

**PERFECT**  
**expert paper 1**



# health, wealth and happiness – the multiple benefits of green infrastructure



By Erin Gianferrara and Janine Boshoff  
eftec

Foreword by Ece Ozdemiroglu  
eftec and Member of the Adaptation Sub-Committee of the  
UK Committee on Climate Change

PERFECT Project – Planning for Environment and Resource efficiency in European Cities and Towns

PERFECT Expert Paper 1: *Health, Wealth and Happiness – the Multiple Benefits of Green Infrastructure*

By Erin Gianferrara and Janine Boshoff

Erin Gianferrara is a Consultant and Janine Boshoff is a Researcher with eftec (Economics for the Environment Consultancy). This Expert Paper has been prepared on behalf of the PERFECT project.

Copyright © The TCPA and the PERFECT Project Partners  
Published by the Town and Country Planning Association, June 2018

Cover illustration; Yelizaveta Tomashevskaja/iStock

This Expert Paper reflects only the authors' views, and Interreg Europe is not liable for any use that may be made of the information contained therein.

## About eftec

eftec conducts sound economic analysis, measuring what is conventionally overlooked. Since 1992, it has been providing comprehensive, high-quality and clear evidence to support decision-making. It believes that economic thinking can be put into good use for the environment and humankind now and in the future. In addition to the core team, eftec works with a network of individual associates and organisations to ensure it can form the team with the most appropriate skills and experience for each project. For more information about eftec's team, services and projects, visit the eftec website: <http://www.eftec.co.uk>

## About PERFECT

PERFECT (Planning for Environment and Resource efficiency in European Cities and Towns) is a five-year project, running from January 2017 to December 2021, co-funded by Interreg Europe. It aims to demonstrate how the multiple uses of green infrastructure can provide social, economic and environmental benefits. It will raise awareness of this potential, influence the policy-making process, and encourage greater investment in green infrastructure.

To find out more about PERFECT, visit <http://www.interregeurope.eu/perfect/>  
Or contact: Henry Smith, Project Manager – PERFECT,  
TCPA, 17 Carlton House Terrace, London SW1Y 5AS, United Kingdom  
e: [henry.smith@tcpa.org.uk](mailto:henry.smith@tcpa.org.uk) t: +44 (0)20 7930 8903  
Follow the project on Twitter: [#perfect\\_eu](https://twitter.com/perfect_eu)



# health, wealth and happiness – the multiple benefits of green infrastructure

By Erin Gianferrara and Janine Boshoff  
eftec

## Contents

- 2 Foreword
- 3 Introduction
- 7 Green infrastructure benefits for mental health
- 9 Green infrastructure benefits for physical health
- 11 Air quality regulation and health benefits
- 12 Noise mitigation and health benefits
- 13 Conclusions

# Foreword

Contrary to popular opinion, economics is essentially about human health and happiness, or wellbeing. Income and wealth are important determinants of wellbeing, but by no means the only ones. Living in happy and safe societies, and in clean and pleasant environments, is just as important. Unfortunately, while our desire to be healthier and happier is endless, what makes us healthier and happier is usually in short supply. This mismatch between the goals and means is what keeps us economists busy: how to allocate limited means to their various uses to sustain wellbeing.

This challenge is nowhere greater than in urban areas, where increasing human populations means increasing demand for vital services provided by green infrastructure – for example, looking for some rest and rejuvenation in parks and open spaces, which are under pressure from air pollution, urban heat impact, noise, encroaching development, and declining funding from public budgets.

There is increasing evidence on how green infrastructure benefits human wellbeing. The evidence also shows that, with proper public funding and private finance, the potential to increase these benefits is significant. This Expert Paper, produced for the PERFECT project, showcases some of this evidence, focusing on mental and physical health benefits due to recreation, and reduced air and noise pollution due to urban vegetation.

The evidence comes from environmental, health and economics research showing that any argument in favour of investing in green infrastructure needs to be a multi-disciplinary one. Building on other evidence, economic analysis highlights how much money society saves by investing in green infrastructure – for example, avoided medical expenditure, days off work, and pain and suffering. There are many other ways of making such economic arguments, including improved property prices, staff retention, avoided heating or cooling costs, or avoided flood risk management. Most of the evidence is convincing but hidden from decision-making that relies on financial analysis. We hope that the days when evidence of wellbeing benefits is viewed as being just as important as financial returns are not too distant.

## **Ece Ozdemiroglu**

Eftec

Member of the Adaptation Sub-Committee of the UK Committee on Climate Change

# 1 Introduction



IR\_Stone/Stock

Green infrastructure is the term used to describe networks of green spaces and features such as parks, green roofs, green walls, verges, street trees, rivers and waterways (often called 'blue infrastructure') designed and managed to deliver a range of benefits. It is a type of natural capital,<sup>1</sup> a key aspect of our cities, towns and villages, and, in fact, is vital to our very health and wellbeing.

At the EU level, critically important green infrastructure policies include the Birds and Habitats Directives that underpin the Natura 2000 network of over 27,000 protected areas, the EU Green Infrastructure Strategy, the Biodiversity Strategy to 2020 (including the 15% restoration target it sets), cohesion policy, and research and innovation policy.

Despite the support of these policies, making the investment case for green infrastructure has been difficult in practice. One reason for this difficulty is that it has long been hard to measure and/or quantify the functional capacity that green infrastructure provides in terms of performing its role as 'infrastructure'. Green infrastructure also provides environmental, social and economic benefits (see Box 1) that historically have not been easy to quantify and value. Investment in green infrastructure can require (often high) up-front costs, while delivery of the benefits may come later in the project time-horizon – and not always in terms of a clear financial return, at least not directly. The result is that, in many cases, green infrastructure is under-funded, opportunities to improve human health and wellbeing are missed, and beneficial environmental, social and economic outcomes are forgone.

---

1 The elements of nature that directly and indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions' – in *Towards a Framework for Measuring and Defining Changes in Natural Capital*. Working Paper 1. Natural Capital Committee, Mar. 2014, p.5. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/516946/ncc-working-paper-measuring-framework.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/516946/ncc-working-paper-measuring-framework.pdf)

## Box 1

### Benefits of green infrastructure

Investing in green infrastructure generates:

- **environmental outcomes** – such as improved air quality and associated improvements to health;
- **social outcomes** – such as increased community engagement and associated improvements in mental health; and
- **economic outcomes** – such as improvement to the ‘sense of place’ or ‘attractiveness’ of an area and associated increases in property values.

Foregoing these outcomes results in welfare losses and increased costs to society through increased environmental, social, and medical costs.

Although grey infrastructure solutions are often preferred as they are seen as tried and tested, in fact, green infrastructure should be the preferred option for decision-makers seeking to enhance wellbeing, alleviate social and budgetary pressures, and to ensure more efficient allocation of public resources.

The timing for greater incorporation of green infrastructure within policies, projects and programmes has never been better. Environmental and social issues are at the forefront of public concern, linking to both climate change targets<sup>2</sup> and the UN's Sustainable Development Goals.<sup>3</sup> Importantly, there is now enough evidence to support the case for green infrastructure for multiple health, social and environmental outcomes.

Green infrastructure offers the ultimate opportunity to facilitate ‘thinking globally, acting locally’, a phrase brought about to call people to take environmental action by driving change locally, without waiting for global legislation. If we use Europe as an example, air pollution is the largest environmental health risk, and the World Health Organization (WHO) estimates that the annual economic burden of health impacts from air pollution is in excess of 1 trillion euros.<sup>4</sup> Noise pollution is considered the second largest environmental health issue in Europe, with the WHO estimating that 40% of the population in EU countries are exposed to road traffic noise exceeding recommended levels.

When making a case for green infrastructure, three types of evidence are needed and useful in their own right or in combination:<sup>5</sup>

- **qualitative evidence** – scientific understanding, expert judgment, anecdotal evidence or qualitative social research that demonstrates the links between green infrastructure and its benefits for human health and wellbeing, such as outdoor activity, aesthetics, cleaner air, and reduced flood risk and noise;
- **quantitative evidence** – measurements of the quality and quantity of green infrastructure and its benefits, such as changes in the number of properties affected by flood risk, in air quality, in ambient temperature (reduction in the heat island effect), in noise levels and in bird counts, the numbers of visitors to a new park, and

2 See the EU's ‘Climate strategies and targets’ webpage, at [https://ec.europa.eu/clima/policies/strategies\\_en](https://ec.europa.eu/clima/policies/strategies_en)

3 See the UN's Sustainable Development Goals website, at <https://www.un.org/sustainabledevelopment/>

4 *Economic Cost of the Health Impact of Air Pollution in Europe: Clean Air, Health and Wealth*. World Health Organization Regional Office for Europe, 2015. [http://www.euro.who.int/\\_data/assets/pdf\\_file/0004/276772/Economic-cost-health-impact-air-pollution-en.pdf](http://www.euro.who.int/_data/assets/pdf_file/0004/276772/Economic-cost-health-impact-air-pollution-en.pdf)

5 For example, qualitative evidence is necessary to understand what kind of quantitative evidence can be collected, and both qualitative and quantitative evidence are necessary to estimate economic (monetary) value

Box 2

## Valuation techniques

Three types of data are used for the monetary valuation of environmental benefits: market prices, observed consumer behaviour (revealed preference), and individuals' statements of value (stated preference). Methods developed to analyse such data are summarised in the table below. Where it is not possible to undertake research using these methods, economic value estimates from the literature can be used. The process of selecting and, where necessary, adjusting these estimates is called value transfer (also known as 'benefits transfer'). It is typically a quicker and lower-cost approach to generating economic valuation evidence compared with commissioning new research. This makes value transfer a practical tool for project appraisal. However, informed judgements are required as to when value transfer can be used and the level of effort that is appropriate. In the UK the government has developed specific value transfer guidance<sup>i</sup> to aid in its use.

Market prices	Revealed preferences	Stated preferences
<p>Valuation using market prices considers the purchases people make for direct consumption.</p> <p><b>Example:</b> We can look at how much food, water, timber, fuel, minerals, etc. people buy (and at what price) either for direct consumption or to use as an input to production. We could then observe how these purchases change in response to changes in the quality and quantity of the goods and services.</p>	<p>Valuation using revealed preferences considers the purchase of market goods or services that substitute for or complement environmental goods and services.</p> <p><b>Example:</b> We can observe the amount that people spend on travelling (for example in terms of fuel spend, entry fees, time) to a beautiful landscape for recreation. What they pay to travel is at least how much they value the recreational benefit, otherwise they would not make the trip. Data collected on the number of visits and travel costs can be analysed to estimate the demand for the recreational benefits of a site. This method is known as the travel cost method.</p>	<p>Where we cannot observe individuals' behaviour in existing markets, we design questionnaires that elicit people's preferences for environmental goods and services. These questionnaires in effect create hypothetical markets in which respondents can make choices about changes to the quality and quantity of the environment.</p> <p><b>Example:</b> We can conduct a survey where respondents have a limited budget to spend on different options that improve bathing water quality, greater biodiversity, or cleaner air.</p>

<sup>i</sup> *Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal*. Economics for the Environment Consultancy (eftec), for the Department for Environment, Food, and Rural Affairs, Feb. 2010. <https://www.gov.uk/government/publications/valuing-environmental-impacts-guidelines-for-the-use-of-value-transfer>

Source: Adapted from R Hails and E Ozdemiroglu (Eds): *Demystifying Economic Valuation*. Valuing Nature Paper VNP04. Valuing Nature Programme, Jun. 2016. <http://valuing-nature.net/sites/default/files/images/VNN-Demystifying%20Economic%20Valuation-Paper.pdf>

the number of businesses relocating to an area and the number of people they employ; and

- **economic evidence** – the economic (monetary) value of the benefits of green infrastructure, measured through visitor spending, the premium paid for homes in greener and cleaner locations, the reduction in medical expenditure due to improved health, income from new businesses, and individuals' willingness to pay for such benefits (see Box 2).

All three types of evidence can be found in the literature. Social research focuses on the physical and mental health benefits of green infrastructure;<sup>6</sup> as well as on associated behavioural changes such as reductions in crime and anti-social behaviour<sup>7</sup> and improvements in educational and skills attainment).<sup>8</sup> Economic research uses data from actual markets such as tourism and leisure and property, and data from surveys of individuals exploring their preferences and willingness to pay for the benefits of green infrastructure.

This Expert Paper provides some evidence on the human health benefits of green infrastructure – in particular, mental and physical health benefits, and health benefits arising from reduced air and noise pollution due to green infrastructure are considered.

---

6 I Alcock, MP White, BW Wheeler, LE Fleming and MH Depledge: 'Longitudinal effects on mental health of moving to greener and less green urban areas'. *Environmental Science & Technology*, 2014, Vol. 48 (2), 1,247-55; and MP White, I Alcock, BW Wheeler and MH Depledge: 'Would you be happier living in a greener urban area? A fixed-effects analysis of panel data'. *Psychological Science*, 2013, Vol. 24(6), 920-28

7 FE Kuo and AF Taylor: 'A potential natural treatment for attention-deficit/hyperactivity disorder. Evidence from a national study'. *American Journal of Public Health*, 2004, Vol. 94 (9), 1580-86

8 K Taylor: *Natural Inspiration: Learning outside the Classroom*. The Wildlife Trusts, 2007

# 2 Green infrastructure benefits for mental health



ablokhin/iStock

Mental health is becoming an increasingly important public health issue, with unipolar depressive disorders being the leading cause of disability in middle- and high-income countries and predictions that depression and depression-related illness will become the greatest source of ill-health by 2020.<sup>9</sup> Besides the obvious impact on quality of life, mental health illnesses have a significant negative impact on the public health system and economic productivity.

There is increasing evidence from medical research that improving access to green space is a cost-effective, but often neglected, way of avoiding mental illness or speeding recovery from it. For example, various studies have found that natural environments are generally associated with better mental health, including psychological wellbeing, perceived mental health,<sup>10</sup> stress, anxiety symptoms,<sup>11</sup> and depression.<sup>12</sup> With approximately 78% of the population in the developed world residing in urban areas, targeted social spending to improve mental health could involve making a concerted effort to improve urban dwellers' access to green space.

White *et al.*<sup>13</sup> studied how the density of green space in urban areas impacts self-reported mental health across England. Using these findings, the Greater London Authority (GLA)

- 
- 9 World Health Report – *Mental Health: New Understanding, New Hope*. World Health Organization, 2001. <http://www.who.int/whr/2001/en/>
- 10 I Alcock, MP White, BW Wheeler, LE Fleming and MH Depledge: 'Longitudinal effects on mental health of moving to greener and less green urban areas'. *Environmental Science & Technology*, 2014, Vol. 48 (2), 1,247-55
- 11 K Beyer, A Kaltenback, A Szabo, S Bogar, FJ Nieto FJ and KM Malecki: 'Exposure to neighbourhood green space and mental health: evidence from the survey of the health of Wisconsin'. *International Journal of Environmental Research & Public Health*, 2014, Vol. 11 (3), 3,453-72
- 12 R Reklaitiene, R Grazuleviciene, A Dedele, *et al.*: 'The relationship of green space, depressive symptoms and perceived general health in urban population'. *Scandinavian Journal of Public Health*, 2014, Vol. 42 (7), 669-76
- 13 MP White, I Alcock, BW Wheeler and MH Depledge: 'Would you be happier living in a greener urban area? A fixed-effects analysis of panel data'. *Psychological Science*, 2013, Vol. 24 (6), 920-28

calculated the mental health benefits of living in an urban area with more green space to be around 48 euros per person per year,<sup>14</sup> representing a 2.2% saving in terms of mental health costs. While this may not appear to be a significant amount, it quickly adds up: GLA estimates mental health savings of £17 billion per year for the entire Greater London population. Importantly, the GLA findings also highlight the uneven distribution of green space across London boroughs. Suburbs or boroughs with access to a large park benefit disproportionately from improved mental health outcomes, while parts of Central London face the challenge of providing sufficient green infrastructure in the most densely developed areas of the city. This naturally raises questions about the benefits associated with green infrastructure. Are mental health benefits only associated with green infrastructure of a particular size? Do urban populations miss out on the benefits of extensive green space?

Research based on interview data from the 2010-12 Catalonia Health Survey (in Spain) attempted to answer these questions. The researchers<sup>15</sup> made the distinction between access to green space and surrounding 'greenness', and attempted to identify whether the degree of urbanisation had an impact on mental health. Access to green space was characterised by residential proximity to forests, country parks, green urban areas, and agricultural land and pastures; whereas surrounding greenness accounted for features such as street trees or pavement grass along pedestrian walkways. In both cases, proximity was defined as a circular 300 metre buffer around the geocoded address for each participant.

The results show that while both access to green space and surrounding greenness were associated with improved mental health, the beneficial impact was statistically significant for surrounding greenness. The authors suggest that street trees, paths, greenways or gardens represent more effective opportunities for restoration or stress reduction. They argue that compared with nearby natural environments there are superior benefits from 'micro-environments', such as having a view of trees from a window or listening to birdsong. Similar results were found by research conducted in the Netherlands,<sup>16</sup> which made the case for small-scale infrastructure such as green corridors, urban commons, street trees, and pedestrian and cycling routes.

The mental health benefits of green infrastructure appear to have long-term benefits. Alcock *et al.*<sup>17</sup> used data from the British Household Panel Survey and the General Health Questionnaire to track the mental health and wellbeing of two sub-sets of respondents: those who moved to greener urban areas, and those who moved to less green urban areas. The analysis for each household spans five years, recording mental health two years prior to the move and three years following the move. The results for perceived mental health following a move to a greener urban area reflects a shifting baseline – this means that not only did the move to a greener area improve perceived mental health, but mental health remained at this newly improved level in the long term. This evidence suggests that an initial investment in green infrastructure could contribute to cumulative, long-term mental health benefits for the local and surrounding populations.

---

14 Taking the results at £42 and applying the current average exchange rates

15 M Triguero-Mas, P Davdand, M Cirach, *et al.*: 'Natural outdoor environments and mental and physical health: relationships and mechanisms'. *Environment International*, 2015, Vol. 77, 35-41

16 S de Vries, RA Verheij, PP Groenewegen and P Spreeuwenberg: 'Natural environments – healthy environments? An exploratory analysis of the relationship between greenspace and health'. *Environment & Planning A: Economy & Space*, 2003, Vol. 35(10), 1,717-31

17 I Alcock, MP White, BW Wheeler, LE Fleming and MH Depledge: 'Longitudinal effects on mental health of moving to greener and less green urban areas'. *Environmental Science & Technology*, 2014, Vol. 48(2), 1,247-5

# 3 Green infrastructure benefits for physical health



**PERFECT partners and stakeholders on a study visit in Ljubljana**

The benefits of improved physical health are well established, and research has attempted to further study the benefits of engaging in physical activity within green spaces. Various studies have proven that access to local, safe and natural green space can be a powerful motivating factor, as people who live in areas in close proximity to green space have a higher propensity to exercise.<sup>18</sup> Furthermore, access to green space not only helps individuals to sustain higher levels of physical activity, but such activity is also more likely to be sustained if it takes place in the natural environment.<sup>19</sup> Physical activity and exposure to nature are known separately to have positive effects on physical and mental wellbeing, and there is emerging research that suggests a synergistic benefit in adopting 'green exercise'.<sup>20</sup>

Perhaps one of the most significant social movements that proves the benefit of engaging in physical activity in green space is the establishment and rapid growth of Parkrun. Parkrun has become an international phenomenon, with approximately 3 million participants joining weekly events hosted in almost 1,500 parks<sup>21</sup> worldwide. Provisional findings from research conducted by Glasgow Caledonian University indicate that regular

---

18 A Jones, M Hillsdon and E Coombes: 'Greenspace access, use, physical activity and obesity: understanding the effects of area deprivation'. *Preventive Medicine*, 2009, Vol. 49 (6), 500-05; T Nielsen and K Hansen: 'Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators'. *Health & Place*, 2007, Vol. 13 (4), 839-50; and J Pretty, M Griffin, M Sellens and C Pretty: *Green Exercise: Complementary Roles of Nature, Exercise and Diet in Physical and Emotional Well-being and Implications for Public Health Policy*, CES Occasional Paper 2003-1. University of Essex, Mar. 2003. <https://pdfs.semanticscholar.org/f89f/0ab9c891b17164445bec9e37aad6fba1cdd5.pdf>

19 W Bird: *Natural Fit: Can Green Space and Biodiversity Increase Levels of Physical Activity?* Royal Society for the Protection of Birds, Oct. 2004. [http://ww2.rspb.org.uk/images/natural\\_fit\\_full\\_version\\_tcm9-133055.pdf](http://ww2.rspb.org.uk/images/natural_fit_full_version_tcm9-133055.pdf)

20 J Pretty, J Peacock, M Sellens and M Griffin: 'The mental and physical health outcomes of green exercise'. *International Journal of Environmental Health Research*, 2005, Vol.15 (5), 319-37

21 Statistics available from the Parkrun website, at <http://www.parkrun.com/>

participation in Parkrun significantly improves both health and wellbeing. Surveys conducted with more than 8,000 runners registered with Parkrun indicate that those who participate regularly score 4.4 on the Oxford Happiness Scale, which is above the average score of 4 recorded for the general population.<sup>22</sup>

There is also a strong evidence base linking physical health benefits to economic outcomes. The three most important economic benefits<sup>23</sup> arising from improved physical health have been identified as:

- cost savings to the public health system;
- increases in economic output due to reduced stress, ill health (morbidity) and absence from work; and
- increased economic output, attributed to a reduction in the incidence of premature death (mortality).<sup>24</sup>

Recent studies in the UK have linked physical activity undertaken within green spaces to these economic outcomes. For example, the UK's National Urban Natural Capital Account<sup>25</sup> estimated that nearly 2.1 million people use urban green spaces to undertake enough physical activity to reach recommended guidelines,<sup>26</sup> the value of which (in terms of avoided health care costs) was estimated at £900 million per year. On a local scale, the London Boroughs of Barnet and Barking and Dagenham undertook similar assessments to value physical activity in their publicly accessible green space at £19 million and £2 million per year, respectively. This evidence supports the case for investment in green infrastructure to increase physical activity, which in turn results in reduced costs to national health services.

---

22 J McGuire: 'Running makes you a happier person, new research confirms'. *Runner's World*, 25 Apr. 2018. <https://www.runnersworld.co.uk/health/running-makes-you-a-happier-person-new-research-confirms>

23 S Mourato, G Atkinson, M Collins, et al.: *UK National Economic Assessment: Assessment of Ecosystem Related UK Cultural Services*. UK National Economic Assessment Technical Report. UN Environment World Conservation Monitoring Centre, 2011

24 *Green Infrastructure's Contribution to Economic Growth: A Review*. Economics for the Environment Consultancy (eftec) and the Centre for Regional Economic and Social Research (CRESR), for the Department for Environment, Food and Rural Affairs and Natural England, Jul. 2013. <http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19056>

25 *A Study to Scope and Develop Urban Natural Capital Accounts for the UK*. Economics for the Environment Consultancy (eftec), for the Department for Environment, Food, and Rural Affairs, Jun. 2017. <http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19843>

26 The UK's Chief Medical Officer recommends 150 minutes of physical activity per week for adults

# 4 Air quality regulation and health benefits



Atmospheric pollutants such as sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), ammonia (NH<sub>3</sub>) and particulate matter (PM10 and PM2.5) are major contributors to both morbidity and mortality in urban areas. Green infrastructure can make an important contribution to health outcomes by absorbing some of these harmful pollutants.

A recent study in the UK<sup>27</sup> estimated the monetary value of air pollution absorbed by green infrastructure within urban areas using a comparison of two scenarios:

- 'current urban green and blue space', where green infrastructure within the defined area was classified into three broad categories (urban woodland, urban grassland, and urban fresh/saltwater); and
- 'no green/blue space', represented by replacing all existing vegetation with a neutral 'bare soil' cover.

The amount of pollutant absorption by vegetation was calculated by subtracting the 'no vegetation' scenario from the 'current vegetation'. The net absorption was valued by multiplying the quantity of pollutants with damage costs per unit of pollutant, reflecting the benefiting population at the local authority level for a range of avoided health outcomes:

- respiratory hospital admissions;
- cardiovascular hospital admissions;
- loss of life years (long-term exposure effects from PM2.5 and NO<sub>2</sub>); and
- deaths (short-term exposure effects from ozone).

The value of health outcomes avoided was estimated at over £200 million per year (for Great Britain), providing strong evidence linking urban green infrastructure to real improvements in air quality and significant health outcomes.

27 *A Study to Scope and Develop Urban Natural Capital Accounts for the UK*. Economics for the Environment Consultancy (eftec), for the Department for Environment, Food, and Rural Affairs, Jun. 2017. <http://scienceresearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19843>

# 5 Noise mitigation and health benefits

Environmental noise is considered the second-largest environmental health risk (after air pollution) in Western Europe,<sup>28</sup> and evidence suggests that noise is associated with hypertension,<sup>29</sup> impaired cognitive development in children,<sup>30</sup> and psychological stress.<sup>31</sup> As such, green infrastructure and its noise-mitigating properties have important health benefits in urban areas.

Recent work in the UK has explored the value of noise reduction by green infrastructure.<sup>32</sup> The study identified each vegetation type and classified it based on its characteristics: density, width, and height. Using estimates in the scientific literature, the vegetation in the urban area was assigned a noise reduction value (in decibels or dBA). The location and extent of the beneficiaries were identified using spatial noise maps for road and rail and population estimates. The study supports monetary valuation for changes in decibel levels for three possible impacts:

- **Amenity values:** The impact of a reduction in decibel levels on sleep disturbance and annoyance in terms of quality-adjusted life years (QALY), which is then multiplied by the monetary value of a QALY. Mitigating sleep disturbance requires a larger reduction in noise than that required to mitigate annoyance.
- **Health values:** The QALY impact of reducing strokes, dementia and heart attacks due to noise reduction using exposure and dose-response measures. In practice, the estimated values of strokes and dementia are combined to estimate the impact of noise on hypertension.
- **Productivity values:** A wage-based estimate of the productivity lost from days off due to disturbed sleep or lack of sleep. These values are only a partial measure since they do not take into account workers who are ill but still active in the workplace, or the scale of loss of productivity.

The study estimates the noise reduction benefits of green infrastructure to be around £60 million per year in Manchester alone.

---

28 *Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe*. World Health Organization Regional Office for Europe, 2011.

[http://www.euro.who.int/\\_data/assets/pdf\\_file/0008/136466/e94888.pdf](http://www.euro.who.int/_data/assets/pdf_file/0008/136466/e94888.pdf)

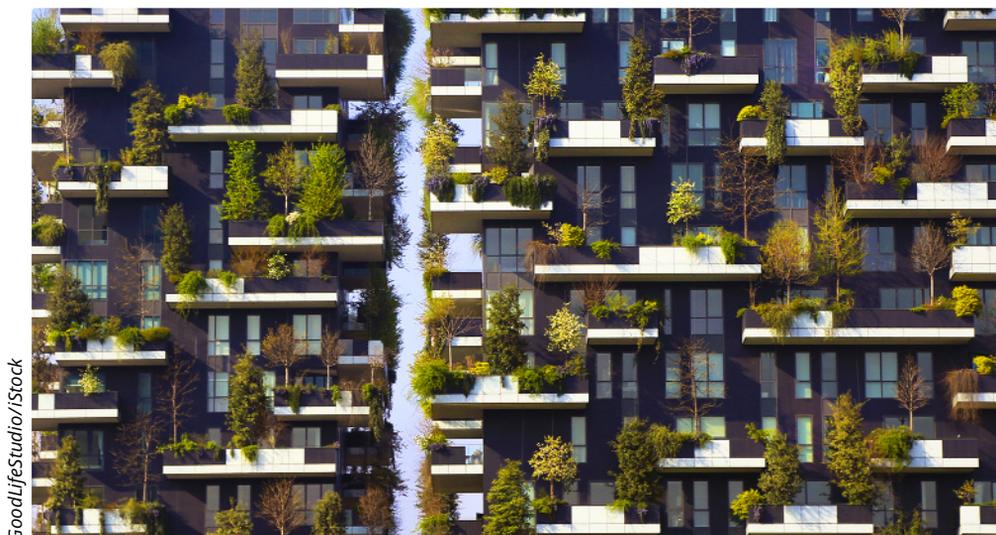
29 L Barregard, E Bonde and E Ohrström: 'Risk of hypertension from exposure to road traffic noise in a population-based sample'. *British Medical Journal*, 2009, Vol. 66(6), 410-15

30 S Stansfield and M Matheson: 'Noise pollution: non-auditory effects on health'. *British Medical Bulletin*, 2003, Vol. 68, 243-57

31 GW Evans, P Lercher, M Meis, H Ising and WW Kofler: 'Community noise exposure and stress in children'. *Journal of the Acoustical Society of America*, 2001, Vol. 109, 1023-27

32 *A Study to Scope and Develop Urban Natural Capital Accounts for the UK*. Economics for the Environment Consultancy (eftec), for the Department for Environment, Food, and Rural Affairs, Jun. 2017. <http://scienceresearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19843>

# 6 Conclusions



Although there are EU level policies that support green infrastructure, making the case for investment can still be difficult. To help in this endeavour there is now a strong evidence base to support the business case for green infrastructure, linking it to social, environmental and economic outcomes.

As the scientific evidence surrounding the links between the natural environment and our health and wellbeing grows, there are further opportunities to explore synergistic benefits. Actions to enable and facilitate the further development of nature-health synergies at all levels would include mapping, modelling and assessment of ecosystem condition in relation to health and social needs, increased research into health-social-nature synergies and risks, communication of the evidence of success, and engagement with communities to help facilitate access to and use of the natural environment.

Green infrastructure can continue to contribute to alleviating the global environmental health challenges at a local scale. This Expert Paper highlights the vast evidence available to support the case for green infrastructure investment based on the link between green infrastructure and human health. Although the health care budget of countries such as Germany, Switzerland and France are more than 10% of GDP, health care **prevention** expenditure represents only 2% to 3% of health care budgets in Europe.<sup>33</sup> Redirecting a larger proportion of health care budgets to prevention could fund the enhancement of green infrastructure to deliver health outcomes such as those evidenced by the literature – avoided mental and physical health costs from increased provision of and access to public green spaces, and avoided costs from treating ailments due to air and noise pollution. There is therefore an opportunity to increase the role of prevention and build on the social health benefits of green infrastructure to support wellbeing and social inclusion, avoiding health impacts and excessive societal and budgetary costs.

---

33 P ten Brink *et al.*: *The Health and Social Benefits of Nature and Biodiversity Protection*. Institute for European Environmental Policy, Apr. 2016. <https://ieep.eu/publications/new-study-on-the-health-and-social-benefits-of-biodiversity-and-nature-protection>

# PERFECT

## a European partnership...

**The PERFECT project will demonstrate how the multiple uses of green infrastructure can provide social, economic and environmental benefits; and it will raise awareness of this potential, to influence the policy-making process and to encourage greater investment in green infrastructure.**

PERFECT aims to:

- spread awareness of the value of green infrastructure for the jobs and growth agenda among a wider audience;
- identify transferable good practice;
- improve investment and stewardship by engaging managing authorities and increasing the professional capacity of key stakeholders in delivering new projects; and
- help make places more economically, socially and environmentally viable by developing action plans to take advantage of the multiple benefits of strategic investment in green infrastructure.

The PERFECT project will work to identify the multiple benefits of green infrastructure investment through EU Structural Funds Operational Programmes and other policy instruments, in order to help formulate holistic and integrated approaches to the protection and development of the natural heritage.

The PERFECT partners are: Provincial Government of Styria, Department for Environment and Spatial Planning (Austria); Social Ascention of Somogy Development, Communication and Education Nonprofit Ltd (Hungary); Municipality of Ferrara (Italy); City of Amsterdam (Netherlands); Bratislava Karlova Ves Municipality (Slovakia); Regional Development Agency of the Ljubljana Urban Region (Slovenia); Cornwall Council (UK); the Town and Country Planning Association (UK).

