PERFECT
factsheet 3

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green infrastructure and climate change


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Definitions

- ***Climate change mitigation:*** Human intervention to reduce the sources of, or enhance the sinks for, greenhouse gases.
- ***Climate change adaptation:*** The process of adjustment to actual or expected climate and its effects. In human systems, it aims to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.
- ***Green Infrastructure:*** 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.
- ***Greenhouse gases***: Gaseous constituents of the atmosphere that cause the greenhouse effect – primarily water vapour, carbon dioxide, nitrous oxide, methane and ozone.

This Factsheet makes the case to policy-makers for investment in green infrastructure (GI) to combat climate change. It includes statistics and evidence to justify this investment.

The climate challenge

Climate change is now the greatest challenge facing our society. The scientific evidence of climate change is overwhelming and the global impacts of climate change will be severe.[1] Carbon dioxide (CO_2) and other greenhouse gases (GHGs) are changing our climate, causing global temperature rises and making local weather patterns more extreme and less predictable.

At an international level, governments have agreed to *mitigate climate change* by keeping the global temperature rise this century well below 2ºC Celsius above pre-industrial levels.[2] They have also committed to pursue efforts to limit the temperature increase even further to 1.5ºC.

We need to transition to a low-carbon economy in which GHG emissions are dramatically reduced over time. However, at the same time we are already locked into a century or more of climate change. Increases in GHGs in the atmosphere caused by human activities have led to approximately 1.0ºC of global warming above pre-industrial levels. Global warming is likely to reach 1.5ºC between 2030 and 2052.[3] It is crucial that we plan for future climate change. This means governments, local authorities, businesses and individuals need to adopt *climate change adaptation* measures that will help to increase resilience and minimise adverse climate change impacts.

The impacts of climate change

The Intergovernmental Panel on Climate Change (IPCC) *Global Warming of 1.5°C* report of October 2018[4] makes it clear that the impacts of climate change are being experienced now, through unprecedented global trends and more localised severe weather events.

The impacts of climate change are expected to be profound. Projections indicate that the number of people affected by flooding across Europe by the end of the 21st century will increase from 100,000 to 1.5-3.6 million.[5] Other expected impacts include people losing their electricity supply from damage caused by increasingly intense weather and suffering the consequences of extreme heat. A combination of air pollution and high temperatures is expected to cause issues for vulnerable people. The water supply may become limited in certain regions during droughts. This may also have an impact on the production, availability and pricing of food.

While climate change will have a lasting impact on people and wildlife, it will also define future economic progress. Only those places that can demonstrate climate resilience will be able to secure insurance and investment. The insured losses from extreme events in the UK alone costs an average of £1.5 billion per annum.[6]

Climate change – the role of green infrastructure

This Factsheet covers the role of GI in both *mitigating* climate change and *adapting to it*, in both urban and rural areas.

GI can help to *mitigate* climate change by reducing GHG emissions – for example through carbon storage and sequestration and by reducing car use through facilitating walking and cycling. GI is also vital to enable people and wildlife to *adapt* to the rising temperatures and extreme weather events associated with climate change.
We must use all available means to mitigate and adapt to climate change, and the

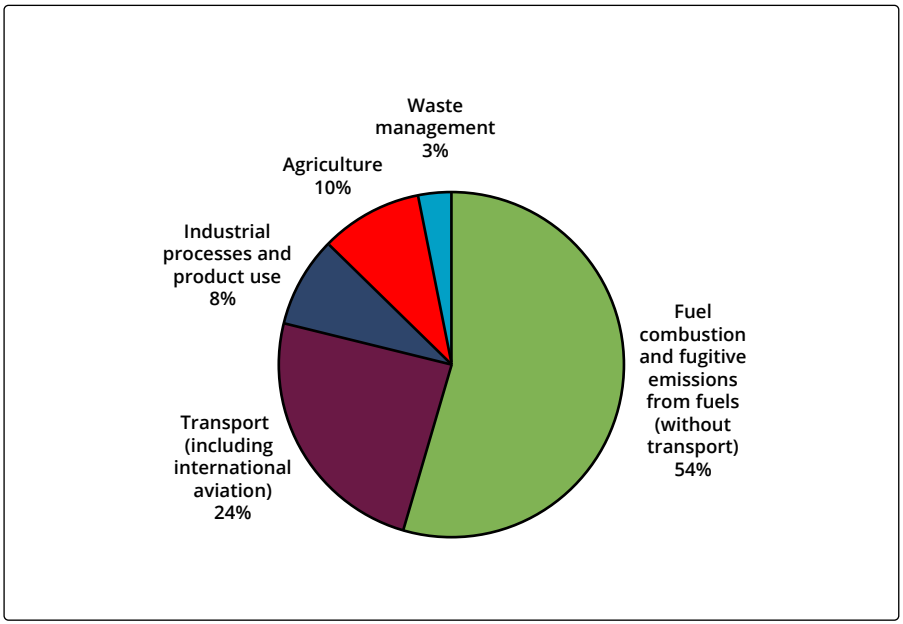

Fig. 1 GHG emissions in the EU, by sector, 2016

natural environment has a significant contribution to make. In urban areas, GI is part of a package of measures that we need to address the challenges.

In addition to mitigating and adapting to climate change, investment in GI will also generate environmental and socio-economic benefits such as improving water and air quality, enhancing biodiversity, and contributing to sustainable transport solutions and better health and wellbeing.[7]

Mitigating climate change through green infrastructure

Fig. 1 shows the level of greenhouse gas emissions by sector for the EU in 2016.[8] Reducing emissions from any of those sectors will mitigate climate change.

This Factsheet considers GI's climate change mitigation potential under four themes: supporting sustainable transport, reducing energy consumption, developing renewable energy, and encouraging carbon sequestration.

'While climate change will have a lasting impact on people and wildlife, it will also define economic progress'

'Creating a greener, more attractive environment can encourage a change in the mode of transport used'

Supporting sustainable transport

Adopting more sustainable transport can deliver a significant reduction in GHG emissions. For example, at average occupancy, CO_2 emissions per kilometre are 127 grammes for car transport, 101 grammes by bus, 28 grammes by coach, 38 grammes by metro, and zero by walking or cycling.[9]

The more that people change their mode of transport to low-carbon modes, the greater the cumulative impact will be.

Creating a greener, more attractive environment can encourage a change in the mode of transport used. More attractive routes to transport hubs, employment sites and sites of interest will encourage more walking and cycling.

Such action is an indirect method of addressing climate change, also requiring (or facilitating) behaviour change. The same is true for pedestrianisation, cycle roads, cycle highways, better signage, and bike hire schemes.

Reducing energy consumption

GI placed on or near a building can help reduce the need for heating in the winter and air-conditioning in summer, thereby reducing the use of fossil fuels. Here the main effect of GI is the direct insulation of buildings or protection from cold winds. Green walls or façades have the additional benefit of providing habitats for wildlife. It is estimated that the sheltering effect of trees could save 3-9% on energy bills for each property in the UK where trees are planted in the correct position relative to the building.[10]

Developing renewable energy

Green spaces can serve as locations for renewable energy generation facilities such as wind and solar farms. Developers can also combine green roofs in new buildings with solar panels to produce renewable energy.

GI such as sustainably sourced timber and grass from road verges can itself be a source of renewable energy. A project undertaken by Lincolnshire County Council in the UK has explored more sustainable management of 4,000 miles of rural roadside verges, collecting grass cuttings for use in a local anaerobic digestion plant to generate electricity and biogas.[11]


Oliver Wendell

'More sustainable land use management practices have the potential to store more carbon dioxide in the soil'

Furthermore, there are about 4.5 hectares road verge per kilometre of highway in the Netherlands available for biomass production. The net energy gain (after energy input costs) could be between 625 and 2215 gigajoules per hectare.[12]

Encouraging carbon sequestration

In cities, trees can absorb significant amounts of CO_2 (acting as 'carbon sinks'). London's urban forest stores 2.4 million tonnes of CO_2 and sequesters 77,000 tonnes per annum, giving an economic value, through carbon sequestration and storage, of £151 million (per annum).[13] An enhanced UK woodland creation programme that involved planting 23,200 hectares per annum could capture 15 megatons of CO_2 per year by the 2050s.[14]

Different types of habitat and land use have varying capacities to act as carbon sinks – or conversely to release carbon from the soil. More sustainable land use management practices have the potential to store more carbon dioxide in the soil. For example, restoring arable land to grassland can remove between 4 and 12 tonnes of CO_2 per hectare per year,[15] and, using 2030 EU carbon trade figures (£78 per tonne of CO_2), that represents an economic value of £312-936 per annum per hectare. The concept of carbon farming – paying farmers to increase the store (or reduce losses) of CO_2 held in the vegetation and soils on their land – is being actively explored.[16]

Adapting to climate change through green infrastructure

This section considers adaptation to climate change through green infrastructure under three themes: flood risk management, moderating extreme temperatures, and supporting wildlife corridors.

Managing flood risk

GI can contribute to river, surface and coastal flood prevention. The impact of *river flooding* can be reduced through large-scale tree planting upstream of urban areas. Trees help to keep water in the catchment area for longer, reducing peak flows. A pilot study in North Yorkshire in the UK found that the flood regulation benefits of river woodland are worth £6,000 per hectare per year.[17]

GI in urban areas can reduce the impact of *surface water flooding* caused by extreme rainfall events. Vegetation and the soil around and beneath it have the capacity to absorb and store water.

Sustainable urban drainage system (SuDS) schemes can protect new or existing development from surface water flooding. Permeable paving, water butts, rain gardens, ponds, green roofs and whole parks designed to flood during flooding events can all form part of a SuDS scheme. Some typical benefits of SuDS schemes include the following:

- During an extreme rainfall event (of 300 litres per hectare per second), green roofs can hold back 30-90% of rainfall.[18]
- A rain garden with a 0.5 hectare catchment can remove around 1,000 cubic metres of water run-off per year.[19]
- London's urban forest can reduce floodwater by 3.4 million cubic metres per annum, giving an economic value, through stormwater alleviation, of £2.8 million per annum.[20]

SuDS scheme at Newcastle Great North Park

'In Amsterdam, temperatures in the summer of 2018 were 6°C higher in dense urban areas without GI… and evidence shows that GI can cool the air by 2-8°C'

The capital costs of traditional drainage systems are more than double the capital costs of SuDS schemes. Annual maintenance costs are 20-25% less for SuDS. Over a 60-year life span, the whole-life costs of a SuDS scheme are around half that of a traditional system.[21]

GI can also protect and enhance the resilience of other infrastructure. For example, it can reduce erosion risk next to transport infrastructure – plant roots stabilise the soil and the plants themselves help to hold back the water.

In terms of *coastal flooding*, many of Europe's urban areas are on the coast and just metres above sea level. With sea levels rising and storms becoming more severe, peak tides are likely to increase. Saltmarshes and other natural coastal vegetation can prevent or reduce coastal erosion and the impact of extreme tidal events.

Moderating extreme temperatures

Temperatures across Europe are set to become more extreme, as evidenced by the heatwave of the summer of 2018 – in Bratislava, Slovakia, one of the PERFECT partner cities, temperatures reached over 39°C.

Due to waste heat – from air conditioning or car exhausts, for example – urban temperatures are forecast to rise more sharply during hot weather than temperatures in rural areas. The physical properties of steel, concrete and other building materials are such that they trap more heat than plants do. This is known as the urban heat island effect (UHIE).

In Amsterdam, temperatures in the summer of 2018 were 6°C higher in dense urban areas without GI. In the Ljubljana Urban Region, in Slovenia, another of the PERFECT partner areas, there was a pronounced difference between the night-time temperatures in the centre of the city and in the outskirts.[22]

GI has a major role to play in combating the UHIE. Evidence shows that GI can cool the air by 2-8°C, helping to reduce heat-related stress and premature human deaths during high-temperature events.[23]

All vegetation has the ability to cool down its environment – the main reason being that plants extract energy from their environment to evaporate water. A single large tree can transpire 450 litres of water in a day, using 1,000 megajoules of heat energy to do so, making urban trees an effective way to reduce urban temperatures.[24] Trees also provide shading during extreme heat events, helping to make daytime temperatures more bearable and to enable physical exercise to continue during daytime hours.

Many of the PERFECT partners are planning GI in their urban areas as a cooling mechanism and to create shaded areas. For example, Cornwall Council is developing a 'Canopy Charter' and is working to encourage the planning of trees in the landscape; and the Government of Styria is funding schemes for greening roofs and façades.[25]

As well as saving energy by insulating buildings against cold and hot temperatures, green roofs also moderate temperatures, helping to make working environments more productive.

Supporting wildlife corridors

There are a range of particular conditions under which each plant and animal species can survive and thrive. Dependent factors include water availability, air humidity, average temperatures, and temperature ranges. In any location, all these factors are likely to be affected by climate change.

Roger Griffith (Rosser1954)

'If we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year'

Cold-associated birds, such as the willow warbler, willow tit and meadow pipit, have already been lost from many areas because of climate change.[26]

GI can be used to provide green corridors for wildlife and can take the form of green roofs, tree-lined streets, or linear green corridors along rivers, canals, roads, and railways. These corridors also offer benefits to people in terms of recreation, health, and reductions in noise and air pollution. They can often help urban populations to access the urban fringe and countryside by walking and cycling, rather than by taking the car.

The economic case for investing in green infrastructure

This Factsheet has presented arguments for investing in green infrastructure, based on the contribution it can make to mitigating and adapting to climate change.

In conclusion, there is an urgent need for policy-makers to invest in measures to mitigate and adapt to climate change. The economic implications of inaction are clear. It is estimated that the global annual cost of investment in climate change mitigation measures – to achieve stabilisation of CO_2 concentrations and so stabilise the global climate – is 1% of GDP, if we were start taking strong action now. If we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year.[27]

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Defintions on page 1:

The defitions are based on IPCC definitions (mitigation, adaptation and green infrastructure) three) and the European Commisions of greenhouse gases.

Pointers to further information

PERFECT project Factsheets and Expert Papers. **https://www.interregeurope.eu/perfect/library/**

Rising to the Climate Crisis – A Guide for Local Authorities on Planning for Climate Change. Second Edition. TCPA and RTPI. TCPA, Dec. 2018. **https://www.tcpa.org.uk/planning-for-climate-change**

Green Infrastructure Resource Library – further documents on the topics of the economic benefit of GI and investment models. **https://www.brillianto.biz/green-infrastructure/?q= GIRL-view**

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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, 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/
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