the ignition PROJECT

Nature-based solutions to the climate emergency

The benefits to business and society

BUSINESS IN THE COMMUNITY
The Prince's Responsible Business Network

GMCA GREATER MANCHESTER COMBINED AUTHORITY

UK GBC

IGNITION Nature-based Solutions Evidence Base

Rachel Morrison, Greater Manchester Combined Authority
Sam Hartley, Business in the Community

Report lead

Sam Evans, Greater Manchester Combined Authority

Authors

Robert Winch, UK Green Building Council
Sam Hartley, Business in the Community
Jennifer Lane, Greater Manchester Combined Authority

Editors

Alastair Mant, UK Green Building Council
Amanda Skeldon, Business in the Community
Jennifer Lane, Greater Manchester Combined Authority
Sam Evans, Greater Manchester Combined Authority
Rachel Morrison, Greater Manchester Combined Authority

Partners

UK Green Building Council (UKGBC), Business in the Community (BITC), Greater Manchester Comined Authority (GMCA), City of Trees, Environment Agency, Groundwork, Manchester City Council, Royal Horticultural Society, Salford City Council, United Utilities, University of Manchester, University of Salford

Funders

Urban Innovative Actions,
European Union - European Regional Development Fund

The evidence included in this document was extracted from the IGNITION nature-based solutions evidence base, produced by IGNITION project partners GMCA and BITC. As the evidence base is a live repository of collated research the summary figures are subject to change. The figures contained within the benefit tables are averages taken from the IGNITION nature-based solutions evidence base summary tables in June 2020 and are correct from the June 2020 edition. These summary tables have, where possible, averaged all data included in the database against each unit of measurement. All sources are available to view within the databases. When quoting specific studies within the text, a reference has been provided. Detailed information on the methodology behind the data collection and summaries is available to download with the databases here.

Contents

The IGNITION project and the nature-based solutions evidence base

The IGNITION project is a ground-breaking programme that aims to develop innovative financing solutions for investment in Greater Manchester's natural environment. This investment will help build the city region's ability to adapt to the increasingly extreme impacts of climate change. The mechanisms and learning from this project can be applied both nationally and internationally.

Working with nature, urban solutions such as rain gardens, street trees, green roofs and walls and development of green spaces can help urban areas adapt to climate change impacts, such as flooding events and heat waves, as well as tackling socio-environmental challenges such as poor air quality, biodiversity loss and human health and wellbeing.

This project, backed by €4.5 million from the EU's Urban Innovation Actions (UIA) initiative, brings together 12 partners from local government, universities, NGOs and business. The project will deliver innovative business models that enable investment in large scale, green infrastructure projects which increase climate resilience. This will generate a significant uplift in functional green and blue spaces across the city in line with the ambitions in Greater Manchester's 5 Year Environment Plan.

The evidence base on urban nature-based solutions (NBS) pulls together the extensive available evidence into an accessible resource. This will continue to be an open source live repository of knowledge on NBS performance, for use within the project and beyond. This research was undertaken by Greater Manchester Combined Authority (GMCA) and Business in the Community (BITC), compiling evidence from over 1,000 sources. The evidence base will continue to grow as further evidence in support of NBS is uncovered. This base of knowledge and gaps within it is informing the research carried out by the University of Salford's NBS Living Lab as part of the IGNITION project.

The NBS covered were green roofs, green walls, sustainable drainage systems (SuDS), urban parks and green spaces, and street trees. The breadth of research compiled demonstrates the economic, social and environmental drivers for investing in NBS and show that, when all benefits are considered together, the payback of nature-based solutions far surpass their non-green alternatives.

The full NBS evidence base is available here, along with a guide on how to use the data and the current data summaries.

What does this mean for businesses and the built environment?

This report translates and highlights key findings in the IGNITION nature-based solutions (NBS) evidence base to address priorities of business and the built environment. **The evidence base contains a vast quantity of the available scientific literature in support of utilising NBS across the built environment.** The purpose of this document is to inspire confidence in business leaders and investors to increase their use of NBS to deliver greater outcomes for business, society and the environment.

This report has curated the relevant data, using the evidence base, to outline how NBS can benefit business and building performance; helping organisations make smarter choices on installations by increasing the understanding of who will benefit and how. We have mapped the benefits of NBS across UKGBC's impact areas: Climate Change Mitigation and Adaptation; Resource Use; Nature and Biodiversity; Health and Wellbeing; and Socio-economic Impact.

By using NBS we can adapt our urban environment into one that provides multifunctional benefits to business, people and nature. By installing NBS onsite or locally, organisations can improve their impacts regarding climate change, resource use, nature and biodiversity, socio-economic impact and the health and wellbeing of the community. Given 85% of the buildings that will be in use in 2050 already exist today, the greatest opportunity to utilise NBS and their benefits is through retrofitting.[1]

Nature-based solutions for the climate emergency: The benefits to business and society The IGNITION Project

Headline findings

The following illustrations provide a summary and comparison of the headline findings* for each of the NBS researched.

* Average cost data taken from IGNITION project cost collation database, containing technical reports and supplier information

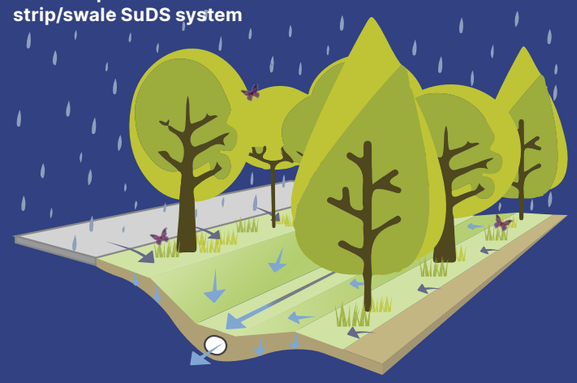
Sustainable drainage system (SuDS)

The management of surface water runoff within the urban environment to mimic the natural drainage processes, while supporting broader biodiversity and amenity aims

60–72%
Rainwater runoff retained

60–80%
Similarity in species richness to a natural pond

79%
Total suspended solids removed in filter strip/swale SuDS system



Common alternative terms: Drainage systems, natural drainage systems, Water Sensitive Urban Design (WSuDS)

Average CAPEX installation cost
(£ per m²)

£30 Detention ponds/basin
£26 Retention ponds/basin
£366 Soakaway
£23 Swale
£336 Raingarden

Average OPEX maintenance cost
(£ per m²yr)

£0.33 Detention ponds/basin
£1.10 Retention ponds/basin
£0.12 Soakaway
£0.10 Swale

Street trees

Trees located next to or within a public road

SuDS-enabled street trees

Street trees combined with a sustainable drainage system

30–50%
Increased restaurant patronage

3˚C
Air temperature reduction

5.5kg
Carbon sequestered per tree annually

Average CAPEX installation cost
(£ per m²)

£248 per tree
£7,477 SuDS-enabled street trees

Average OPEX maintenance cost
(£ per m²yr)

£0.12 per tree

Green roof

Vegetation growing on any structure's horizontal surface

6.7%
Total energy savings for the space directly below the green roof

6.9%
Uplift to property value by an accessible green roof

11db
Noise reduction by an extensive green roof

Common alternative terms: Living Roof, eco-roof, roof garden, brown roofs, green-blue roofs, biodiverse roofs

Average CAPEX installation cost
(£ per m²)

£126 Extensive green roof
£176 Intensive green roof

Average OPEX maintenance cost
(£ per m²yr)

£6 Extensive green roof
£11 Intensive green roof

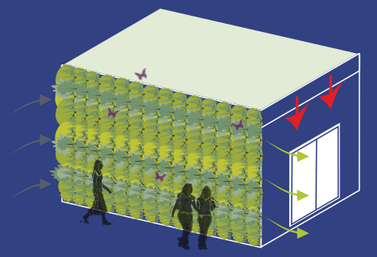
Green wall

Vegetation growing on or against a vertical surface

8%
Total energy saving for adjacent space

2.7˚C
Reduction in indoor temperature from green façade

18–35%
NO_2 removed in street canyons



Common alternative terms: Green facades, bio-responsive/bio reactor façade, living walls, vertical greening system, green screen, hedges

Average CAPEX installation cost
(£ per m²)

£282 Green façade
£702 Living wall

Average OPEX maintenance cost
(£ per m²yr)

£38 Living wall

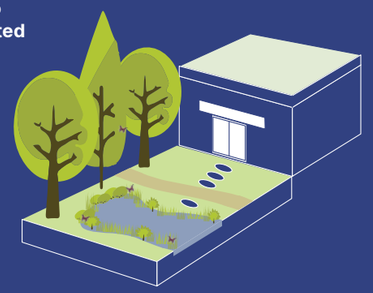
Urban parks and green space

Areas that are naturally or artificially covered with vegetation (e.g. grass, bushes or trees). Can range from playing fields and highly maintained environments to relatively natural landscapes

10%
Increase in willingness to pay for products associated with green cover

9.5%
Increase in property value in direct or close proximity to a park

84.2%
Rainwater runoff retention



Common alternative terms: Urban parks, urban green cover, amenity grassland and sports pitches

Average OPEX maintenance cost
(£ per m²yr)

£0.71 Urban parks and green space

Climate change

Climate change mitigation

If UK business achieve net zero carbon by 2030 rather than by 2050 then a £1.1tn cost to society would be avoided.[2] With increasing recognition that we are facing a climate emergency, organisations are increasingly taking steps to measure, reduce and offset their carbon emissions.

NBS have a role to play in mitigating climate change through carbon capture and storage, however, whilst this is an important function, there is considerable evidence that some NBS can also reduce carbon emissions at source by providing insulation and temperature control.

Therefore, NBS can help mitigate climate change through:

- Reducing energy use through provision of insulation and reducing surrounding air temperature
- Carbon sequestration

Reducing energy use

One-quarter of human-made greenhouse gas emissions come from burning fossil fuels for electricity and heat production.[3] Moreover, energy consumption from heating and cooling buildings is a significant proportion of an organisation's management costs and a key contributor to their scope 1 and 2 emissions.

Green walls and roofs provide added insulation to buildings meaning less energy is needed to heat and cool buildings. Green roofs can also provide exterior protection from solar radiation, extending the lifespan of the roof. See resource use.

In urban environments, cooling requirements can be more intense due to the Urban Heat Island effect (UHI). It was found that the UHI intensity (the difference between the rural and urban temperatures) in Manchester can be as high as 8˚C in summer and 10˚C in winter.[4] NBS can help to cool the surrounding air temperature, reducing cooling energy demands within the surrounding buildings. Any vegetation layer applied to a building will shade the heat-storing hard surfaces and contribute to cooling by absorbing solar radiation, and through evaporation and evapotranspiration. Similarly, street trees, parks and green spaces also reduce the temperature of the surrounding air and can reduce cooling requirements in adjacent buildings.

Total energy savings

Green walls

Total energy savings for the space directly behind the green wall

Living wall
Energy savings for cooling

15%

Green façade
Energy savings for cooling

8%

Green roofs

Total energy savings for the space directly below the green roof

Extensive < 150mm / **Intensive** > 150mm

6.7%

Carbon sequestration

The plants and soil within NBS sequester and store carbon; the more extensive the planting system, the greater the sequestration capabilities.

The carbon sequestration rate and storage capacity of trees varies depending on the species, the size of the tree and the age of the tree. It also greatly depends on management regimes and disturbance from humans. Carbon reduction benefits have generally been found to be highest in large, long-lived and fast-growing species.[5]

Green roofs and green walls provide a layer of soil and plants to store and sequester carbon; this performance depends on the substrate depth and planting used. Green spaces and urban parks provide a host site for various plants, trees and grass that all capture carbon.

Carbon sequestered and stored

Green walls

Living wall / Green façade
Carbon sequestered per m^2yr

0.68kg

Trees

Street trees
Carbon sequestered per tree annually

5.5kg

Street trees
Carbon storage capacity per tree

231.6kg

Green space

Carbon sequestered per m^2yr

0.2kg

In vegetation carbon storage capacity per m^2

1.01kg

In soil carbon storage capacity per m^2

5.9kg

Green roofs

Extensive < 150mm
Carbon sequestered per m^2yr

1.28kg

Intensive > 150mm
Carbon storage capacity per m^2

0.375kg

SuDS

Filter strip / swale system
Carbon sequestered per m^2yr

0.27kg

Filter strip / swale system
Carbon storage capacity per m^2

3.05–5.04kg

Climate change adaptation

NBS can be harnessed to increase the ability of the built environment to adapt to the impacts of climate change by:

- Managing and storing water from increased rainfall to avoid flooding
- Mitigating changes in air temperature to prevent overheating

Water management and storage

The impact of flooding on UK business has increased in recent years. Ten years ago, in the UK, an increase in extreme winter rainfall was detectable and there is evidence that the likelihood of these extremes is increasing by 7% or more per degree of global warming.[6] So far, the UK's average annual temperature has increased by 1.2˚C above pre-industrial levels.[7]

The estimated cost of floods to the UK per annum is £340 million, and is forecast to rise to £428 million at a 2˚C rise and £619 million at a 4˚C rise.[8] The impact on business of flooding is huge; during 2013/2014, the average cost of flood damage to businesses affected was £82,000 and 40% of businesses failed to re-open after a flood.[9]

NBS create more porous surfaces on and around buildings, which help to manage rainfall and flood risk onsite and locally. SuDS are widely utilised to manage rainfall and can reduce construction costs by up to 30% compared to traditional drainage systems.[10] SuDS include a multitude of differing systems, from raingardens to green roofs. SuDS-enabled street trees are widely used in urban areas to form interconnected channels of drainage. Urban parks and green spaces provide much-needed surface area where infiltration can take place and green walls capture runoff within their structure and slow the rate at which water would usually run off.

Water management

Green walls

Living wall / Green façade
Rainwater runoff retention

<75%

Trees

Street trees
Rainwater runoff retention

43%

SuDS-enabled street trees
Rainwater runoff retention

78%

Stormwater runoff delay

81%

Green roofs

Extensive < 150mm
Rainwater runoff retention

62%

Intensive > 150mm
Rainwater runoff retention

73%

Stormwater runoff delay

73%

Green space

Rainwater runoff retention

84.2%

Annual rainfall infiltrated

30%

SuDS

Filter strip / swale system
Rainwater runoff retention

69%

Filter strip / swale system
Stormwater runoff delay

57%

Mitigating overheating

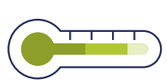
The heatwaves of 2003 and 2006 each caused over 2,000 deaths in the UK.[11] This impact is likely to worsen given the global average temperature increase has now surpassed 1˚C and is expected to reach 1.5˚C between 2030 and 2052 and if climate action isn't taken, 4˚C by 2100.[12] For the UK, this means hotter drier summers, which by 2040 are estimated to regularly reach 38.5˚C and by 2050 could cause 7,000 heat-related deaths a year.[13]

NBS can provide significant levels of cooling; street trees can provide shaded avenues and urban green spaces can provide cooler hubs for relief, while green walls and roofs add a heat-absorbent exterior. All of these measures help to mitigate the UHI and create temperatures comfortable to live and work in.

Outdoor and indoor temperature reductions

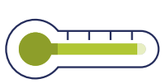
Green walls

Green façade
Reduction in surrounding air temperature



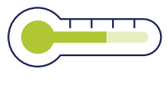
1–3°C

Living wall
Reduction in surrounding air temperature



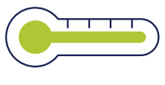
0.5–4.1°C

Reduction in indoor temperature



2.7°C

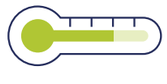
Reduction in indoor temperature



4.8°C

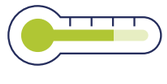
Trees

Street trees / SuDS-enabled
Reduction in surrounding air temperature



3°C

Maximum reduction in indoor temperature



3°C

Green roofs

Extensive < 150mm
Reduction in temperature of air directly above green roof

0.8°C

Reduction in
indoor temperature

2°C

Intensive > 150mm
Reduction in temperature of air directly above green roof

1.1°C

Reduction in
indoor temperature

0.3–4°C

Green space

Reduction in daytime
air temperature

2.7°C

Resource use

As we move towards a more circular economy and responsible consumption and production, we can use NBS to:

- Capture water for onsite use
- Increase the lifespan of buildings and infrastructure

Capturing water for onsite use

Increased development of hard infrastructure in urban areas impacts the natural flow of water and increases pressure on local waterways and drainage networks. Many sites further increase the demand on water networks by using potable water irrigation systems for greenery or maintenance. As irrigation and maintenance do not require potable water, SuDS provide a more efficient way to store water for this use. This reduces runoff pressure on local waterways and reduces the consumption of chargeable potable water onsite. This could range from a simple water butt to an in-built system that diverts water from buildings through pipes into raingardens or irrigation systems for existing green spaces. Additionally, these systems can showcase the water movement in a visually appealing or educational way.

Water retained

Green walls

Living wall / Green façade
Rainwater runoff retention

<75%

Trees

Street trees
Rainwater runoff retention

43%

SuDS-enabled
Rainwater runoff retention

78%

Green space

Rainwater runoff retention

84.2%

Green roofs

Extensive < 150mm
Rainwater runoff retention

62%

Intensive > 150mm
Rainwater runoff retention

73%

SuDS

Storage facility
Rainwater runoff retention

72%

Increasing the lifespan of buildings and infrastructure

Refurbishment and thorough maintenance of properties can be extremely resource intensive. The inclusion of NBS within new projects and existing structures could provide significant improvements in the longevity and quality of a site's assets.

Green walls and green roofs provide buildings with an additional layer of protection from solar radiation and extremes in weather such as frost or heat waves. Studies within the evidence base show that the protection provided by a green roof can extend the lifespan of the roof by an average of 23 years, compared to the lifespan of a conventional roof.

Surface temperature reduction

Green walls

Living wall
Reduction in exterior wall temperature

3°C

Green façade
Reduction in exterior wall temperature

3.8°C

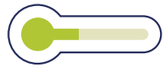
Trees

Street trees / SuDS-enabled
Reduction in ground temperature

11°C

Green roofs

Extensive < 150mm
Reduction in surface temperature



6.5°C

Intensive > 150mm
Reduction in surface temperature

14.5°C

Nature and biodiversity

Creating a 10% uplift in biodiversity on new developments has recently become a focus of national government policy in an effort to deliver on their 25-Year Environment Plan. This is likely to become law by 2023.

Restoring nature and biodiversity results in increasing the long-term resilience within the systems that support our communities and businesses. We rely on healthy ecosystems for food security, water management, air quality and regulating temperature.

The existing evidence provides no single metric that can be used to summarise the impact of NBS on nature and biodiversity, however, valuable insights can be found in individual studies that are available to view in the evidence base.

NBS have a positive impact on nature and biodiversity by:

- Creating spaces and greater connectivity for wildlife
- Maintaining suitable temperatures for native species
- Limiting disruption to wildlife by reducing noise pollution
- Reducing the run-off of pollutants into rivers

Creating spaces and greater connectivity for wildlife

The continual reduction in functional space for nature and the separation of populations is leading to a greater number of species being at risk of extinction, 15% are currently threatened within Great Britain.[14] These factors mean smaller and disconnected populations, which can result in smaller and isolated gene pools. While in some instances this is positive and can lead to speciation, the reduced genetic variation in populations often makes them more susceptible to things like disease, invasive species and climate change. NBS increase the area of habitat and can connect existing green spaces via habitat corridors or stepping stone habitats.

In practice, green walls and roofs can reinstate sizeable green surface areas in the built environment that otherwise could not exist or be host to habitats and food growing. SuDS can mimic natural pond conditions, adding to species richness by 60-80%. Street trees can be utilised to connect urban parks and provide corridors for animals such as hedgehogs.

Maintaining suitable temperatures for native species

Different species are adapted to live and thrive under particular climatic conditions. When these conditions change, it limits the species' ability to survive. NBS can provide a cooling effect on air temperature and provide cool hubs to reduce UHI effect, helping to mitigate the overheating associated with climate change. Maintaining the air temperature at a level consistent with species tolerance levels leads to greater longevity in the survival of those populations.

Outdoor temperature

Green walls

Living wall
Outdoor air temperature

0.5–4.1°C

Green façade
Outdoor air temperature

1–3°C

Trees

Street trees / SuDS-enabled
Reduction in surrounding air temperature

3°C

Green space

Daytime air temperature reductions

2.7°C

Green roofs

Extensive < 150mm
Reduction in temperature of air directly above green roof

0.8°C

Intensive > 150mm
Reduction in temperature of air directly above green roof

1.1°C

Reducing disruption to wildlife by reducing noise pollution

Human-made noise is a global pollutant, one which negatively impacts wildlife, including many species of amphibians, arthropods, birds, fish, mammals, molluscs and reptiles.[15] Human-made noise can impact the ability of animals to communicate, negatively impacting their ability to find mates and warn each other of predators. Noise pollution has also been found to disrupt species' migratory paths and hunting. NBS can reflect and absorb acoustic sound energy, reducing the impact of human made noise on wildlife. NBS are particularly useful in urban environments to reduce traffic noise and to limit noise pollution in narrow streets and street canyons.

Noise **db–Decibels**

Green walls

Living wall
Reduction of

9.8db

Green façade
Reduction of

2.6db

Trees

Street trees / SuDS-enabled
Reduction per tree

4db

Green space

Reduction per m^2

4db

Green roofs

Extensive < 150mm
Reduction

11db

Intensive > 150mm
Reduction

46db

Reducing the run-off of pollutants into rivers

Phosphates and nitrates often pollute rivers through surface run-off. These chemical compounds are nutrients to algae and stimulate their growth. Under the right conditions and when their concentration is high enough in a river, they cause algal blooms. When algal blooms die their decay can result in the depletion of oxygen from the water, subsequently leading to the death of fish and other aquatic life dependent on oxygen, a process known as eutrophication. By 2050 it is likely that the number of days where algal blooms occur will increase by 95% as a consequence of climate change.[16] NBS can reduce the incidence rate of eutrophication by filtering water of phosphates and nitrates and providing shade to stop the rate of photosynthesis in algae. Additionally, total suspended solids such as microplastics can be captured by the filtering system within NBS.

Water quality **NO_3 – Nitrates | TSS – Total Suspended in Solids | P – Phosphurus**

Green walls

Living wall / Green façade

Reduction in NO_3
30–83%

Reduction in TSS
33–99%

Reduction in P
15–30%

Trees

Street trees
Reduction in NO_3

70%

Green space

Reduction in NO_3
31–100%

Reduction in TSS
42–100%

Reduction in P
22–95%

Green roofs

Extensive < 150mm / **Green Intensive** > 150mm

Reduction in NO_3
80%

Reduction in TSS
70%

Reduction in P
67%

SuDS

Filter strip / swale system

Reduction in NO_3
19–70%

Reduction in TSS
79%

Reduction in P
62%

Nature-based solutions for the climate emergency: The benefits to business and society The IGNITION Project

Health and wellbeing

Exposure to nature is widely evidenced to improve human health and wellbeing. The inclusion of nature within our built environment will contribute to happier healthier communities. The COVID-19 pandemic re-emphasised the critical importance of good quality green space for health and wellbeing, particularly in urban areas where these spaces are rarer.

While evidence attributed to individual NBS and health and wellbeing is limited, data from green spaces highlights their ability to:

- Remove air pollution
- Provide exposure to nature that improves mental health
- Provide green space for physical exercise
- Positively impact employees leading to a reduction in sick leave, greater employee retention and increased productivity

Removing air pollution

The UK regularly breaches legal limits for outdoor air quality which causes up to 36,000 deaths a year.[17,18] Around 67% of the UK population are exposed to these high levels of pollution that exceed World Health Organisations guidelines.[19]

Outdoor air quality is predominantly impacted by road traffic and industrial emissions. Poor air quality can induce minor symptoms such as headaches, colds, eye irritation or fatigue. In more serious cases poor air quality leads to heart disease, strokes, respiratory disease, cancer and the exacerbation of asthma. In an office, poor air quality can also lead to reduced productivity and low employee satisfaction.

Vegetation is widely acknowledged to be able to improve air quality through the deposition and trapping of pollutants on plant surface, absorption of pollutants and in some cases acting as a barrier to the spread of pollutants.

Air quality

NO_2 – Nitrogen dioxide | PM10 – Particulate matter ≤ 10 micrometres

Green walls

Living wall / Green façade

NO_2 removed in street canyons

18–35%

PM10 removed in street canyons

22–50%

Trees

Street trees

NO_2 removed per tree annually

0.17kg

PM10 removed per tree annually

0.11kg

Green space

NO_2 removed 50m inside a park

2.6%

PM10 removed 50m inside a park

9.1%

Green roofs

Extensive < 150mm / **Intensive** > 150mm

NO_2 removed directly above green roof

24%

PM10 removed directly above green roof

14%

Improving mental health

Approximately one in four people in the UK will experience a mental health problem each year.[20] The correlation between exposure to nature and improved mental health is well documented within the evidence base. However, the metrics used to measure the impacts vary across the research, meaning it is not possible to summarise in single statistics.

An insight into some key findings are:

- Green façades appear to enhance human physiological and psychological relaxation compared to the building-walls[21]
- Visits to outdoor green spaces of 30 minutes or more during the course of a week result in a 7% reduction in the prevalence of depression[22]
- For every 1% increase in the proportion of useable or total green space near to the home there is a 4% reduction in the number of anxiety/mood disorder treatment cases[23]
- Bird and plant diversity have been found to increase the wellbeing benefits from visiting green space and can lead to a reduction in anxiety, stress and depression[24]
- Studies have also found that species richness and perceived species richness has a positive correlation with mental wellbeing[25]

Green space for physical exercise

Through placemaking, the inclusion of accessible nature is proven to encourage physical activity. Green space has shown to have a huge improvement on physical health covering general health, self-reported health, all-cause mortality, cardiovascular mortality, physical activity, obesity, cholesterol levels, heart rate and blood pressure, type 2 diabetes, pregnancy outcomes, and the behavioural and cognitive development of children.

Some insightful pieces of evidence include:

- People living in greener areas were 24% more likely to achieve recommended levels of physical activity[26]
- Those that live within a mile of green space are 38% more likely to exercise than those living further away[27]

Positively impacting employees

Of adults, 26% have at some stage in their life been diagnosed with a mental illness and in 2016 the country lost 4.3 days per worker due to associated sick leave.[28, 29] Exposure to nature through NBS can result in reduced staff sick leave, reduced staff turnover and an increase in worker productivity.

Some insights taken from studies of incorporating nature into the workplace include:

- 15% increase in worker productivity when office spaces are enhanced with plants[30]
- 12% increase in reaction time when in the presence of plants[31]
- Employees with views of trees and landscapes took an average of 11 hours less sick leave per year than employees with no view. This equates to an average saving of around £1,600 ($2,000 reported) per employee[32]
- Workers with a view of nature handle calls 6-7% faster than those with no view. This generates annual productivity savings of around £2,400 ($2,990 reported) per employee[33]
- 23% decrease in sick leave taken by employees with a view of nature[34]

Socio-economic impact

NBS have been found to stimulate socio-economic value by:

- Reducing crime rates and improving quality of life
- Increasing land and property values
- Generating local economic growth

Reducing crime rates and improving quality of life

NBS have been shown to reduce crime rates, potentially a consequence of increased social cohesion. Green space allows individuals to engage in more social activities, fostering social interactions and promoting a sense of community. It is also suggested that areas with good-quality green space appear to be in good social control and so deter criminal activities.

Some insights taken from the evidence of nature reducing crime rates and improving quality of life are:

- 1.2% decrease in crime levels for every 1% increase in tree canopy[35]
- 56% reduction in violent crime associated with increased greenness[36]
- 46% reduction in property crimes associated with higher levels of greenness[37]
- 85% of people consider that the quality of public space and the built environment has a direct impact on their lives and on the way they feel[38]

Increasing land and property values

The value of green space can be identified in people's willingness to pay for access to it and services within it. The presence of parks, urban green spaces and street-tree lined avenues also contributes to the enhanced attractiveness of an area, recreational opportunities and environmental functions which can all contribute to individuals' willingness to pay a higher price to buy or rent land or property nearby.

NBS may increase the durability, and thereby value, of buildings by reducing their exposure to sunlight, air temperature fluctuations, acid rain and air pollution so leading to greater longevity of the building's exterior surface material (see resource use).

Land and property value

Green walls

Living wall / Green façade

Increase in property value **2.5%**

Increase in land value **2%**

Trees

Street Trees / SuDS-enabled

Increase in property value **4.7%**

Increase in rental value **6.15%**

Green space

Increase in property value when in direct or close proximity to a park **9.5%**

Increase in rental value **7%**

Green roofs

Extensive < 150mm / **Intensive** > 150mm

Increase in property value for non-accessible green roof **2.9%**

Increase in property value for accessible green roof **6.9%**

SuDS

Increase in property value when a small blue space within 200m of a property **0.9%**

Increase in property value when a large blue space close to the property **3.6%**

Generating local economic growth

The high street continues to decline, with an 8% reduction in high street shops since 2013.[39] NBS as part of placemaking can have a direct impact on consumer behaviour and help bring life back to high streets.

Street trees can help form a more positive consumer experience and increase consumers' willingness to pay. In general, studies on the economic benefits of green walls for local business suggest that high-quality green spaces can help businesses build a good image and improve reputation, which will encourage inward investment and employment into an area. Accessible green roofs can provide valuable onsite recreation or hospitality areas for previously underutilised space.

Some insights taken from the evidence of NBS generating local economic growth:

10–50%

Increased willingness to spend on products whilst in the presence of street trees in central business districts[40]

30–50%

Increase in restaurant patronage due to street trees[41]

40%

Increase in commercial trading rates after investment in well planned green space[42]

10%

Increase in willingness to pay for products associated with high green cover[43]

50%

50% of park visitors visit a local business before or after their visit[44]

Glossary

Term	Definition
Biodiversity	*The variety of plant and animal life*
Carbon sequestration	*The long-term removal, capture and storage of atmospheric carbon dioxide*
Carbon sink	*Something which absorbs more carbon than it releases*
Climate change adaptation	*The process of adjustment to the actual or expected impacts of climate change*
Climate change mitigation	*The efforts to reduce or prevent emissions of greenhouse gases*
Climate resilience	*The ability of a system to absorb stresses and retain function when external stresses from climate change are imposed upon it*
Eutrophication	*Excessive richness of nutrients in a body of water, typically caused by run-off, which leads to dense plant growth and subsequent death. During the decay of plant matter the oxygen concentration is depleted leading to the death of other aquatic life such as fish*
Evapotranspiration	*The transfer of water from land to the atmosphere by evaporation from soil or transpiration from plants*
Extensive green roof	*A green roof with a thin layer of soil that is mostly self-sustaining and inaccessible*
Gene pool	*The stock of genes in an interbreeding population*
Genetic diversity	*The number of genetic characteristics in the genetic makeup of a species*
Habitat corridors	*An area of habitat connecting separated wildlife populations*
Infiltration	*The process by which water on the ground enters the soil*
Invasive species	*A species introduced from outside its natural area*
Intensive green roof	*A green roof with a greater depth of soil than an extensive green roof, is more accessible and usually consists of roof gardens and parks*
Life-cycle cost	*All the costs associated with a product for its entire life cycle*
Nature	*Elements of the natural world such as plants and animals*
Nature-based solutions	*The sustainable management and use of nature for tackling socio-environmental challenges*
Photosynthesis	*The process used by plants to convert light energy into chemical energy*
Placemaking	*A multifaceted approach to planning, designing and managing public spaces*
Potable water	*Water that is safe to drink*
Urban heat island (UHI)	*Where an urban area is significantly warmer than its surrounding rural areas due to human activities. It is primarily caused by the replacement of natural surfaces with hard impervious surfaces that are generally dark and absorb large amounts of solar radiation, for instance roads, paved areas, and roof tops*
Rainwater runoff retention	*The process by which rainwater is stored within a system*
Scope 1 Emissions	*Direct emissions from owned or controlled sources*
Scope 2 Emissions	*The indirect emissions generated from purchased electricity, steam, heating and cooling*
Scope 3 Emissions	*All the other indirect emissions that occur in a company's value chain*
Speciation	*The evolutionary process by which populations become distinct species*
Species richness	*The number of different species represented in an ecological community, landscape or region*
Sustainable drainage systems	*Water management systems that align modern drainage systems with natural water processes*
Stepping stone habitats	*A type of habitat corridor that consists of multiple smaller habitat areas which connect larger disconnected habitats. Species can jump between these*
Street canyon	*Where a street has buildings on both sides*
Willingness to pay	*The maximum amount a consumer is willing to pay for a product or service*

Nature-based solutions for the climate emergency: The benefits to business and society The IGNITION Project

References

1 The Chartered Institute of Building (2013). Submission to the All Party Parliamentary Group for excellence in the built environment on inquiry into sustainable construction and the Green Deal. Available at: http://cic.org.uk/admin/resources/charetered-institute-of-building.pdf [Accessed: 02/07/20].

2 Business in the Community (2020). Challenge 2030 – let's make the climate crisis history as we build back better from COVID-19. Available at: https://www.bitc.org.uk/blog/challenge-2030-lets-make-the-climate-crisis-history-as-we-build-back-better-from-covid-19/ [Accessed: 02/07/20].

3 Intergovernmental Panel on Climate Change (2014). AR5 climate change 2014: mitigation of climate change. Available at: https://www.ipcc.ch/report/ar5/wg3/ [Accessed: 02/07/20].

4 Cheung H.K.W. (2011). An urban heat island study for building and urban design (Doctoral dissertation, University of Manchester).

5 McPherson E.G. and Kendall A. (2014). A life cycle carbon dioxide inventory of the Million Trees Los Angeles program. The International Journal of Life Cycle Assessment, 19(9), pp.1653-1665.

6 Committee on Climate Change (2020). Climate change is getting worse but it is no worse than we predicted. Available at: https://www.theccc.org.uk/2020/05/04/climate-change-is-getting-worse-but-it-is-no-worse-than-we-predicted/ [Accessed: 02/07/20].

7 Committee on Climate Change (2020). Inevitable change table. Available at: https://www.theccc.org.uk/wp-content/uploads/2020/04/Inevitable-change-table-Final.png [Accessed: 02/07/20].

8 Committee on Climate Change (2016). Infographic: Future flood risk in the UK. Available at: https://www.theccc.org.uk/2016/01/15/infographic-future-flood-risk-in-the-uk/ [Accessed: 02/07/20].

9 Business in the Community (2020). Would your business premises be ready for a flood? How property flood resilience measures can help protect your business. Available at: https://www.bitc.org.uk/fact-sheet/would-your-business-premises-be-ready-for-a-flood/ [Accessed: 02/07/20].

10 Department for Environment, Food and Rural Affairs (2011). Commencement of the Flood and Water Management Act 2010, Schedule 3 for Sustainable Drainage – Impact Assessment. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/82428/SuDS-consult-annexf-ia-111220.pdf [Accessed: 02/07/20].

11 HM Government (2014). Heatwave plan for England. Available here: https://www.gov.uk/government/publications/heatwave-plan-for-england [Accessed: 02/07/20].

12 Intergovernmental Panel on Climate Change (2018). Special Report Global Warming of 1.5°C. Available at: https://www.ipcc.ch/sr15/ [Accessed: 02/07/20].

13 House of Commons (2018). Heatwaves: adapting to climate change. Available at: https://publications.parliament.uk/pa/cm201719/cmselect/cmenvaud/826/826.pdf [Accessed: 02/07/20].

14 Hayhow D.B., Eaton M.A., Stanbury A.J., Burns F., Kirby W.B., Bailey N., Beckmann B., Bedford J., Boersch-Supan P.H., Coomber F., Dennis E.B., Dolman S.J., Dunn E., Hall J., Harrower C., Hatfield J.H., Hawley J., Haysom K., Hughes J., Johns D.G., Mathews F., McQuatters-Gollop A., Noble D.G., Outhwaite C.L., Pearce-Higgins J.W., Pescott O.L., Powney G.D. and Symes N. (2019). The State of Nature 2019. The State of Nature partnership.

15 Kunc H.P. and Schmidt R. (2019). The effects of anthropogenic noise on animals: a meta-analysis. Biology letters, 15(11), p.20190649.

16 Environment Agency (2019). Climate change and eutrophication risk in English rivers. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/822908/Climate_change_and_eutrophication_risk_in_English_rivers__-_summary.pdf [Accessed: 02/07/20].

17 Kings College London (2016). London Air Quality Network summary report 2016. Available at: http://www.londonair.org.uk/london/reports/2016_LAQN_Summary_Report.pdf [Accessed: 02/07/20].

18 Committee on the Medical Effects of Air Pollutants (2018) Associations of long-term average concentrations of nitrogen dioxide with mortality. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734799/COMEAP_NO2_Report.pdf [Accessed: 02/07/20].

19 Trading Economics (2018). United Kingdom – Urban Population. Available at: https://tradingeconomics.com/united-kingdom/urban-population-percent-of-total-wb-data.html [Accessed: 02/07/20].

20 McManus S., Meltzer H., Brugha T., Bebbington P.E. and Jenkins R. (2009). Adult psychiatric morbidity in England: results of a household survey. Health and Social Care Information Centre.

21 Elsadek M., Liu B. and Lian Z. (2019). Green façades: Their contribution to stress recovery and well-being in high-density cities. Urban Forestry & Urban Greening, 46, p.126446.

22 Shanahan D.F., Bush R., Gaston K.J., Lin B.B., Dean J., Barber E. and Fuller R.A. (2016). Health benefits from nature experiences depend on dose. Scientific reports, 6, p.28551.

23 Nutsford D., Pearson A.L. and Kingham S. (2013). An ecological study investigating the association between access to urban green space and mental health. Public health, 127(11), pp.1005-1011.

24 Cox D.T., Shanahan D.F., Hudson H.L., Plummer K.E., Siriwardena G.M., Fuller R.A., Anderson K., Hancock S. and Gaston K.J. (2017). Doses of neighborhood nature: the benefits for mental health of living with nature. BioScience, 67(2), pp.147-155.

25 Dallimer M., Irvine K.N., Skinner A.M., Davies Z.G., Rouquette J.R., Maltby L.L., Warren P.H., Armsworth P.R. and Gaston K.J. (2012). Biodiversity and the feel-good factor: understanding associations between self-reported human well-being and species richness. BioScience, 62(1), pp.47-55.

26 Mytton O.T., Townsend N., Rutter H. and Foster C. (2012). Green space and physical activity: an observational study using Health Survey for England data. Health & place, 18(5), pp.1034-1041.

27 Cohen D.A., McKenzie T.L., Sehgal A., Williamson S., Golinelli D. and Lurie N. (2007). Contribution of public parks to physical activity. American journal of public health, 97(3), pp.509-514.

28 Health Survey for England (2014). Mental Health Problems. Available at: http://healthsurvey.hscic.gov.uk/support-guidance/public-health/health-survey-for-england-2014/mental-health-problems.aspx [Accessed: 02/07/20].

29 Office for National Statistics (2016). Sickness absence in the UK labour market. Available at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/articles/sicknessabsenceinthelabourmarket/2016 [Accessed: 02/07/20].

30 Nieuwenhuis M., Knight C., Postmes T. and Haslam S.A. (2014). The relative benefits of green versus lean office space: Three field experiments. Journal of Experimental Psychology: Applied, 20(3), p.199.

31 Lohr V.I., Pearson-Mims C.H. and Goodwin G.K. (1996). Interior plants may improve worker productivity and reduce stress in a windowless environment. Journal of environmental horticulture, 14(2), pp.97-100.

32 Elzeyadi I. (2011). Daylighting-bias and biophilia: quantifying the impact of daylighting on occupants health. US Green Building Council. http://www.usgbc.org/sites/default/files/OR10_Daylighting%20Bias%20and%20Biophilia.pdf.

33 Heschong L. and Mahone D. (2003). Windows and offices: A study of office worker performance and the indoor environment. California Energy Commission, pp.1-5.

34 Kaplan R. (1993). The role of nature in the context of the workplace. Landscape and urban planning, 26(1-4), pp.193-201.

35 Troy A., Grove J.M. and O'Neil-Dunne J. (2012). The relationship between tree canopy and crime rates across an urban–rural gradient in the greater Baltimore region. Landscape and urban planning, 106(3), pp.262-270.

36 Kuo F.E. and Sullivan W.C. (2001). Environment and crime in the inner city: Does vegetation reduce crime? Environment and behavior, 33(3), pp.343-367.

37 Kuo F.E. and Sullivan W.C. (2001). Environment and crime in the inner city: Does vegetation reduce crime? Environment and behavior, 33(3), pp.343-367.

38 CABE Space (2002) The value of public space: How high quality parks and public spaces create economic, social and environmental value. Available at: https://www.designcouncil.org.uk/sites/default/files/asset/document/the-value-of-public-space1.pdf [Accessed: 02/07/20].

39 The Guardian (2019) High street crisis deepens: 1 in 12 shops close in five years. Available at: https://www.theguardian.com/cities/ng-interactive/2019/jan/30/high-street-crisis-town-centres-lose-8-of-shops-in-five-years [Accessed: 02/07/20].

40 Wolf K.L. (2003). Public response to the urban forest in inner-city business districts. Journal of Arboriculture. 29 (3): 117-126., 29(3), pp.117-126.

41 GreenBlue Urban (2018). Street Tree Cost Benefit Analysis. Available at: https://www.treeconomics.co.uk/wp-content/uploads/2018/08/GBU_Street-Tree-Cost-Benefit-Analysis-2018.pdf [Accessed: 16/07/20].

42 Department of the Environment (1997). Managing Urban Spaces in Town Centres: Good Practice Guide. London: Department of the Environment.

43 Wolf K.L. (2003). Public response to the urban forest in inner-city business districts. Journal of Arboriculture. 29 (3): 117-126., 29(3), pp.117-126.

44 The Land Trust (2018). Port Sunlight River Park. Available at: https://thelandtrust.org.uk/space/port-sunlight-river-park/ [Accessed: 16/07/20].

Nature-based solutions for the climate emergency: The benefits to business and society The IGNITION Project

Further information

The IGNITION project, and the 12 project partners led by the GMCA, will continue to engage with businesses as key stakeholders and continue to enable greater investment in nature-based solutions.

UKGBC's Increasing Nature-based Solutions programme aims to enable industry to set more ambitious targets and increase their application of NBS. To find out more, including how to get involved see here.

BITC will continue to address the climate emergency through Challenge 2030, and through the incorporation of nature into solutions for mitigation and adaptation.

Design and creative direction by Sabroso Studio