the importance of awareness raising, and to creating a common use and understanding of the health and social benefits of nature protection and biodiversity. Among the survey responses, several nature and biodiversity stakeholders considered that research and good practice examples related to the benefits of nature to health and social inclusion have provided them with valuable arguments for cooperation.

> *"More research has been conducted over the last 10-15 years that shows the relation between nature and health benefits." [Nature research organisation]*

The type of evidence that is currently available may not be enough for certain stakeholder groups. Particularly the actors from the public health sector seem to require more scientific evidence of the importance of nature-based treatment practices before they will be fully convinced of the benefits that green infrastructure and nature have to offer. There is a need for rigorous syntheses, reviews and meta-analyses of the benefits as well as more systematic, quantitative, high quality research in order to fully involve and interest this group of stakeholders. However, in many aspects it is possible to build on anecdotal evidence, for example the benefits of physical exercise are intuitive and do not need to be reassessed.

Engaging the research community

The involvement of a university or topic expert, who is responsible for investigating and disseminating evidence on the links between nature, health and social inclusion, could be beneficial for a project. Having an external research body or researcher present the evidence and facts can be more convincing to certain stakeholder groups, as they bring a level of objectivity and have expertise in the specific field in question.

Availability of funding

Funding was another trigger mentioned by the stakeholders in response to our survey. It is the lack of funding through regular means that can drive stakeholders to reach out to other types of funding streams and thus policy areas. Sharing resources, combining forces and reducing workloads by dividing tasks can be a useful solution in certain cases and can create opportunities for further action. On the other hand, our research suggests that funding alone (e.g. without awareness raising activities or networking among key players) may not be sufficient in terms of increasing collaborative work.

> *"When budgets are tight, organisations tend to go into silo thinking and become more focused. But actually, if they would work together, they would get more for their money." [European health NGO]*

Responding to acute challenges

In a number of cases identified, national and city authorities sought to take action on public and environmental health risks and saw the value of nature and conservation areas to address these. For example, high summer temperatures in 2003, which caused up to 70,000 deaths in the EU in the space of four months, showed decision makers that extreme temperatures are a real threat to Europe (EEA 2012). Consequently, climate adaptation tools are being developed by many cities, and are regularly linked to health and social objectives (such as the Climate Plan Greater Lyon, for reducing the risk from intense summer heat, and wider issues associated with climate change (see section 13.3). Other risks such as high levels of air pollution (see the London Mayor's Air Quality Strategy) or flooding (see Copenhagen's Cloudburst Management Plan) may also have prompted stakeholders to change their views on how they can benefit from green infrastructures and nature conservation.

Prevention before cure

Stakeholders from the health sector, who tend to focus on health care rather than prevention, as discussed in earlier chapters. Presenting the preventive functions that biodiversity and nature can have on patients can be eye-opening for some groups.

Healthy Lungs For Life

Coordinated by: Health sector

Success factors of the Healthy Lungs for Life projects, initiated by the European Lung Foundation, are changing the perception of stakeholders to thinking th prevention is better than cure, and a slow change in the health sector's attitude is noticed. The focus on health and the environment is promoted by linking health issues with other topics such as clean air. Medical professionals are offered tools like, information for patients regarding environmental issues linked to health.

Thus, real collaboration, teamwork and shared interests are important to stimulate stakeholder engagement.

Source: http://www.europeanlung.org/en/projects-and-research/projects/healthy-lungs-for-life/home/

Mapping tools

Mapping was a common tool identified in the project to facilitate stakeholder engagement at the nature/health/social nexus. A number of cities and regions have applied mapping tools and GIS covering a range of variables to identify and support collaboration on the benefits of nature. Aspects covered by mapping tools include access to green space, air quality, heat stress, health variables (e.g. prevalence of asthma) as well as qualitative data (see Table 12.1).

Table 12.1: Selected examples of mapping tools

Tool	Description
Atlas living environment (Atlas Leefomgeving), The Netherlands	This tool (Atlas), developed by the National Institute for Public Health and the Environment, provides Dutch citizens with information about the quality of their physical living environment, government environmental or spatial policy and the impact on health of factors such as air quality and nature. The information in the Atlas has been made available by government authorities such as municipalities, provinces and the state. The atlas allows people to select their living area on an interactive map, and provides access to information on the air quality, noise or green spaces at a specific location. People can also view area development plans, compare maps and find information about whether there are any building plans in their neighbourhood. Source: https://www.atlasleefomgeving.nl/
StadtKlima Atlas, Stuttgart, Germany	In Stuttgart, Germany, municipal authorities have established a multidisciplinary dedicated team to survey, map and monitor the city's climate and air exchange. In 2008, the city developed a climate atlas, StadtKlima, which has been used to influence city planning and zoning policies. Based on the mapping services, the city has determined where green spaces can be most beneficial for facilitating clean air to flow through the city from surrounding protected areas, with the aim of cooling the city and improving air quality in a number of problematic areas that pose health risks to the city's inhabitants.

	Source: http://www.stadtklima-stuttgart.de/index.php?klima_klimaatlas_region
Arnhem Urban Heat Map, Netherlands	To avoid the formation of an urban heat island, the city of Arnhem has applied ICT to generate a heat map that analyses which areas require intervention. Besides high temperatures, other factors were measured as part of this heat map, including[35] wind paths, the structure of the city, the material and colour, the features of an area and landscape height. The heat map was turned into a heat attention map, that shows four types of areas and the measures required to address heat. Based on the maps, city planners have built parks and other forms of green and blue infrastructures. Source: http://www.future-cities.eu/fileadmin/user_upload/pdf/The_Future_Cities_Guide_EN.pdf#page=36
Maptionnaire Tool Lahti, Finland	The city of Lahti (Finland) implemented its 2025 Strategy to highlight the importance of child-friendly city development. The city developed a tool that allowed day care children to participate in city planning. As day care centres use city green areas for playing, physical activities and collecting berries and other nature products, children can be useful stakeholders to localise important places and play areas. The tool, which is called the Maptionnaire tool, is developed by Mapita Oy. The same city planning tool has also been used with adolescents to identify their most and least favourite places in Lahti. The tool allows residents to pin their ideas and concerns about future development on a map. The tool is also widely used In Helsinki, where during one month almost 5,000 people mapped 33,000 opinions and ideas including 9,000 places for new residential areas[36] . Source: https://maptionnaire.com/
Green Space Accessibility Mapping in London Borough of Brent , UK	The Natural England Accessible Natural Greenspace Standard (ANGSt) model[37] of 2010 proposes that everyone, wherever they are living, should have access to a natural greenspace: • of at least two hectares in size and no more than 300 metres (five minutes' walk) from home; • of 20 hectares that is accessible within two kilometres of home; • of 100 hectares that is accessible within five kilometres of home; and

[35] Lippeverband (2013) The Future Cities Guide: Creating liveable and climate-proof cities. Lippeverband, Essen.

[36] Happy World Cities Day 31.10.2014; www.urbanfinland.com, presentation by Timo Hämäläinen.

[37] Natural England (n.a), Accessible Natural Greenspace Standards (ANGSt), Available at: http://webarchive.nationalarchives.gov.uk/20140605090108/http:/www.naturalengland.org.uk/regions/east_of_england/ourwork/gi/accessiblenaturalgreenspacestandardangst.aspx.

	• of 500 hectares that is accessible within ten kilometres of home. Such standards can be used to model (for example by using GIS mapping) existing levels of access, and also to help plan the provision of green infrastructure, particularly in urban areas, to ensure access levels for all people. Source: http://webarchive.nationalarchives.gov.uk/20140605090108/http:/www.naturalengland.org.uk/regions/east_of_england/ourwork/gi/accessiblenaturalgreenspacestandardangst.aspx
Ghent Heat Island Analysis, Belgium	A detailed analysis of the urban heat island effect and heat stress dynamics was performed for the city of Ghent, Belgium. In the summer of 2012, an experimental measurement campaign was conducted with various fixed sampling locations (both own as well as third party e.g. coming from hobbyists) and mobile transects. The surface heat island (SUHI) was visualised and analysed based upon remote sensing LST retrievals from ASTER/Landsat. These maps were further translated into an estimated level of potential heat stress during the day. Next, the canopy layer heat island was studied in addition by UrbClim model runs. A subcontractor, the University of Ghent (Department of Spatial Planning) was responsible for detecting the causes of the UHI in Ghent and performing a vulnerability analysis with relation to heat stress in the city. Complemented with a number of scenario runs taking into account changing climate conditions and land use projections (2030), the project results were translated into policy-relevant information. Source: http://www.urban-climate.eu/c/12/

Strategies and plans at the local and regional level

Regional and local plans and strategies can form the basis and provide mandates for green space projects and cross-sectoral initiatives. A wide range of implemented local and regional policy programmes were identified in the project, which are mostly initiated by the environmental sector. However, some are led by public health authorities, and many of them consider societal factors. In addition, when comparing the number of examples identified with the number of national policies, our results again show that actions across sectors that aim to promote biodiversity or protect nature are mostly taken at the local level and that local and regional authorities thus play a key role in promoting cross-sectoral action in this area. Cities that have developed a so-called 'green policy' are often aware of the importance of green space in the city and they stimulate projects that could improve the environment. Such green policies often include aims to improve health and social inclusion for the citizens. There is a growing number of examples of cities (and regions) that have planned or implemented urban regeneration programmes (e.g. transformation of previously industrialised areas), including dedicated green spaces to allow for physical activities, recreation, clean air, etc. and at the same time cater for strengthening biodiversity (e.g. the 'Emscher region', the city of Berlin with its Tempelhof-area and the city of Barcelona).

Green Capital Ljubljana, Slovenia

Coordinated by: Local authority

Ljubljana has devoted special attention to the creation of open and green public areas. The city is aware that green areas and pleasant surroundings are very important for health and quality of life, which is something they wish to preserve and enhance.

One of the environmental projects in Ljubljana, Smart City, was designed with the aim of incorporating shared best practices in the field of environmental and nature protection from the widest range of stakeholders. Ljubljana is aware that the ambitious environmental targets cannot be achieved without the cooperation of both locals and organisations. For example, to involve citizens in the development of a new programme of environmental protection for 2014-2020, a website was launched where they could give suggestions and opinions and share experiences with the City of Ljubljana. Their participation was also rewarded.

Source: http://www.ljubljana.si/en/green-capital/

Table 12.2 provides some examples of strategies and plans at the local and regional level identified in this project.

Table 12.2: Selected examples of regional and local cross-sectoral policy documents

Title	Description
All London Green Grid, UK	The All London Green Grid (ALGG) is a policy framework that aims to increase the provision of green infrastructure across London. The ALGG includes policies on green infrastructures and urban greening, which relate to open spaces, increasing biodiversity, trees, woodlands and rivers. The ALGG recognises the contribution of GI to healthy living, recreation, urban farming, climate change adaptation, and green growth. Source: https://www.london.gov.uk/sites/default/files/ALGG_SPG_Mar2012.pdf
Green Infrastructure Strategy Carlisle, UK	Carlisle City Council, UK, has included health benefits from nature in their overall Green Infrastructure Strategy. The trigger for this was a study[38] that reported that street trees could filter out up to 70% of air pollution and reduce childhood asthma by up to 29%. Carlisle's Green Infrastructure Strategy is the evidence base for local spatial planning and policies in relation to the city's green spaces. Its aim is to ensure that the city takes account of the role of existing and proposed green spaces in generating a number of benefits when considering future developments. It estimated that existing green spaces in Carlisle could save the city £79 million in avoided costs for air pollution control in the next 50 years. Source: http://rebanksconsultingltd.com/resources/2501_A4_Carlisle_GI_07_PROOF.pdf
Climate Plan & Water Strategy, Lyon, France	The development of the city of Lyon is increasingly guided by strategies such as the Climate Plan and a Water Strategy. The strategies stress that while flooding has been a priority issue of past decades, increasing water scarcity and summer heat waves are expect to affect the city in the future. They therefore introduced the 'Greater Lyon Initiative', which includes a shade indicator, calculating annually the area of shade provided by trees (this is roughly 3.5 million m^2 for public spaces). Source: http://www.economie.grandlyon.com/fileadmin/user_upload/fichiers/site_eco/200912_gl_cleantech_plan_climat_plaquette_en.pdf
Forest Biodiversity Action Programme for Southern Finland 2008-2025	The Forest Biodiversity Action Programme for Southern Finland (METSO) was initiated by the government in 2002 and continues until 2025. It contains a measure to support forest biodiversity cooperation networks via projects that aim to enhance voluntary forest conservation alongside other societal benefits. Thus, the METSO programme has provided room for new stakeholder-driven activities that combine nature conservation with health and social benefits. Source: http://www.metsonpolku.fi/en/
Copenhagen Cloudburst Management Plan, Denmark	In Denmark, city authorities in Copenhagen have developed innovative green and blue strategies for addressing increasing flood risk from cloudbursts. In doing so, they have also considered the health and social implications of these strategies, as well as benefits for biodiversity. For instance, in 2010, the city implemented a green roof law, which stipulated than any new building with roofs that are at an angle of less than 30 degrees must incorporate soil and vegetation into the roof's design. Green roofs can significantly reduce surface run off, but the Copenhagen green roof paper also gives examples of roofs in the

[38] Lovasi, G, Quinn, J, Neckerman, K, Perzanowski, M, and Rundle, A (2008) Children living in areas with more street trees have lower prevalence of asthma. *Journal of Epidemiology Community Health*, No 62, pp647-649.

	city that provide new habitats for native species and spaces for urban gardening and recreation[39]. Source: http://en.klimatilpasning.dk/media/665626/cph_-_cloudburst_management_plan.pdf
Barcelona Green Infrastructure and Biodiversity Plan 2020	The City Council of Barcelona has developed a Biodiversity Plan 2020, which has the objective of preserving and enhancing natural heritage in the city and to enable everyone to benefit from it. The plan aims to increase greening and the connection of citizens with nature, for example with green roofs and walls, parks and gardens, plus coastal areas and rivers. Moreover, Barcelona wants to move from using greenery as decoration to more structured greening that enhances the environmental purposes and that increase habitats and the surface area of green space in the city. Source: https://w110.bcn.cat/MediAmbient/Continguts/Vectors_Ambientals/Espais_Verds/Documents/Traduccions/GreenPlan_2020full.pdf
Air quality plan Berlin, Germany	Berlin's Air Quality Plan provides a package of measures that aim to improve air quality in the city. Many of the measures focus on strategies for reducing the amount of road transport and the implementation of a low emissions zone. However, the strategy also explicitly acknowledges the role of city greening and vegetation in reducing levels of harmful pollutants. Source: http://www.stadtentwicklung.berlin.de/umwelt/luftqualitaet/de/luftreinhalteplan/download/lrp_150310_en.pdf
Biodiversity Strategy, Reykjavik, Iceland	Reykjavik's Biodiversity Strategy serves as a roadmap of how the city can become greener and nature more sustainable. For the development of this policy strategy, cooperation between different stakeholders such as public and private organisation in the fields of health, fitness and recreation, environmental affairs, conservation and forestry, volunteer groups and schools was stimulated. Also during the implementation of the strategy, citizens are actively involved and invited to meetings organised in different neighbourhoods. Source: http://reykjavik.is/

[39] http://www.klimatilpasning.dk/media/631048/green_roofs_copenhagen.pdf.

12.4 Success factors contributing to effective stakeholder engagement

This section presents some of the success factors that can contribute to good stakeholder engagement in the nature/health/social nexus. There are a range of success factors that contribute to effective stakeholder governance in the context of nature protection and biodiversity. The chapter provides practical information, cases and guidance for stakeholders on how to implement a successful and effective governance structure or cross-sectoral initiative.

Defining clear and common objectives

Setting clear and common objectives for a cross-sectoral project that involves nature, health and social stakeholders can help to determine its success. The objectives of the project should clarify what the project is about and what it will focus on, but - and this is perhaps even more important - should set out the roles and responsibilities of each of the different stakeholder groups.

Addressing health, social and environmental inequalities in Aberdeen, UK

Coordinated by: Local authority

Aberdeen City Council is currently working with their partners in the National Health Service (NHS) Grampian on a project that identifies multiple benefit opportunities that address health, social and environmental inequalities together. Under this project, a Geographical Information System (GIS) based map will be developed showing open spaces within neighbourhoods to maximise the use of these spaces for physical and outdoor activities.

The major success factor is pooling resources and bringing the right expertise to deliver shared objectives. For example, if an authority has technical expertise, the other authority could provide financial resources to work together. Data sharing on health, biodiversity and social issues and development of common tools and instruments benefit everyone. It is of great advantage in decision-making as it provides a strategic approach by not looking at one sector but other sectors as well to achieve common objectives.

Source: http://www.aberdeencity.gov.uk/gis/gis.asp

Ecosystem services and Human Health project, Finland

Coordinated by: Nature/health sector

A wide range of researchers, experts and decision-makers participated in a series of seminars and workshops about ecosystem services, health and wellbeing. Because of the project, funded by the Finnish Cultural Foundation, a clear proposal for a Government decision and a multi-disciplinary research programme on nature and public health was compiled. The project report (Jäppinen et al., 2014) outlined that these would contribute to "…health-promoting decision-making with respect to urban planning, the development of nature-based services and business opportunities, and protection of biodiversity. The knowledge and expertise generated could promote health of all citizens and aid in prevention of non-communicable diseases and social exclusion, while also being

applicable to support the well-being and rehabilitation of vulnerable citizen groups (for example, elderly persons, the unemployed, mental health patients, prisoners, and disabled people)".

This project and its outcome is an example of cross-sectoral and multi-disciplinary collaboration that yielded clear and common objectives. It is now up to decision-makers to give opportunities for the stakeholder networks to start work towards meeting the objectives.

Source: http://www.syke.fi/en-us/Research__Development/Research_and_development_projects/Projects/Ecosystem_Services_and_Human_Health__Argumenta_Project

Empowerment and building trust

It is important to give all stakeholders involved a feeling of empowerment, equity and trust. This can be achieved by ensure frequent and clear communication, as well as by involving stakeholders in the decision-making processes and allowing their voice to be heard. Actively engaging stakeholders in the different processes and ensuring that they have the possibility to give feedback and share their opinion will give them the feeling of ownership over a project or initiative.

Moy Hill community garden, Ireland

Coordinated by: Social/nature sector

The Moy Hill community garden is a community-supported agricultural space that provides vegetables to the community, involves the community in growing food and allows people to learn by doing. The aim of the organisation is to have a healthy green space where people can socialise and learn how to grow their own food

There are two gardens: one large garden of one acre where the vegetables are grown and the other garden is half an acre and here, the weekly cooking take place. Groups taking part in the project vary from young children with parents to young adults and older people.

By linking experts with residents and giving people a responsibility, nature becomes more valuable to them.

Source: https://moyhillcommunitygarden.wordpress.com/

Engaging the public

The lack of engagement from organisations and governments for a longer period can be addressed by involving citizens directly in initiatives and projects. This group of stakeholders is not working with a specific agenda nor is their involvement limited by formal periods. For example, the municipality of Nijmegen in the Netherlands has a long tradition in working with citizen groups to construct and maintain green space. They directly involve residents during meetings and consultation processes, and ensure that they have a concrete role to

play whenever a new project or initiative is being implemented. This stimulates the feeling of empowerment and has resulted in more involvement and support from residents.

Iron Curtain Trail, Hungary – Natura 2000

Coordinated by: Nature sector

The West Pannon Regional and Economic Development Public Non-profit Ltd is a Local Action Group that works on different projects related to sustainable development. One example is the Iron Curtain Trail that improved the cycling accessibility in the South East European region. This project was executed in partnership with a number of other organisations from the South East part of Europe.

"It is important to involve all stakeholders from the very beginning, from the first step of the first meeting. At local and regional level, it is important to find the relevant partners, including local authorities, for the concrete topic from the beginning.."

Source: http://www.westpannon.hu/projektjeink/pelda1

Defining a common language

It is important to define a common language among different stakeholders, to ensure that everybody is talking about the same topics and that people will understand each other when issues are raised. The right balance should be struck between avoiding jargon, making the approach understandable, and addressing the evidence base that underpins decision making.

Developing standards and formal structures

It can be beneficial to put formal governance structures and standards in place that support work at the nature/health/social nexus. The benefits of such structures should be further studied as well as restructuring the use of resources for more efficient, joined-up work that can facilitate the implementation of cross-sectoral action.

Leeds City Council, UK

Coordinated by: Authority

Natural England (the public body responsible for England's natural environment) developed the Accessible Natural Greenspace Standards (ANGSt). These standards present the minimum distances between natural green spaces and citizens. Natural England believes that natural environments increase the quality of life of people. However, local authorities have not implemented these standards in their planning policy. To overcome this lack of policy support, Leeds City Council suggests setting up a separate government-funded body that is required to engage specifically with the health sector and local community in biodiversity projects.

Source: http://www.leeds.gov.uk/Pages/Default.aspx

Integrating the evidence base

The evidence-base should be integrated into practical knowledge and implementation to ensure that the initiative or project is based on elements that have proven to be successful through evaluations and studies. Particularly at the local level, research has shown that the combination of scientific and local knowledge contributes to the successful management of environmental change in local communities (Stringer and Reed, 2007; Reed et al., 2007; Ingram, 2008; Reed et al., 2008; Raymond et al., 2010). Thus, with more interaction between scientists and local communities, it is possible to increase the effectiveness of environmental policies and practices.

Developing a communications strategy

It is important to define a clear communications strategy during the initial stages of a project or initiative, so that information will be disseminated throughout the duration of the action and the right methods and means are established early in the process. Moreover, communications should not be defined as a one-way mechanism, but stakeholders should have the possibility to provide feedback and share their opinions (see section on empowerment above). A so-called 'sustained interactivity' between researchers and users should be ensured during the whole process. Moreover, transparency is crucial to further building trust and ensuring engagement of all stakeholders involved.

Applying suitable communication tools

The different methods and means of communication that exist should also be carefully considered, as they can initiate, facilitate or strengthen stakeholder engagement. Examples include brochures to inform, mass media to communicate, opinion polls and referendums to consult, and consensus conferences and citizen's juries to participate (Reed, 2008).

Campaign to Protect Rural England (CPRE), London, UK

Coordinated by: Nature sector

CPRE London is the London regional branch of Campaign to Protect Rural England but is an autonomous charity. It focuses on two campaigning and practical support missions:

a. protecting and extending green spaces across their region through education, and planning interventions and support for local groups;

b. Working with community groups and professionals to build healthier features in urban neighbourhoods, such as green spaces.

The work of CPRE mainly consists of campaigning literature, some of this derived from their officers' research work; and they respond to members' requests for information, advice and support.

Source: http://www.cpre.org.uk/

Communicating the benefits

Particularly during the development phase, communicating the potential benefits that a project or initiative may bring for each sector is crucial. When stakeholders are fully aware of the benefits, their level of participation is likely to increase and the success rates of working together towards the common goals will be higher. The benefits of a project initiative can also be expressed in terms of a cost-benefit analysis. If the financial means are there, stakeholders who participated in our research indicated that such analyses could provide powerful arguments that can significantly increase engagement and interest. It was noted that if such a cost-benefit analysis or any other kind of evaluation is being carried out, this should be done by a reputed independent research institute or university. This will ensure objectivity and validity, and therefore increase take-up of messages by different stakeholders.

Regular contact with stakeholders

During the implementation of the project, it is important to be in regular contact with all parties involved and to inform them in case changes occur to the overall project plan or when new information or evidence has been identified that is of interest to or relevant for one or more stakeholders involved. Regular meetings can be useful, if the scale, size and geography of the project allows for this (e.g. this will be more difficult if a project involves multiple countries).

Urban Green Centres, Madrid, Spain

Coordinated by: Local authority

The Environmental Awareness Department in Madrid has developed a net of Urban Green Centres (Environmental Wariness Centre) located in the main green areas of the city, such as urban forest, and urban wildlife conservation centres. These green centres are promoting initiatives regarding nature protection and biodiversity. Most of the projects and initiatives aim to use the natural environment to reduce pollution through, for example, physical activities (urban farming project), guided tours through urban green areas, and biodiversity projects. They involve different NGOs, such as sea and birdlife, and local stakeholders.

Political support, finding the most effective way to communicate activities and reaching target groups are success factors for the different initiatives in the city.

Source:
http://www.madrid.org/cs/Satellite?c=CM_Actuaciones_FA&cid=1142314660051&idConsejeria=1109266187260&idListConsj=1109265444710&language=es&pagename=ComunidadMadrid%2FEstructura&sm=1109265843983

Persistence and ensuring continuity

Projects, policies and initiatives that address the health and social benefits of nature and biodiversity often have a long-term focus, because results (e.g. increased physical health or improved social cohesion) are often only visible after a longer period. Moreover, a range of

initiatives identified through our research also addresses the maintenance and conservation of large green areas, which requires the persistence of stakeholders for a longer period. Immediate results are not always visible and this makes it challenging to keep stakeholders involved. Ensuring persistence and continuity is thus key for projects.

Körös Valley Action Group, Hungary – Natura 2000

Coordinated by: Nature sector

The primary aim of the Körös Valley Action Group (Korosok Volgye Akciocsoport Nonprofit Kft, KVAN) is to develop rural areas and tourism. Moreover, it protects the environment and strengthens the involvement of the local society.

Among their projects are educational programmes for children that involve professionals, such as environmental experts, teachers and parents. Local government decision makers and civil organizations took part in the community investments.

Community development through environmental initiatives is effective because it increases consciousness. The trouble is that the invested time, energy, and money is repaid slowly. Since there are no spectacular results in the short term, certain stakeholders, especially mayors, do not want to waste their time and money with these projects. Nevertheless, it is believed that one good idea or a small-scale initiative could attract supporting partners. The most important factor is that local stakeholders remain in contact with each other continuously.

Source: http://korosokvolgye.hu/

Replication of existing projects

Replication can provide useful frameworks and guidance when setting up a new project or initiative. For example, the 'Alnarp Rehabilitation Garden' project in Sweden (see Chapter 6) has been replicated in the Netherlands and Japan. The 'Slí na Sláinte' initiative (see Chapter 7) in Ireland has been replicated by heart foundations across the globe.

12.5 The role of funding

As described in section 13.4, funding can play a major role in the successful and effective implementation of projects and initiatives focusing on the health and social benefits of nature and biodiversity. This section goes into further detail about the types of funding that exist and provides suggestions on how funding can be used to stimulate cooperation and engagement of different sectors.

> *"The involvement of organisations with enough resources and commitment is key, particularly in the current challenging economic environment." [European NGO, health sector]*

The projects and initiatives identified through our research are funded through different mechanisms. For example, various examples receive **funding from national or local governmental bodies**:

- PE Prisons Production (Bulgaria) is a social programme that involves prisoners in nature-related projects and is partly funded by the state.
- Another example of national state funding is TAPIO Oy in Finland, from which the Government regularly buys services relating e.g. to forest biodiversity and other ecosystem services and related various benefits.
- The Õuesõpe project (Estonia), an educational project for children about local heritage, is co-funded by the Ministry of Culture and Ministry of Education and Science.
- In Latvia, a special Foundation exists for the financial management of the Kemeri National Park. It uses financial tools to gain support from state institutions such as the Environmental Protection and Regional Development Ministry, and the Nature Conservation Agency.
- The Belgian Biodiversity Platform is a long-term project that provides services to the Belgian scientific community that is involved in biodiversity networks. This Platform is funded by the federal government.
- The City Council of Barcelona has a fund for projects that relate to the city's Biodiversity Plan. These projects are also initiated by the City Council itself.

Several projects, particularly those implemented in the UK, mentioned that they received **funding from lotteries** as well. For example, OPAL Imperial College (UK) has developed free, accessible-to-all and easy to use environmental surveys and other resources that allow all citizens to get out and monitor nature in their local area. These were developed with funding from the largest UK Lottery fund. Another example is the Woodland Trust, described below.

Woodland Trust, UK

Woodland Trust coordinates different nature-related initiatives such as the "Visit woods initiative" which aimed to get people out and into their local woods.

Current initiatives include "ObersvaTREE", a project that uses citizen science to foster better understanding of the current state of play for tree disease; "The Ancient Tree Hunt" which has engaged over 140,000 people to find and document ancient trees across the UK, enabling people to preserve their cultural stories and protect them from future threat through a database that has been created collectively; "Natures Calendar" which actively motivates families to get out and about through free downloadable guides and games; "Tree for All" which has enabled 5 million children to plant trees; and "Tree Packs" which provides trees and guidance on tree management to communities with the fewest trees in the UK.

Where shared interests are obvious, the Woodland Trust will fundraise to bring these stakeholders together. The majority of the work is funded by the Heritage Lottery Fund for which partnership work and engagement are key.

Source: http://www.woodlandtrust.org.uk/

Another possibility is the use of **cross-funding mechanisms**, as shown by the following examples:

- Forest Research (UK), the research agency of the Forestry Commission (who mainly initiates projects), is funded both by the Forestry Commission and receives funding from a lottery.

- The Swedish University of Agricultural Sciences created a living lab in the form of the Alnarp Rehabilitation Garden, to develop evidence-based treatment or rehabilitation for people by doing activities in the garden. They received funding from the European Social Fund and from several research foundations that helped to carry out their studies.

- The International Sport and Culture Association (ISCA) is funded by several sources from the international, European and national level. The Danish Sports Association (DGI) and the Danish Ministry of Culture are examples of national funders that support ISCA, while it also receives support from the European Commission Youth in Action Programme and the European Commission Second Programme of Community Action in the field of Health. The ISCA is also funded by a private international beverage enterprise.

- The Lake Constance Foundation (Bodensee Stiftung) is a project-oriented organisation for nature conservation and is funded by several national organisations such as Pro Natura Switzerland, WWF Switzerland, Austrian Nature Protection Federation and the German Nature Protection Federation.

Another example of a funding mechanism that can be considered is are **public-private-Partnerships**. One of the respondents of the survey, Climalia, mentioned the Rockefeller Foundation as one of their funders that helped to establish public-private partnerships in Italy. In 2013, the Rockefeller Foundation set up a framework called 100 Resilient Cities to

support cities that are resilient to physical, social, and economical challenges. Thus, funding from international bodies can help to stimulate local collaboration between different stakeholders.

Climalia, Italy

Coordinated by: Nature sector

Climalia is the first Italian company to provide specialized services on climate adaptation and resilience. They work on urban parks, private gardens, green roofs, rivers and coastlines etc. due to the potential for climate change adaptation. They also look at the co-benefits of green areas and support cities to develop resilient strategies. Under the framework of the 100 Resilient Cities programme funded by the Rockefeller Foundation, different Public-Private Partnerships have been created in Italy.

Source: http://www.climalia.eu/

Sečovlje Salina Nature Park and Lepa Vida spa, Slovenia

Coordinated by: Nature sector

The Sečovlje Salina Nature Park is part of the Piran Salinas (salt flat lands) which comprise Strunjan Salina which is still active and Lucija Salina which has been abandoned. It is situated on the Adriatic coast at the mouth of the Dragonja River. The area was designated a Nature Park by the Government of Slovenia in 2001.

A significant area of the park is covered by saltpans that are state-owned but managed by a private company. As a result of this, the park is the first state-designated protected area in Slovenia where the management concession has been given to a company. As per the concession, the company is responsible for the management of the Nature Park and use of its natural resources. In return, the Republic of Slovenia provides partial funding for the management of the protected area. The rest of the funding is provided by the company itself with additional funding generated by tourism in the park area, including health tourism.

The park provides health-related services in an outdoor spa called Lepa Vida. Lepa Vida uses by-products of salt production as natural remedies (saltpan mud and brine) for people suffering from rheumatic, skin, and urological diseases. The curing effects are being recognised by the Slovenian Ministry of Health.

Despite large numbers of people wanting to visit the park, the authorities manage the area as a strict nature reserve. Therefore, they have limited the number of visitors to one hundred people per guided visit, three visits per day, in compact groups and channel the visitor stream only on the main roads.

Source: http://www.kpss.si/, http://www.thalasso-lepavida.si/en

Funding can be strategically used to stimulate cross-sectoral cooperation; e.g. in the form of subsidies, which can help to attract certain stakeholders from other sectors to participate in a project. For example, when subsidies are available for farmers for using their lands for educational programmes, this can stimulate their engagement and participation.

> *"Subsidies and financial incentives - for example for businesses or farmers to engage more in environmental friendly behaviour – can encourage involvement of stakeholders enormously." [Regional NGO, nature sector]*

Białowieża National Park, Poland

The Białowieża National Park is a UNESCO World Heritage site fully covered by Natura 2000 protected areas. In 2011, a network of 100km of Nordic walking trails were opened in the forest, with the aim to engage the local rural community and tourists in physical activity and increase their appreciation of this important protected area. The park has been developed thanks to a collaborative effort of multiple stakeholders involved in the Białowieża National Park management as well as finance from EU and national sources. The demarcation of trails was initiated in 2011 by the Hajnówka County Office and co-financed from the European Agricultural Fund for Rural Development (EAFRD) aiming at increasing the social potential of rural areas (pfnw.eu, 2015). The total cost of the initiative was ~ €8,500, including over €4,500 from EAFRD.

Source: http://bialowiezaforest.eu/

Other solutions mentioned by the stakeholders that could result in increased funding opportunities for nature/health/social inclusions projects and initiatives included increased media attention and investigating new ways for funding, such as **crowdfunding** or introducing entrance fees for people who wish to make use of a certain nature areas. **Pooling of financial resources** across government departments was also frequently mentioned as a possible solution that should be further investigated.

> *"Subsidies can stimulate collaboration between sectors when they require stakeholders to show that they not only address health issues but also take nature and social inclusion into account."[National NGO, nature sector]*

Lake Constance Foundation (Bodensee-Stiftung)

The aim of the Lake Constance Foundation is the protection of biodiversity. They promote, for example, biodiversity-friendly designed premises and public green spaces.

Restoration of ecosystems and green infrastructure is costly, and financial resources from administrations are not sufficient. Payments for ecosystem services were implemented as an alternative source of funding.

Stakeholders would be more interested in collaborating if there were incentives, such as tax reduction, available in return for their cooperation.

Source: http://www.bodensee-stiftung.org/en/lake-constance-foundation

The EU could also play a role in ensuring that funding is available for projects and initiatives working on the nature/health/social synergies. The Horizon 2020 programme from DG RESEARCH could stimulate the further identification of evidence showing the health and social benefits of nature and green spaces – particularly in the longer-term – and DG REGIO could provide specific financial assistance regarding the implementation of initiatives and projects at the local level through the EU Structural and Investment Funds.

12.6 Conclusions

Who are the stakeholders and authorities working on the health and social benefits of biodiversity and nature protection?

This report has illustrated the broad range of initiatives and projects that exist across the EU to tap into the health and social benefits of biodiversity and nature protection. In this context, the research aimed to identify the different types of stakeholder groups from the health, social and environmental sectors that are involved in cross-sectoral collaborations, and found that the majority of initiatives identified involve or are led by NGOs (mainly those operating at the local level). Other groups, like academic and research institutions, the private sector and local voluntary associations, play an important role as well. In addition, the involvement of local citizens or residents as a specific stakeholder group was often considered key, particularly where an initiative addresses urban planning or the restructuring of neighbourhoods or districts.

The research also investigated what type of formal governance structures and approaches have been developed and implemented within European countries that bring together stakeholders from the nature, health or social sectors, and the role of government bodies in cross-sectoral work at the nexus. The results highlight the important role of local governments and authorities, as most projects and initiatives focus on specific local sites, including urban green areas, Natura 2000 sites, other protected areas, and unprotected rural areas. Examples of the formal governance structures identified include cross-ministerial or municipal working groups, fora or platforms or thematic/topic committees.

What are the relationships between stakeholders and what are their stakes in the process?

Stakeholders involved in cross-sectoral cooperation are aware that there are benefits associated with cross-sectoral collaboration, however, their level of knowledge differs, which directly influences their level of engagement and involvement.

Stakeholders involved in biodiversity and nature protection benefit from cross-sectoral cooperation because it can help to resolve conflicts (such as those between conservation versus use of nature), strengthen action to protect nature, and raise awareness of sustainable and responsible use of nature. For the social sector, stakeholders are increasingly aware that actions at the nexus can benefit local communities, vulnerable groups and also children and youth.

The research found fewer examples of collaboration with the health sector. It appears that further awareness raising on the issue is required among this group of stakeholders and that efforts can be strengthened. Particularly in relation to preventive measures and health promotion, nature and green spaces have an important role to play in terms of improving health and reducing the incidence of chronic diseases. Also in the areas of rehabilitation, disabilities and mental health, nature can have a positive impact on people's overall well-being. The health sector increasingly acknowledges this, but the research suggests that relatively few health actors are involved in collaborative actions at the nexus and that it is harder to break through silos in this specific sector.

Health stakeholders tend to hold on to their traditional approaches to health and often focus on care rather than prevention of disease and illnesses. Moreover, the health sector traditionally relies on strong evidence from medical sciences and controlled health treatment experiments. This type of data and information in relation to the topic of this report is not available in abundance, which further contributes to a limited involvement of the health sector. However, various stakeholders indicated that the situation may be changing, particularly as concepts such as 'Health in All Policies' and 'Healthy Public Policy' are increasingly being used and implemented among actors from this sector, thereby acknowledging that wider determinants outside the direct remit of the health sector should be considered when improving the health of citizens and populations.

What is the role of governance structures and policy frameworks in cross-sectoral work?

Not only for the health stakeholders, but also for the other stakeholders, the importance of having a supportive policy framework or governance structures in place can greatly facilitate cross-sectoral work. The research identified a range of policy documents and formal governance structures implemented in Member States such as Finland, Ireland, the Netherlands and the UK that promote the health, social and nature sectors to work together and address issues related to green spaces and nature conservation collaboratively.

The difficulty when an authority or government is involved in or leads a cross-sectoral initiative that addresses the health and social benefits of biodiversity and nature, is that these people often work with a fixed agenda and are bound to a specific time period in which they can implement action and introduce change. Political priorities can rapidly change due to elections and political parties changing seats. Moreover, stakeholders indicated that it takes a lot of time and effort to get political engagement in the first place, as the majority of departments and ministries operate within their own fields and silos.

Seeking support from a higher governance level (e.g. national government) is considered a particularly difficult process, compared to local level authorities. In the area of nature/health/social collaborations, the bottom-up approach thus seems to dominate, while stakeholders indicated that top-down support could be beneficial for the successful delivery and implementation of projects and initiatives. The need for more national level policy support is often mentioned as one of the ways forward to improve cooperation between environmental, health and social sectors.

The existence of formal policy frameworks often goes hand-in-hand with the presence of funding opportunities that can support stakeholders in their efforts to work towards common goals and objectives. For example, in Member States such as Germany and the Netherlands, national funding programmes are available that support urban action at the local level. Only a few cases could be identified that used private sector contributions, and the potential that public-private partnerships have to offer could therefore be further explored.

What are the success factors for cross-sectoral collaboration among the health, social and nature sector?

One of the crucial factors for supporting further and future action on addressing the health and social benefits of biodiversity and nature protection is increased awareness raising. While evidence on the benefits produced by research bodies is growing, better data and information is required on the short-term benefits and advantages of investing in this topic in terms of costs and return-on-investments. Stakeholders agreed that this type of evidence would help them greatly in promoting action at the nexus.

Not only will such evidence provide them with strong arguments to influence and convince policy makers to address the issue and to make the necessary funding available, it can also promote engagement from sectors and stakeholder groups that are currently difficult to reach or not interested in collaborating (particularly among the health sector).

Another key factor highlighted by the majority of stakeholders is the importance of having a common language to ensure that all parties involved understand each other's objectives, interests and stakes in the process. Stakeholders from the three sectors often use different terms to refer to similar issues (e.g. the nature sector uses concepts such as 'nature-based solutions' and 'sustainable development of green areas', the health sector addresses the issue by looking at the 'wider determinants of health' and focusing on 'health in all policies' and the social sector will looks as nature as an environment to meet new people or to regenerate neighbourhoods). It was suggested that 'ecosystem services' or 'sustainable living' could be considered as concepts that can be understood by all parties and easily linked to their work, priorities and objectives. Having a common language in place will greatly facilitate overall communication processes, which can influence levels of cooperation, trust and engagement significantly.

13 Conclusions and Recommendations

13.1 Health and social challenges across Europe and the role of nature

Europe faces a number of health and social challenges. Respiratory diseases from air pollution, thought by some as yesterday's problem, continue to affect European cities. Heat stress in an urbanised society is a growing risk, exacerbated by climate change. Noise is now recognised as a major environmental health challenge. Obesity and related diseases, such as Type-2 diabetes, are on the rise. With an aging population and a high-stress environment, incidences of various mental health problems from dementia to burnout are also on the rise. There is also a growing recognition that many individuals feel isolated and socially excluded in modern society. There is a need for measures to promote social inclusion and cohesion, and to develop a sense of wellbeing, place, and self-esteem.

Health and social challenges facing the EU: some examples

- **Air pollution**. Particulate matter, ozone, and nitrogen dioxide create risks of cardiovascular, cerebrovascular and respiratory disease. Poor air quality is responsible for early mortality - more than 400,000 deaths in the EU-28 in 2012 - and recent progress on air quality in cities has been limited.
- **Heat stress** causes exhaustion, heat stroke and mortality. Europe's 2003 heat wave caused 70,000 additional deaths. The urban heat island effect (UHI), or the temperature increase (by up to 12°C) experienced by urban areas, coupled with projected climate change will exacerbate the risks of heat stress.
- **Low physical activity levels** is one of the biggest health risks in Europe, with high levels of obesity and related diseases (e.g. Type-2 diabetes), undermining wellbeing and health, and putting enormous strain on health care systems. In terms of all-cause mortality, inactivity has been called the "new smoking".
- **Noise** pollution is considered the second-worst environmental cause of ill health after air pollution. Symptoms include annoyance, sleep disturbance, stress, hypertension and cardiovascular diseases (e.g. coronary heart disease and stroke), as well as impaired cognitive development of children. 20% of the EU population is exposed to levels exceeding 65 dB.
- **Mental disorders** alone account for about 20% of the burden of disease in the European Union (EU). Depression is responsible for about 15% of all days lived with disability.
- **Urban demography** 70% of Europe's population lives within urban settlements, often with limited access to green space (within 300m or a 5-minute walk). Inequality in wealth and access to services, as well as unemployment, threaten Europe with pervasive social exclusion.
- **EU public health budgets** are under pressure across the EU and there is a need for low-cost, sustainable solutions.

The cost of health care to private and public budgets in Europe is substantial - the EU health sector represents 10% of GDP, 15% of public expenditure and 8% of employment (Eurostat, 2015b). The EU health sector also plays a pivotal role in supporting productivity, labour supply, employability, and workforce mobility. Since the millennium European health systems have increasingly been faced with a number of challenges – increasing costs,

demographic change (and associated rises in chronic disease and multiple morbidity), and growing demand, resulting in a shortage of health provisions with unfolding social implications (EC, 2014). Exploring nature-based solutions to health care offers opportunities to reduce some of these pressures.

The OECD anticipate that overall expenditure on health care will increase in the future due to technology, relative prices and exogenous factors, however low levels of economic growth will place costs under pressure, and in competition with other social budgets. This is already visible in many Member States (Eurostat, 2015b). Following the financial crisis in 2008, there were notable changes in health expenditure, notably growth in public expenditure in health came to a halt and in several places, there were reductions (Maisonneuve & Martin, 2013). Preventative care is an area, which has seen its budget cut, contracting by 0.6% annually since 2009 across the OECD. Recent years have also seen private expenditure on health care increase as a share of total spending, this includes both "out of pocket spending" and private health care insurance (OECD, 2015). This may have distributional consequences in terms of access to and quality of care.

All countries in Europe are experiencing ageing populations – with a decrease in the number of people of working age relative to the number of retirees (Rechel, et al., 2009). A declining working population, ultimately results in less revenues for health and pension systems, putting further strain on health care systems. Many argue that this will result in an increase in expenditure in long term care, but that with the appropriate policies, particularly to support "healthy ageing" it does not necessarily need to increase overall spending (Rechel, et al., 2009; Maisonneuve & Martin, 2013).

In order to respond to both budgetary pressures and demographic change, there is a need for an adequate response from health care system and in wider policy. WHO Europe outlined the kind of measures that could support such a response (Rechel, et al., 2009, p. 4):

- Better coordination of care across health and social services
- Introducing measures which support treatments outside of hospitals
- Support healthy ageing and ease the pressure on health care systems with measures that reduce the risk of disease, and increase function, confidence and engagement
- Disease prevention programmes should target key causes of morbidity and premature mortality, in particular obesity and hypertension, as well as mental illness
- Measure should include physical exercise and social involvement

The European Commission communication on effective, accessible and resilient health systems outlines the pressures which health care is under, and some of the outcomes that will be necessary to provide an adequate level of care, and support healthy populations and societies in the future (EC, 2014).

There are multiple solutions to these complex problems. This report presented a summary of the scientific evidence of the role that nature can play in addressing these challenges.

Beyond presenting the available research, the analysis attempted to assess the strength of the evidence. For a number of thematic areas such as improving climatic conditions in urban areas, supporting physical exercise or providing mental health benefits, the available evidence is relatively strong. The thematic chapters above also highlighted existing knowledge gaps as well as areas where the evidence base needs to be strengthened, such as identifying which types of green infrastructure could be especially beneficial to encourage activities in nature.

While nature cannot be a remedy to all challenges of society (e.g. air pollution control will primarily need to address the sources of pollution), there exist many both small and significant opportunities to realise health and social benefits, that often come with co-benefits for biodiversity and nature protection.

Nature can contribute solutions – conclusions from the evidence

There is robust scientific and practice-based evidence that nature can contribute to addressing health and social challenges that EU citizens are facing – from access to Natura 2000 sites and other protected areas in urban, peri-urban, rural and coastal areas, to investments in wider green infrastructure. The report also presented numerous practical examples where initiatives have been and are using nature to realise these benefits.

Protected areas and other nature parks are being recognised as "preventative health care centres" and "health hubs", with increasing numbers of health related activities hosted by these areas, and facilitated by protected area managers in coordination with other stakeholders. The current health-social-nature engagement through Europarc members, for example, is already proving a catalyst of change across many parts of Europe. Similarly, small scale initiatives such the Walkability Project in Wales is seen as an inspiration to others, promising a change of scale over time.

Nature-based solutions can offer affordable, sustainable, and reproducible benefits across a range of areas affecting public health and social well-being, complementing the many approaches based on grey infrastructure or indeed hospitalisation and treatment-based health care. In some cases the nature-based solutions are alternatives to "traditional" treatment (e.g. prescription for regular walks in the park, reducing the need for medication) and in others a complement (e.g. rehabilitation to facilitate recovery).

Practical examples of the direct and indirect public health benefits from Natura 2000 sites, other protected areas and wider green infrastructure can be found across every EU Member State – from micro scale for citizens, streets and neighbourhoods, to city-wide levels, regions, country level, as well as cross border multi-country benefits. EU-wide scale benefits arise from the Natura 2000 network and a potential Trans-European Network on Green Infrastructure (TEN-GI).

- **Mitigating heat stress**: Nature can help to reduce the risks associated with heat stress by providing cooling, by shade and evapotranspiration. Recognition of these benefits has led to riverside restoration in Lyon in France, where asphalt was replaced with 5km of riverside green space and soft mobility infrastructure.

- **Reducing exposure to pollutants**: Green infrastructure contributes directly and indirectly to reducing personal exposure to air pollutants. In 2008, Stuttgart developed KlimaAtlas to map air pollution, wind and climate that informed a green infrastructure strategy and new planning legislation. Commitment let an increase in green space to 60% and a greening of 300,000 m^2 of rooftops.
- **Mitigating noise stress:** Vegetation can impede noise propagation by absorbing or diffracting noise. A former industrial zone in a southern suburb of Paris was converted into a 23 hectares park that acts as a buffer between a highway and a residential area, reducing the noise level in the park to 20dB lower than at the highway, with inhabitants at the east of the park exposed to noise levels below 55dB.
- **Reducing stress and maintaining everyday well-being** (preventative). Regular exposure to nature has a positive effect on mood, concentration, self-discipline and physiological stress. Evidence shows that people living in a greener environment experienced fewer health problems and scored their health more positively compared to people living in less green areas. There is also some evidence that being in natural environments lowers blood pressure, pulse, and reduces cortisol level.
- **Providing spaces for effective treatment and rehabilitation** (therapeutic). Forests and parks are used for therapeutic interventions, providing active and passive benefits for patients. NHS Forest, a national project in the UK, created green spaces near healthcare sites, to support rehabilitation and recuperation. The Alnarp Rehabilitation Garden in Sweden demonstrated the benefits nature-based rehabilitation (NBR) on different users groups - individuals recovering from stress-related mental disorders, stroke and war neuroses (e.g. with refugees) – and is being rolled out in other sites.
- **Supporting children's development**. Nature areas can contribute to children's development – notably to their concentration, motor skills, self-esteem, and emotion regulation. Nature-based learning and nature play initiatives exist across Europe. In the Social Forest, Barcelona, the Collserola forest is being used to reintegrate and educate children otherwise marginalized and threatened by future unemployment.
- **Promoting recreation and sustainable mobility**. Exercising and being physically active in green areas provides not only physical health benefits but also positive effects on mental health**.** Furthermore, people want to spend more time exercising in green areas, so proximity to green areas increases the frequency and duration of physical activities. "Moved by Nature" in Finland was launched to promote collaboration between nature and health sectors to allow vulnerable groups to benefit from access to physical activity in natural spaces, delivering tangible results in physical condition and self-esteem.
- **Supporting social cohesion**: Having access to and using green public spaces and wider green infrastructure can contribute to increased social cohesion and reduced social tension, particularly for minority groups (e.g. ethnic, religious) and the socially excluded (e.g. immigrants, economically deprived). Urban green space was used to enhance social cohesion in Almada, Portugal. When designing and maintaining urban parks, attention was given to stimulating social integration of different ethnic and cultural groups in green spaces. The Green Routes without Obstacles initiatives in Lithuania, Latvia and Belorussia increased the availability of nature-based tourism for disabled people in three protected areas.
- **Volunteering and local participation** in nature can increase social support and reduce social isolation, and the natural environment can provide opportunities for learning

and enhance people's personal development and self-esteem, promoting social interactions and connections. Volunteers in the Coastwatch initiative in Ireland cleaned up marine litter from Blue Flag beaches to preserve the quality of green and blue infrastructure.

- **Contributing to employment:** Managing and improving natural spaces also provides multiple direct opportunities for employment**.** The Belgian Province of Limburg, which was threatened with post-industrial decline following coal pit closures, set up the Hoge Kempen National Park that has created an equivalent of 400 full-time jobs and direct economic benefits of circa €20 million.

An increasing number of formal and informal initiatives make use of Natura 2000 sites for activities aim to promote health and social benefits. Evidence is growing that protected areas can play important roles as "health hubs" and "preventive health care centres". Furthermore, the experience – such as lessons learned in the Walkability project and the Healthy Trails initiative in Pembrokeshire, the UK - has underlined that small local initiatives can not only be repeated but also copied and applied in a wider set of regions. Many of the 27,393 terrestrial and marine protected areas in the EU can be seen as potential preventive health care centres and arenas for social integration. To realise this will require investment in the site (e.g. infrastructure, quality), awareness raising, training (e.g. for guides and volunteers) and communication of the benefits beyond simple word of mouth.

For green infrastructure in and around cities, a range of studies have explored how increased green coverage can help address the heat island effect, mitigate noise and improve air quality – whether by urban parks, tree-lined streets or green roofs. As an example, in 2014 the coverage of green roofs in Germany and Austria was 86 million m2 and 4.5 million m2, respectively, and was growing at around 10% per year (11% in Austria, 9% in Germany) with a yearly market of €280 million/year in the two countries combined (Enzi, 2015). Average green space coverage (i.e. combining parks, tree-lined streets and green roofs) was around 18.6% in Europe in 2007 (Fuller et al., 2009), ranging from a couple of percent in the most urban cities to near 50% coverage in the greenest cities – with a per capita green space provision ranging from around $10m^2$ per capital to over $200m^2$. Despite of the recent increase, there remains an untapped potential for green roofs, tree lined streets and wider urban greening, which in turn can support the delivery of improved health and social benefits.

13.2 Recommendations for action – a Road Map for health-social-nature synergies

The research presented and discussed in this report and the practical cases across Europe can form a basis for a road map in Europe to better realise the health-social-nature synergies. A forward-looking approach will need to address several elements, which are interconnected:

- Knowledge – understanding the problem and solutions
- Awareness and integration of knowledge

- Policy objectives, strategies and plans
- Instruments, measures, legislation
- Financing and investment

The above elements involve stakeholders at local, regional, national and EU level. The remainder of this section presents some specific areas of action and elements of a Road Map.

Better implementation

The full implementation of existing biodiversity policies and conservation measures will help to lead to significant health and social benefits. The designation, management, funding and choice of investments (e.g. infrastructure for access to Natura 2000 sites; which brownfield sites to restore) can each improve public health and social wellbeing. There remain significant investment requirements for protected areas to attain good ecological status. Equally, for a range of marine areas, there is still a need for increased designation of the sites themselves as well as improved management and enforcement.

The implementation of a range of other policies will help achieve the health-social-nature synergies, including the **Water Framework Directive and the Marine Strategy Framework Directive**. Similarly, meeting objectives such as the **Paris Agreement on climate change** and the **Sustainable Development Goals** (SDGs) will provide wider frameworks for progress given the links between their objectives and nature-based solutions that can offer health and social benefits.

Links of Health-social-nature benefits and the SDGs

The 2030 Agenda for Sustainable Development or Sustainable Development Goals (SDGs) provide the overarching global framework for sustainable development for the next 15 years. These goals will also have implications for society, the health of populations and the role of nature. The replacement to the Millennium Development Goals (MDGs) is comprised of a more comprehensive and broad range of economic, social and environmental objectives. Across the 17 goals and 169 targets, it is possible to identify where the possible contributions of health and social benefits of nature might be. Communicating where synergies and opportunities exist could support the achievement of the goals and support the wider engagement with nature-based solutions.

Health - The SDGs include one specific goal on health, "Goal 3 – Ensure healthy lives and promote well-being for all at all ages". Some of the targets under Goal 3 relate to specific health indicators have links with the aspects of health covered in this report (see table 14.1). Some other targets under different goals are relevant to health, and may have links with nature-based solutions – for instance relating to climate change adaptation. See the table below for a summary of SDG health objectives and links to nature.

Table 13.1: Linking SDG health objectives with nature based solutions

SDG Target	Link with benefits of nature

3.4 - By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	See chapters 4, 5, 6, 7 & 8 – non-communicable diseases (such as obesity), preventive case, mental health and well-being are all covered extensively in this report. These are some of the core health benefits of nature.
3.8 - Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	Cross chapters - this target is supported by nature-based solutions in reference to their cost-effectiveness in comparison to alternative approaches. Universal access to nature is one determinant of public health.
3.9 - By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Chapter 2 – this target could be supported with nature-based solutions to air pollution. See also case study on Copenhagen, which explores water quality.
1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Chapter 3 – this target could be supported with nature-based solutions to climate adaptation (including heat stress).
11.6 - By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Chapter 2 – on air quality

Society - many of the SDGs refer to aspects of societal development, including employment, culture and social integration, which have synergies with nature-based solutions.

"Goal 11- Make cities and human settlements inclusive, safe, resilient and sustainable" refers to many aspects picked up in this report. Notably, "Target 11.7 - By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities", echoes a key message on access to nature which has been a key policy message from this study. With reference to "Target 11.a Support positive economic, social and environmental links between urban, per-urban and rural areas by strengthening national and regional development plans", nature has been shown to support development of areas otherwise threatened with decline (e.g. Emscher Landscape Park).

In addition, "Goal 8 – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all", has clear synergies with the current Commission's investment programme. Within this goal, there are opportunities for employment and economic growth linked to investing in nature. With reference to "Target 8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value", the Social Forest programme in Spain demonstrates how marginalised young people can find employment through nature. In addition, target "Target 8.9 - By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products", could arguably be met by supporting nature based tourism, such as those considered by the Saline nature park with its salt pans and associated products for tourists.

Integration with biodiversity – supporting nature based approaches to health and social targets can support the biodiversity objectives of the SDGs, reiterating the multiple benefits of natures.

"Goal 9 - Manage natural resource assets sustainability", as well as specific targets, such "Target 6.6 - By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes", are all relevant. For example we have seen in both Italy (Slow Food) and Luxembourg (TERRA) how nature based initiatives can support the genetic diversity of seeds, and promote the use of traditional knowledge – i.e. "Target 2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed"

Evidently, nature will have to be included in the implementation of the SDGs, and may support goals and targets that do not focus on ecology or sustainability. Efforts will need to be made to integrate and capitalise on possible synergies.

Source: https://sustainabledevelopment.un.org/sdgs

Policy integration and policy coherence

There is a need for a **systematic integration of the health-social-nature links into policies, programmes and finance.** This will require health and social issues to be reflected in nature policy, and nature issues into health and social policies (i.e. two-way policy integration), as well as all three issues being integrated into wider socio-economic policies given the links to jobs and growth. This type of "proofing for coherence" will be useful both for ensuring synergies are taken on board (as this helps with the added value of policies) and avoiding unacceptable trade-offs that can undermine effectiveness and increase the cost of meeting objectives.

There is also a need to clarify, and in some cases set, standards and norms, such as what constitutes suitable green infrastructure for different purposes in different areas (e.g. green roofs, tree-lined streets) to facilitate suitable uptake of nature based solution.

Proofing tools for integration

Common framework for biodiversity-proofing of the EU budget

EU level guidance has been developed for proofing EU funding for biodiversity (Medarova-Bergstrom et al. 2014). The common framework for biodiversity proofing can be used by national, regional and European authorities to a) avoid measures taken under EU sectoral policies having negative impacts biodiversity and nature objectives and b) highlight measures that are designed to directly enhancing or preserving biodiversity and ecosystems. Regarding the latter point, the framework promotes the mainstreaming of beneficial spending for biodiversity, e.g. through identifying opportunities for investment in green infrastructure and mainstreaming the priorities of the EU Green Infrastructure Strategy into the different EU sectoral funds. Consequently, the application of the framework for

biodiversity-proofing can support the policy coherence, and concrete funding opportunities, for health-social-nature synergies.

Assessing policy needs and opportunities for operationalising ecosystem services

A recent review of the EU sectoral policies shows that there is a range of gaps – both in terms of needs and opportunities – in the current integration of ecosystem services into the EU policy framework (Kettunen et al. 2014). While a number of relevant EU policies have, at least partially, integrated ecosystem services and natural capital into their conceptual basis, the uptake of these concepts in the context of concrete policy instruments remains limited. The identified gaps in the level of integration imply that the EU policy sectors are currently underperforming as regards their contribution to achieving the EU biodiversity targets and mainstreaming biodiversity benefits. Similar systematic assessments at national, regional or urban level can help to assess the state-of-play and, based on that, identify concrete opportunities for improved policy coherence and integration. Such assessments can also help the decision-makers to identify opportunities for health-social-nature nexus.

Clarifying standards and norms

Integrating policies across sectors and traditions of different disciplines requires a discussion of standards and norms as regards the quantity and quality of nature areas in order to deliver benefits for human health and wellbeing, and for social objectives. These discussions can partially build on existing research e.g. on which kind of green infrastructure, including specific species and varieties, could be used to address air pollution in cities.

In other cases, further research is advisable, e.g. as regards combining increased green coverage to mitigate urban heat islands with further measures as more impervious surfaces. Another example regarding noise is the definition of a 'quiet area'. The EU Noise Directive leaves it up to the Member States to determine limit values in this area.

For policies, **windows of opportunity** include policy reviews, impact assessment for reforms and REFITs. In terms of funding, there is a large window of opportunity every 5 years at the EU level when the EU Budget (the Multiannual Financial Framework) priorities are agreed. Different windows of opportunity will naturally occur across Member States, regions and cities. For example, in Germany, the Federal building code includes requirements for green parking and green roofs. Similarly, court judgements in Stuttgart have shown that following assessment, undeveloped hills that facilitate city air exchange are more important than building individual houses.

A range of **EU policies** and **programmes** can support progress on an ongoing basis. Climate change adaptation policy can support the integration of nature into future solutions for cities and **RTD policies can help to develop the evidence base**, while **Cohesion Policy** and associated use of supporting funds (ERDF, CP and ESF) can help fund projects (see below). There is also potential for the Natural Capital Finance Facility (NCFF) of the European Investment Bank (EIB) to integrate health-social-nature issues into the objectives and selection criteria for eligible investments. A potential Trans-European Network Green Infrastructure (TEN-G) offers a particularly interesting potential EU-wide initiative. Health

policies as such are under the jurisdiction of Member States, so input from DG Health and Food Safety will therefore be more supporting than active in the coming years.

Strategies and plans can help facilitate actions (e.g. health strategies and plans for green infrastructure, climate change adaptation, and noise). Some of these are at national level, others at city level (e.g. the urban heat islands strategy in Vienna, and the Biodiversity and Green Infrastructure strategy and noise action plan in Barcelona), and others at EU level (e.g. green infrastructure strategy).

Identifying and integrating health-social-nature issues into strategies, plans and tools

To realise the multiple benefits of nature, a diverse set of stakeholders need to collaborate over a longer period. An improved management of protected areas as well as wider green infrastructure requires investments into physical infrastructure, building up individual skills, as well as establishing networks. Different participants with backgrounds in nature conservation, public health and social policy will naturally pursue different agendas. The practical challenge is then to integrate the different perspectives across the sectoral agendas:

- Health policies and strategies that consider nature as one instrument, especially for the prevention of diseases, but also for therapeutic purposes
- Social policies that use nature and green spaces as part of the toolkit to promote social cohesion
- Strategies to address environmental quality (air quality, urban heat islands, noise etc.) that work with nature based approaches whenever feasible in the local context
- Nature protection and green infrastructure strategies that aim at realising multiple benefits, beyond biodiversity objectives and the ecological status of sites (e.g. integrating noise considerations into landscape planning (e.g. as in the Villejuif investment in France)

Such cross-sectoral integration can happen at all levels of governance, from the local and regional levels (which are also the levels where actual investments and expenditures will occur) to national and EU levels. In many cases, such integration into strategies and plans can build on existing structures, which can be adapted to facilitate the exchange between the health, social and nature communities.

Integration also offers the opportunity to use common tools, e.g. mapping of physical characteristics of urban heat islands in conjunction with socio-demographic mapping of vulnerable populations (e.g. elderly people) to identify needs for action. Similar mapping approaches can take place for social objectives, e.g. as regards the accessibility of green spaces for disadvantages groups to support inclusion and social cohesion. Mapping and improving the accessibility of nature areas is not only an issue for dense urban areas, but also for rural regions (see e.g. Latvian case “Green Routes without Obstacles”). Material prepared within such efforts can also be a useful instrument to engage communities and start discussions on how to improve local/regional conditions. If sufficiently detailed, it can also guide investment decisions on e.g. where to place new green roofs or where to keep land undeveloped.

Improving governance

Multi-stakeholder engagement and partnerships are critical for improving the governance of health-social-nature synergies. World Health Organisation (WHO) engagement with the Convention on Biological Diversity (CBD) and United Nations Framework Convention on Climate Change (UNFCCC) processes and actors is a success story at global level. At EU level, it requires cross-DG collaboration, for example between DG Regional and Urban Policy, DG Climate Action, DG Environment and DG Research & Innovation, on nature for climate adaptation in cities. At national level, examples such as the Finnish "Moved by Nature" initiative, success is often facilitated by cross-sectoral collaboration. Private-public partnerships, as shown in Slovenia with the Saline nature park and a mobile phone company, can also be a possible alternative.

High level commitment to strength cooperation between biodiversity and health – CBD & WHO

At the Conference of the Parties in Hyderabad, India 2012 (COP11) an emphasis was placed on integrating biodiversity objectives into other areas, including health, in order to support the full implementation of the Convention on Biological Diversity and the Strategic Plan for Biodiversity 2011-2020. Points 27, 28, and 29 under "Action C - Collaboration on biodiversity and agriculture, forest biodiversity, and biodiversity and health" demonstrate this commitment.

More recently, at the Conference of the Parties in Pyeongchang, Republic of Korea 2014 (COP12), "Decision XII/21. Biodiversity and human health" (CBD, 2014), links biodiversity and health explicitly, with notable points of action, which are supported by the conclusions of this study:

- Encourages Parties to consider the linkages between biodiversity and human health in the preparation of national biodiversity strategies and action plans, development plans, and national health strategies
- Encourages Parties and other Governments to promote cooperation between sectors and agencies responsible for biodiversity and those responsible for human health
- Recognize the value of the "One Health" approach to address the cross-cutting issue of biodiversity and human health, as an integrated approach consistent with the ecosystem approach
- To further strengthen collaboration on the interlinkages between biodiversity and health with other relevant organizations, including with the Food and Agriculture Organization of the United Nations, the International Union for the Conservation Nature, Biodiversity International, Future Earth, EcoHealth Alliance, FIOCRUZ and the Wildlife Conservation Society, as well as with initiatives, such as the COHAB Initiative and Biodiversity and Community Health Initiative
- In cooperation with relevant international scientific programmes, to promote further research on the relationship between biodiversity and disease outbreak

The release of the UNEP, CBD and WHO report "Connecting Global Priorities: Biodiversity and Human Health" at the 14th World Congress for Public Health in 2015 provides an important reference for exploring the evidence of linkages and also supports the findings of this study (UNEP,

CBD & WHO, 2015).

Further high-level integration of health and biodiversity objectives is needed. The action points outlined above provide guidelines on how this can happen both at the EU-level and at the national level for the member states.

Investing in social-human capital: understanding, skills and jobs

Realising the benefits requires **investment in people.** This can be in the form of **staffing** e.g. having a meteorologist in Stuttgart city, or having a public access officer and permanent specialist walking officer post in a national park. In other cases, it is about **bringing in the right skills from the outside** – for example horticulture experts are brought in by some cities to choose the right plants for tree lined streets and urban parks to ensure not just suitability for the ecosystem and condition, but also for the wider benefits (e.g. shading potential). The assessment of socio-benefits, that can be helpful to communicate to stakeholders, can also require **partnerships** between parks and universities.

Training is equally important e.g. training of volunteers in protected areas, and vocational training of young people as e.g. in the 16-25 age bracket in the Social Forest initiative in Barcelona, Spain[40].

Building and communicating the knowledge base

The knowledge base needs to be developed further, which merits both EU and national funding. Areas include physical and mental health benefits, cognitive development benefits to children, and social cohesion benefits of working with nature. Recent work includes the DG RTD Phenotype and Blue-Health projects[41].

Sharing Research Knowledge Across Countries – EU UHI-Project

The EU-UHI project is an example of support being provided to eight cities/regions challenged by heat that facilitates cooperation for addressing UHI as a common issue. The project has yielded a decision making tool to be used by members to input data and generate mitigating and risk prevention strategies for addressing urban heat islands (UHI-Project 2014). The project has benefited Vienna, as the city has moved forward with the recommended actions generated from being engaged in the program into its Urban Heat Island – Strategy Plan Vienna (Czachs et al. 2013). The strategy has also fed into Vienna's Master Plan, which actively zones for green spaces, an important tool in addressing climate change.

Source: Mutafoglu et al. (2016 forthcoming)

[40] To do: integrate with Europe 2020 objectives – i.e. R&D and innovative sectors
[41] http://www.phenotype.eu/ and http://www.ecehh.org/research-projects/blue-health/

Priorities will differ across countries and regions given the different environmental conditions, health and social challenges, and demographics. For example, the role of nature mitigating air pollution is a problem across most EU cities and the role in minimising the heat island effect exacerbated by climate change will relate to some countries more than to others. EU funding can usefully be focused on both, but national funding for knowledge development will clearly need to vary depending on differential needs. As the European population is aging and the level of dementia is increasing, EU research could usefully focus here as well. Furthermore, obesity is a major health problem of this generation and a strain on public finances due to associated health impacts (e.g. Type 2 diabetes), the role of nature in encouraging exercise merits attention.

Health-based research tends to have a hierarchy of analysis types that are seen as of increasing robustness from (a) case study analysis, to (b) cross-sectional studies; (c) case control studies (with time series causal chain analysis); (d) retrospective and prospective cohorts; to (e) non-randomised, and randomised, control trials (NRCT; RCT). For health-social-nature, the first four are each important, while the last is neither realistic nor necessary the assessment tools apply more to clinical test conditions than for real world cases where it is impossible to control for all conditions.

Case examples are already important sources of insight that can capture the mix of biophysical issues (the scale, nature and location of green infrastructure), the links to the population affected (i.e. living or making use of), the governance mechanisms leading to the decisions and investment (i.e. political science analysis) and the effectiveness of the measures (i.e. causal chain impacts. such as epidemiological studies). The latter would require more than simply case examples.

The knowledge base needs to be integrated into **decision frameworks and** a **wider science-policy interface** (SPI) – from **city investment decisions** as noted above, to **integration into EU policy assessments** (e.g. impact assessment and REFITs, integration into **proofing tools and ex ante and ex post assessment** of EU funds) to ensure that EU policies, programmes, their implementation and their reform take on board lessons from practice and insights from science.

Tools for implementation: measurement, mapping and evaluation

More tools can help in the identification of suitable areas for investment and management and support communication, for example, **ecosystem mapping tools, indicators, monetary and multi-criteria evaluation**. The MAES initiative, an EU initiative with in-depth engagement from a number of Member States, is helping to provide a foundation of knowledge and data that should prove valuable to authorities across the EU. EU RTD projects such as OPERAs and OpenNESS are also providing a range of helpful tools[42]. At a local level, tools such as heat and pollution mapping proving useful tools. The KlimaAtlas, for example leads to a practical categorisation in seven build/no build land use options to

[42] http://www.operas-project.eu/ and http://www.openness-project.eu/ which will provide tools also via the OPPLA portal http://oppla.eu/what-oppla

facilitate decisions by urban planners and developers in the Stuttgart Region. Mapping and modelling, when combined with demographic statistics and/or building stock information can help identify cost-effective options for investment in green infrastructure that helps address health and social objectives.

Research tools and instruments to support health and social benefits

A number of research and valuation tools can support the integration of the health and social benefits of nature into policy**.** A number of tools, and their applications are outlined below (Mederly, 2016):

Table 13.2: assessment tools for the multiple benefits of nature

Tool	Uses	Types of tool/example[43]
Biophysical valuation tools	Develop an evidence base for the multiple health and social benefits of nature. Specific tools include	Field mapping: blue-green factor assessment, structural diversity mapping, urban green infrastructure mapping, biotopes mapping Spatial GIS: spreadsheets, green frames, Ecosystem Service Mapping Tools, SITxell, Quick Scan Bayesian Belief Network Valuation, Ecosystem Services Conceptual Models.
Economic valuation tools	Place a financial value on the on the benefits of nature	Benefit transfer methods: willingness to pay, economic valuation of city trees (e.g. i-Tree) Hedonic property pricing (based on proximity to green) Economic liability (air pollution), time value (recreation), insurance (flooding), cost of prevention.
Socio-cultural valuation tools	Evaluate the various user values of certain benefits of nature, for instance, how much a green space is used and by what groups of society. This can include preference assessments, deliberative valuation, public surveys, and web/smartphone applications.	Preference assessment & deliberative valuation, Ecosystem demand & mapping Public surveys: time value of recreation, travel costs and willingness to travel, recreational value Web-based applications: web-surveys, blue-green smartphone applications, participatory GIS tools

[43] Case examples from main report to be added in additional column

Integrated assessment of Ecosystem Services	Integrate multiple aspects of valuation (biophysical, economic, social, health etc.) and providing a basis to include these in policy considerations.	Spatial mismatch – assess the imbalance between demand for ecosystem services and the supply Integration of multiple spatial levels

In addition, **the assessment of the benefits** can prove valuable not only for the identification of where the greatest benefits may accrue from investments, but can also be used for **public communication** - e.g. to highlight the importance of action, as was the case in the Emscher region regeneration. Assessment of the regional revenue streams created by visitor spending is carried out in Finland on an ongoing basis with view to highlight the local economic development, jobs and growth contributions of national parks.

Assessing and Communicating the health and social benefits using multiple measures

The health and social benefits of nature will inevitably include a range of indicators[44] that measure different aspects – some qualitative, others quantitative indicators and a few monetary ones. Each are needed to provide the whole picture of the benefits to the wide range of stakeholders interested in the benefits. Examples[45] include:

Qualitative:

- Self-reporting on wellbeing from recreation and sporting activity in nature.
- Stakeholder survey on sense of social exclusion, sense of place, and wellbeing surveys.
- Which minority groups make (greatest/least) use of access to nature possibilities?

Quantitative:

- Number of people accessing nature, number of (full time equivalent) jobs supported or created, numbers of volunteer hours.
- Level of reduction of noise, ambient temperature or air pollution due to green infrastructure measures.
- Increase level of sporting activities, weight reductions and reduce stressor levels in the blood.
- Reduced risks - of respiratory disease, type-2 diabetes.

[44] To do: integrate wider agenda on Beyond GDP and well-being indicators as part of high level stats reporting
[45] To do: add in examples of where used as this anchors it more for readers.

Monetary

- Revenue streams and cost-benefit ratios from investments to underline the business case for action (ideally complemented by the wider picture of multiple benefits)
- Avoided or reduced treatment costs from nature-based solutions where they replace other treatments – to underline the saving potential of preventative care, or treatment.
- Avoided unemployment benefits cost from increased employment - to communicate the potential savings to public budgets.
- Turnover of nature based healthy aging activities, green roof investments – to demonstrate the importance of new markets.

Ideally, the above would be spatially explicit – i.e. linked to specific communities and activities and linkable to specific measures or parks.

The above information needs to be built on solid biophysical, ambient, medical, social, economic data to ensure robustness and relevance. **Investment in spatial mapping and modelling can be useful** (e.g. for heat, air pollution, noise maps and green infrastructure coverage, and links to population and use levels); in time investment in natural capital accounts linked to social statistics could prove useful.

Who does the assessment can be as important as what the assessment say. For example, assessments on health improvements, health cost savings or job creation potential is developed, are often taken more seriously if carried out by an independent reputed organisation, such as a university department.

In summary, multiple criteria are needed to present the whole picture, with different elements of pertinence to different stakeholders.

Communication and awareness

Improved communication helps, but often helps most if done by the right people namely those who are perceived as being independent. **It is therefore important to identify what analysis should be carried out, who undertakes the analysis and to whom it is communicated.** In the Emscher Region case, the benefits of regeneration were analysed independently by researchers, to ensure that decision-takers and the wider public took the outputs seriously.

In case of national parks and other protected areas, visitor surveys (and web-based surveys) can be helpful to identify the social, psychological and physical benefits as well as the economic value. If these are carried out and published in peer-reviewed journals, they can contribute to the literature on the health-social-nature benefits, helping to develop the evidence base. Coast watch activities that monitor beaches, the level of marine litter and the effect of volunteer schemes, can also be helpful to communicate the scale of the problem and the possible solutions, while encourage individuals to change their behaviour and become further engaged.

Financing change

Financing ensures the progress and the sustainability of initiatives. At the EU-level, sources of funds include the Cohesion/Structural Funds, LIFE (Financial Instrument for the Environment) funding for nature protection, H2020 funding for research, and the European Territorial Cooperation (ETC) and European Neighbourhood Instrument (ENI) funding for transboundary cooperation, as well as the Natural Capital Financing Facility of the European Investment Bank. The most frequent funding for initiatives promoting health and social benefits originates from the national, regional, and city level, with some contributions from private sources. Often initiatives blend a range of funding sources.

For example, KlimaAtlas in Stuttgart received city funding and EU-wide research funding. The city also supported investments by private individuals for green roofs. In Finland, Moved by Nature was 75 % funded by the European Social Fund (ESF) and complemented by private and public organisations funds. While Wales is a recipient of significant contributions of EU funds, the Pembrokeshire Walkability case received money from the National park itself and the Welsh government. Private sector companies can also be involved, as in the case in Slovenia where a mobile phone company invests in the Saltpans, similarly to how private companies have invested in green roofs in cities across the EU.

Financing options: What EU funds are available?

A range of EU funds provides opportunities for financing initiatives promoting health and social benefits of nature. Key funding opportunities are outlines below, with the case studies included in this report providing concrete examples of existing projects.

Structural and Cohesion Funds: European Fund for Regional Development (ERDF), European Social Fund (ESF) and Cohesion Fund (CF) provide financial support to initiatives enhancing social and economic cohesion and sustainable regional development in the EU. Support can be provided to projects supporting the protection of biodiversity, ecosystem services and related green infrastructure. Under these funds health and social benefits of nature can be linked, for example, to the mitigation of and adaptation to climate change, promoting and developing cultural heritage (e.g. Natura 2000 sites) and integrating nature into broader plans to regenerate deprived urban and rural communities.

European Territorial Cooperation (ETC) under ERDF: In the context of ERDF, dedicated support is also envisaged to support cooperation between different EU regions, including cross-border, transnational and interregional cooperation. Cooperation in the context of ETC is relevant for financing a range of cross-border and transnational initiatives for biodiversity conservation and green infrastructure, e.g. possible initiatives linked to health and social benefits of nature. ETC can, for example, support capacity building and information sharing between authorities responsible for cross-border sites or help to integrate nature-related opportunities into macro-regional strategies for sustainable development.

European financial instrument for the environment (LIFE): The EU LIFE fund provided dedicated funding for the protection of biodiversity, ecosystems and related ecosystem services in the EU. Grants are made available for, for example, pilot, demonstration and best practice projects with possible focus on promoting synergistic solutions between biodiversity conservation and health and social wellbeing.

EU framework Programme for research and innovation (Horizon 2020): Horizon 2020 supports

transnational research in a range of priority areas (e.g. environment). Theme-specific calls related to the conservation and sustainable use of biodiversity, ecosystems and related ecosystem services could provide opportunities for further developing the evidence base on nature's health and social benefits and developing innovative solutions for taking up these benefits in practice.

European Agricultural Fund for Rural Development (EAFRD) and European Maritime and Fisheries Fund (EMFF): Among other things, EAFRD and EMFF support the protection and sustainable use of agricultural, forest, and marine and coastal ecosystems. Opportunities are made available, for example, for managing Natura 2000 sites, diversification of livelihoods in rural communities, enhancing business development and promoting organic farming. Such opportunities can be linked to nature's role in delivering health and social benefits, such as linking the management of Natura 2000 sites with the delivery of health related co-benefits.

European Neighbourhood Instrument (ENI): ENI supports, among other things, social and territorial cohesion, rural development, climate action and disaster resilience between EU and its neighbouring countries. Depending on the partner country priorities, opportunities might be available for supporting environmental and nature conservation, with possible links to be made with promoting nature's health and social benefits.

European Fund for Strategic Investments (EFSI): By means of loans, guarantee and other instruments, the EFSI aims for mobilising additional, economically viable investments across the EU. Funding is available for the private sector, including SMEs, but also for public sector entities. A number of investments yielding economic benefits e.g. into green infrastructure as discussed throughout this report could potentially be eligible.

It is to be noted that, as a majority of the above EU funds operate according to a programming process with shared management of funds between the EU and Member States, the concrete opportunities for nature, health and social wellbeing related initiatives depend on the national and regional priorities identified in fund-specific programmes.

Based on Kettunen et al. 2015

Making use of windows of opportunity and developing new windows

Progress with health-social-nature synergies can be incremental (e.g. gradual replication of projects that work) or more of a step change (e.g. with either qualitative changes such as through a new policy or plan or large quantitative changes such as via a new funding line or prioritisation). The latter generally occur when specific "windows of opportunity" are made use of – whether planned (e.g. budget debate) or unplanned (e.g. environmental crisis).

Windows of opportunity in EU, national and local decision-making are key moments to make steps forward, for example, on financing rules such as EU Cohesion Policy regulations, regulation reviews, public consultation on strategies and plans, mid-term evaluations and local and national budget declarations. In addition, there are regular windows of opportunity through private investment or procurement decisions, e.g. health and social services and cities. At the global level, windows of opportunity include the Conference of Parties (COPs) linked to the Conventions (e.g. CBD, UNFCCC) and the Sustainable Development Goals. There can also be windows of opportunity following on from external events such as heat events or air pollution peaks.

Making use of Cohesion Policy funding opportunities

There is a major opportunity to Improve the integration of health-social-nature projects in EU Structural and Investment funds. There is not only a specific objective on nature/environment under the current programme (Objective 6: Protecting the environment and promoting resource efficiency), but also a clear link to a range of other priority objectives:

- Objective 1 - Strengthening research, technological dev. & innovation
- Obj. 4: Shift towards a low-carbon economy in all sectors
- Obj. 5: Promoting climate change adaptation, risk prevention
- Obj. 7: Promoting sustainable transport
- Obj. 10: Investing in education, skills and lifelong learning
- Obj. 11: Enhancing institutional capacity & an efficient public administration

A guide on the role of natural capital in meeting Cohesion objectives has been produced by DG Regio (IEEP et al., 2014). However, more needs to be done at the Partnership Agreement (PA) level, at the level of the Operational Programmes (OPs) to ensure that there are formal hooks for nature-based solutions. In addition, there is a need to raise awareness further on the health-social-nature projects that can meet Cohesion objectives, such that there is a bottom-up demand to use the funds for nature-based solutions. Furthermore, at a practical level, integration can also be supported by ensuring that "health" and "nature" are clear categories for project selection and for project search engines.

It is also possible to develop new windows of opportunity – e.g. passing new laws on green roofs, launching and publishing research, or simply making use of marketing opportunities for business (e.g. urban offsetting and green roofs; zero emissions hotels as in Vienna). There can also be other measures such as fiscal reform – for example, German wastewater fees provide incentives for green roofs.

Tackling risks

The way forward is not just about focusing on the benefits and synergies nature can provide to people's health and social wellbeing, but **also about understanding and addressing the possible risks hindering the uptake of these benefits**. These include for example **social risks** (e.g. delinquents in parks) – which can be addressed by maintaining quality and keeping the park well lit; **health risks** (e.g. tick-borne diseases in certain high risk areas; allergic reactions to certain plants) – which can be addressed through risk management processes (awareness, response facilities); and **environmental risks** (e.g. degradation of nature and green areas due to inappropriate or over-use of areas) – which can be addressed by mapping, zoning, information provision and training.

Champions and collaborations to make it happen

Champions drive forward change and it is important to identify who these can and need to be and bring them on board. They could be **public representatives** with climate change strategies, regions with regeneration ambitions, local citizen groups, doctors and hospitals, as well as Members of Parliament. In Stuttgart, the Lord Mayor helped drive the KlimaAtlas project and subsequent investment in greening the city. In Sweden, the Alnarp case included a wide range of champions from the region, including academia, medical practitioner, politicians and the farming community. This helped to create joint ownership of both the problem and the solution.

How can the transferability of good practice be catalysed?

There is major scope for building on the good practice in some sites, cities and regions in other parts of Europe. A large change can be built on small local initiatives.

The role of cities is particularly important as a multiplier and existing networks, coalitions, events (e.g. resilient cities, Covenant of Mayors) and prizes (e.g. Green City and Greenleaf) can be critically important. The integration of the health-social-nature links into the range of strategies and plans can in themselves be examples of good practice to others, and important drivers for rolling out good practice in their own jurisdiction. The Committee of the Regions use of network of regions have the potential to multiply change in others. Within cities, more **engagement with communities** is needed to help **facilitate access and use of the natural environment**. Practice has shown that making available the infrastructure is not enough, proactive investment in social capital is needed to encourage actual use.

Protected area managers are already trying to build on the lessons from sites across a range of countries to the wider network of 27,393 Natura 2000 sites, supported by green, social and health NGOs. This indicates that the framework(s) for protected area governance – including existing links to a range of different stakeholders - can provide a good basis for collaborative initiatives and projects around the health-social-nature nexus.

The role of protected area managers: roles and opportunities

Existing examples show that individual initiatives linked to the health and social sector are often initiated by protected area managers, with policies and funding supporting such initiatives playing an important role in supporting the development process.

A range of different partners are collaborating with protected area and Natura 2000 site managers including, for example, representatives of research and academia, regional and urban planners, public health sector, youth sector, organisations engaged with sports and outdoor activities, businesses linked to health and wellbeing and stakeholders working in the context of social inclusion (e.g. special needs groups, groups working with immigrants and correctional facilities). This indicates that protected areas provide a suitable framework for cooperation with a wide variety of stakeholders.

The possible funding sources for the collaborative initiatives between protected area managers and other stakeholders also vary. However, it appears that – as with Natura 2000 management in

general - public funding (e.g. EU funds) is the most common source of funding. The experience of protected area managers in accessing different funding opportunities, including more innovative means for funding, can be considered one of the strengths in successfully championing the concrete uptake of nature's health and social benefits.

Finally, a range of factors can identified to play a role in successfully integrating health and social aspects into protected area management, with benefits to both the conservation and health sectors. Stakeholder engagement early on in the process, good coordination and communication of outcomes, adaptive approach to management and securing long-term funding appear to be among the key aspects.

Citizens are also grass-roots drivers of change. From investing in green roofs, initiatives that replace pavements with plant creepers, to green walls; these each support community identity. They can also engage with communities to help them make use of nature, or engage directly in nature, for example volunteering to support beach clean ups or keeping public parks tidy, which can further support use. Citizens can also play a participatory role to ensure **inclusive access to nature for all citizens** since the benefits from nature are realized through repeated use.

Business can also recognise the benefits of action and roll out initiatives to take advantage of these benefits, whether for savings or for marketing purposes.

Countries remain arguably the most important actors in driving health-social-nature synergies given their responsibility for health –by enabling measures such as policies, strategies, plans and funding for research and investment that can build on lessons from other practice and in turn create more cases to emulate.

The role of countries in a Road Map

Health and social policies are largely an area of national policies across the EU. Health and social strategies are developed largely at the national level and offer an opportunity of integrating the role of nature areas, including protected areas, and wider green infrastructure for pursuing health and social objectives. This report identified some examples from the EU such as in Belgium, Finland or Northern Ireland, where cross-sectoral governance structures exist, bringing together government departments in charge of health and environment. There exists scope for further strengthening such cross-departmental collaboration in many member states of the EU.

Finally, **the EU** remains a critically important driver for transferring good practice and catalysing change – whether through the leverage it has in its funding i.e. getting maximum EU added-value and policy coherence by using the EU sectoral policies as means to implement EU biodiversity goals (e.g. Birds and Habitats directives, restoration targets and green infrastructure strategy; Water Framework Directive) and supporting information, awareness and knowledge (e.g. MAES process and H2020 funding). In some cases, the EU has a legal basis for policy action. In others, funding or softer mechanisms are used, such as

the European Semester process whereby country practices are compared against agreed objectives and recommendations are made for what more can usefully be done in light of lessons learnt across the Union.

The role of the European Union

While health and social policies are a domain of the member states, the European Union can play a supporting role for many aspects covered in this Road Map. Policies and legislation at EU level should be consistent and allow for considering health and social concerns in nature protection, while pursuing biodiversity objectives. Conversely, biodiversity related actions at EU level could be screened systematically for opportunities to realise health and social co-benefits. Similar opportunities could be sought in other legislation such as the Water Framework Directive or the Marine Strategy Framework Directive.

A number of opportunities also exist within current funding programmes. One immediate and practical suggestion would be improve the integration of health-social-nature projects in European Structural and Investment Funds and in LIFE+ funding by ensuring that "health" is a category for project selection and for project search engines. A review of existing funding opportunities under Horizon 2020 is advisable as well, to ensure that funding opportunities for research looking at the health-social-nature synergies exist and can be identified easily by the research community.

There is no "best solution" or "most important actor" for transferring practice, but rather a need for action at each of the governance levels by each of the stakeholders to ensure that good practice inspires more initiatives so that the health-social-nature synergies can come to fruition (see Synthesis Table 14.1).

Table 13.1: Health & Social Benefits of Nature Roadmap: role of stakeholders, policies and measures: Examples

	Knowledge – understanding the problem and solutions	Awareness and integration of knowledge	Policy, objectives, strategies and plans	Instruments, measures, legislation	Financing and investment
Global	**WHO & impacts; CBD and solutions**	**WHO with UNFCCC, UNCBD, UNCSD; SDG and nature links**	**CBD (Aichi targets); UNFCCC (e.g. 1.5o C Paris); SDGs**	**Conventions, Protocols**	**Climate adaptation funds; GEF**
EU	MAES – mapping RTD (H2020 calls) Policy studies (DGs Clima; Env; Regio; Mare; Empl, Sante) SPI networks	Guidelines for Nat. Cap. solutions (e.g. e.g. Cohesion Policy, CP); Use of proofing tools (e.g. for biodiversity, health and social benefits across policies and programmes)	Biodiversity & GI strategies; CP rules recognise climate adaptation, health & social benefits of nature; Climate strategies integrate nature; Heath & Environment strategy; Europe 2020 Strat. (employment, R&D)	Birds & Habitats Directives; Water & Marine Stewardship Framework Directives implementation; European Semester recommendations	CP funding; LIFE (ensure health link); ENPI; TEN-GI (ensure health link); NCFF & EIB; EFSI & the Investment Plan for Europe; Development cooperation
National	National research (e.g. epidemiological studies, links to effectiveness of measures); monitoring and mapping; biophysical ecosystem capital accounting; practical case study development	Assessing the value of pre-emptive health care (e.g. of avoided air pollution or exercise); Assess the range of health and social services from nature	Integration of nature in regional development, climate adaptation, health, and noise strategies and plans, as well as in Partnership Agreements linked to EU CP & associated national & regional operational programmes (OPs)	Designation of institutional responsibilities; Inter-ministerial coordination; Building codes (e.g. min. green space requirements, green roof legislation)	Environmental funds grants, loans, green public procurement & improve incentives
Regions & Cities	Climate/heat, air pollution and noise monitoring and mapping; Tree and population mapping; Carry out "access to nature" and vulnerability assessments	Independent valuation of benefits to support action; Awareness raising; Heat emergency plans	Integration of nature (e.g. synergies with biodiversity conservation objectives) in urban development / regeneration, climate adaptation, health, noise and green infrastructure strategies; Integration of health and social benefits into GI strategies	Pilot projects (for scaling up); Zoning (e.g. for land use types); Law (e.g. enabling pavements to be dug up by local residents to plant creepers/green walls)	Investing in parks, tree lined streets, green roofs, with dedicated biodiversity objectives where appropriate; Finance activities to get citizens out to nature
Private Sector	Assessment of noise, pollution and cooling benefits of green roofs and walls and multiple benefits of landscape architecture and planning	Integrate into management systems; Accounting and reporting; Communicate effectiveness of solutions	Opportunities for citizens to buy into reforestation / greening schemes; into green roofs	Support to pilot projects from e.g. health insurance and care providers; partnerships	Building: Investment in green roofs and green walls
Protected area managers	Assess the potential for the parks to be useful and used for health and social benefits; Identify health & social stakeholders to collaborate with	Communicate benefits across the network, to local stakeholders and wider health & social stakeholder networks	Where appropriate (i.e. synergetic with the delivery of set conservation objectives), integrate nature and social benefits into management plans and use of investments (e.g. to improve access and information)	Recruitment e.g. permanent health wardens; Programmes for training volunteers	Targeted own investment when available; targeted support from external sources (e.g. national and EU funds) and blending funding from different instruments as suitable
Civil Society & Citizens	Identify vulnerable groups & needs of groups to make use of nature (i.e. access to use)	Communicate risks and opportunities for action/initiatives	Collaborate e.g. with local, regional authorities in contributing to strategies and plans	Tree ownership programmes; bonds	Own investment in green roofs, urban farming, planting pavements
Research	Provide robust research: on heat island reduction through nature; also for air pollution, noise, mobility and social justice benefits from access to nature	Expert groups supporting evidence-based policymaking	Research strategy on health-social-nature synergies; Research into nature's roles in the transition to an green economy	Funding grants; field experiments; networks for expertise; education and training	Research and training grants (e.g. EU Horizon 2020); finance collaborative research centres

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