



What is Green Infrastructure?

Green Infrastructure “is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings.” Linked together, these strategically planned networks of green elements are able to provide multiple benefits in the form of supporting a green economy, improving quality of life, protecting biodiversity and enhancing the ability of ecosystems to deliver services such as disaster risk reduction, water purification, air quality, space for recreation and climate change mitigation and adaptation.

The European Green Infrastructure Strategy

The Green Infrastructure Strategy proposed by the European Commission, promotes the development of Green Infrastructure across the EU delivering economic, social and ecological benefits and contributing to sustainable growth. It guides the implementation of Green Infrastructure at EU, regional, national and local levels. A main feature of the Green Infrastructure Strategy is its integration into relevant policies through: ecosystem-based adaptation into climate change policies; nature-based solutions into research and innovation policies; natural water retention measures into water policies; and through its focus on delivering multiple ecosystem services and their underlying factor - a rich biodiversity - into nature policies. The

Natura 2000 network in particular plays a major role in protecting many of the core areas with healthy ecosystems.

As Green Infrastructure can make a significant contribution to many sectors and EU policy objectives, Green Infrastructure is being integrated into many funding streams including Structural Funds (the European Regional Development Fund (ERDF); European Social Fund (ESF)), the Cohesion Fund (CF), the European Maritime and Fisheries Fund (EMFF), the European Agricultural Fund for Rural Development (EAFRD), LIFE+ and Horizon 2020 project funds and the Natural Capital Financing Facility (NCF) of the European Investment Bank (EIB).

The European Strategy on Adaptation to Climate Change

Climate change adaptation actions are closely linked to Green Infrastructure as often Green Infrastructure can serve as an adaptation measure, e.g. floodplain restoration, urban Green Infrastructure to counter-act the urban heat island effect, etc. The EU Strategy on Adaptation to Climate Change aims to strengthen Europe’s resilience to the impacts of climate change by:

- Promoting action by Member States: the Commission encourages all Member States to adopt comprehensive adaptation strategies and will provide guidance and funding to help them build up their adaptation capacities and take action. The Commission will also support adaptation in cities by launching a voluntary commitment based on the Covenant of Mayors initiative.
- Promoting better informed decision-making by addressing gaps in knowledge about adaptation and further developing the European Climate Adaptation Platform (Climate-ADAPT) as the ‘one-stop shop’ for adaptation information in Europe.
- Promoting adaptation in key vulnerable sectors through agriculture, fisheries and cohesion policy, ensuring that Europe’s infrastructure is made more resilient, and encouraging the use of insurance against natural and man-made disasters.

Links between Climate Adaptation & Green Infrastructure

Climate change adaptation anticipates the adverse effects of climate change by taking appropriate action to prevent or minimise the damage it can cause, or taking advantage of opportunities that may arise. Green Infrastructure is among the most widely applicable, economically viable and effective tools to combat the impacts of climate change and help people adapt to or mitigate the adverse effects of climate change. Examples of how it can help include: using scarce water resources more efficiently; restoring natural flood defences; using tree species and forestry practices that are less vulnerable to storms and fires; implementing natural water retention measures; reducing heat islands in urban areas; and setting aside land corridors to help species migrate.

The Land use, Land Use Change and Forestry (LULUCF) as defined under the UNFCCC's Bali Action Plan of the Kyoto Protocol encourages Green Infrastructure initiatives in the agriculture and forestry sectors that have a positive effect on carbon stocks and the greenhouse gas balances in Member States, thus helping to put EU climate policies into practice. Green

Infrastructure solutions that boost disaster resilience, against climate change related risks, such as flooding, landslides and avalanches, are an integral part of EU policy on disaster risk management. Green Infrastructure solutions linked to adaptation can be found for example in the EU Floods Directive.



Costs & Benefits of Green Infrastructure in relation to Climate Adaptation

Climate adaptation related Green Infrastructure measures are an important instrument for achieving sustainable adaptation, while creating multiple benefits and having the potential to save lives and save costs. An example of the many benefits of Green Infrastructure is the restoration of floodplain forests; adaptation benefits include flooding prevention; other benefits include CO2 storage (climate change mitigation), filtration of pollutants, maintaining the water table, erosion prevention, and restoring connectivity for migrating species. Restoring floodplain forests is often cheaper in terms of maintenance costs than purely technical solutions such as building dams and floodplain reservoirs. Green Infrastructure thus can deliver the same level of flood prevention as purely technical solutions, often at lower cost, while being more resilient, and additionally deliver further benefits (as compared to single-purpose technical solutions).

Examples of economic benefits from climate adaptation related Green Infrastructure have shown that large savings can be achieved. For example, estimations based on the restoration of tidal habitats on 440 ha of agricultural land at Alkborough Flats (UK) show that the project costs were EUR 11.8 million. The scheme is estimated to deliver an annual flood protection benefit of EUR 465,000, with total benefits (including for example benefits for wildlife and ecosystem services) adding up to a present value of EUR 14 million.



Good practices in Climate Adaptation & Green Infrastructure

Agroforestry: agriculture of the future: the case of Montpellier (France, 2014)

The agriculture sector in Montpellier is highly vulnerable to the rising temperatures and more frequent droughts associated with climate change. As part of the SAFE project, a French national scheme is installing 0.5 million ha of agroforestry during the next 25 years. Green Infrastructure is being implemented in the agricultural sector by changing a homogeneous monoculture system into a heterogeneous agricultural approach, in which a mixture of trees and crops is cultivated. Agroforestry is more resilient to the effects of climate change, as trees provide shelter to crops and reduce damage due to high spring temperatures.

Research showed a 40% increase in productivity: 1 ha of a walnut and wheat mix produces the same as 1.4 ha with trees and crops planted separated.

The agroforestry system not only protects against climate change but has many other benefits. It has an economic benefit for farmers because of the 40% increase in productivity. Agroforestry also improves soil and water quality, reduces (wind) erosion and prevents damage due to flooding. It creates a more diverse habitat, which has a positive impact on biodiversity and related ecosystem services such as pollination and natural pest control. Agroforestry schemes are a long-term investment. It takes some time until trees mature and provide the functions and benefits described.

Rotterdam climate resilient city: flood protection (the Netherlands)

The Rotterdam Climate Change Adaptation Strategy enables the city to adapt to climate change and shows how inhabitants, businesses and the city can also achieve maximum benefit. As a global port in a river delta, Rotterdam needs to cope with rises in sea level and extreme river discharges, which can lead to an increased flood risk and the risk of victims and (economic) loss. At the same time, the possibility of frequent heavy rains or long periods of drought is increasing, which may affect the quality of life in the city.

Green Infrastructure, in combination with technical solutions, is an important part of the adaptation strategy in Rotterdam, which includes water squares and canals to relieve the sewage system, green infiltration zones along infrastructure and the integration of trees and greenery in outdoor areas (both public and private) to reduce city temperatures and avoid flooding.

There are multiple benefits of climate change adaptation such as opportunities to strengthen the economy of the city and the port, improving the quality of life in neighbourhoods and districts, increasing biodiversity in the city and fostering



committed and active participation by Rotterdam's residents. This example shows that a climate change adaptation strategy can boost the regional economy, as it is estimated that 3,600 jobs in the region are directly linked to climate change adaptation. Over 100 cities from across Europe (including Rotterdam) have already committed to take action on climate change adaptation by joining the Mayors Adapt Covenant.

Lower Danube Green Corridor: floodplain restoration for flood protection (Bulgaria, Romania, Ukraine and Moldova, 2014)

In 2000, the governments of Bulgaria, Romania, Ukraine and Moldova signed the Lower Danube Green Corridor Agreement to establish a green corridor along the entire length of the Lower Danube River (~1,000 km). The aim of the project is to reduce the risks of major flooding in areas with human settlements. The Green Infrastructure along the river is protected and restored, e.g., through natural wetlands, and the river is reconnected to its natural flooding areas. In addition, co-benefits are created both for local economies (e.g., through fisheries and tourism) and restoring an ecological corridor for migrating species along the river.

The total costs have been estimated at EUR 183 million, while the economic benefits through the avoidance of damage due to floods are much larger

(e.g., the 2005 flood resulted in EUR 396 million in damages). In addition, the expected earnings through ecosystem services (e.g., fisheries, tourism) are EUR 85.6 million per year. Each ha of restored floodplain is estimated to provide EUR 500 per year in ecosystem services, helping to diversify the livelihoods of local people.



Challenges and opportunities

Although Green Infrastructure is already relatively well established in climate adaptation strategies, further uptake would be encouraged through:

- Stronger focus on integrated spatial planning and methods to stimulate cross-sectoral regional cooperation.
- Stronger focus on long-term investments, planning and sustainability in decision making.
- More examples of good Green Infrastructure design options for climate change adaptation and how to design Green Infrastructure for optimal multiple benefits.
- Stronger evidence base on the multiple benefits of Green Infrastructure, quantifying both the economic and social benefits and avoidance of costs.
- Better visibility of Green Infrastructure in climate adaptation sector information sharing mechanisms

References

Floods Directive: http://ec.europa.eu/environment/water/flood_risk/index.htm
 Climate resilient agroforestry: <http://www1.montpellier.inra.fr/safe/english/agroforestry.php>
 COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Green Infrastructure (GI) — Enhancing Europe's Natural Capital /* COM/2013/0249 final */
http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm
 Landscape architecture and the challenge of climate change (2008). Landscape Institute Position statement.
 Lower Danube Green Corridor: floodplain restoration for flood protection <http://climate-adapt.eea.europa.eu/>
 Naumann, S. et al. (2011): Assessment of the potential of ecosystem-based approaches to climate change adaptation and mitigation in Europe.
 Rotterdam climate resilient city; <http://www.rotterdamclimateinitiative.nl/en>
 Mayors Adapt initiative: <http://mayors-adapt.eu/>
 European Climate Adaptation Platform: <http://climate-adapt.eea.europa.eu/>

Contract details: EC DG ENV, ENV.B.2/SER/2014/0012 "Supporting the implementation of the European Green Infrastructure Strategy"

Presented by: Trinomics, Alterra, Arcadis, Regional Environment Centre, Risk & Policy Analysis, Stella Consulting.

Disclaimer: The information and views set out in the factsheet are those of the author(s) and do not necessarily reflect the official opinion of the European Commission (EC). The EC does not guarantee the accuracy of the data included in this factsheet. Neither the EC nor any person acting on the EC's behalf be held responsible for the use, which may be made of the information contained therein.