ESPON

EUROPEAN UNION

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Inspire Policy Making with Territorial Evidence

POLICY BRIEF

Green infrastructure in urban areas

Green infrastructure (GI) is made up of interconnected green and/or blue areas that are developed through a strategic planning approach that creates solutions to problems of land conservation, ecological and social effects of urban sprawl, and the rapid fragmentation of landscapes. GI can be a tool for organising urban areas to protect and support the integrity of ecological and cultural functions and for ensuring the sustainability of urban areas. Local authorities tend to have the main responsibility for implementing GI in Europe due to their remit of planning and investing in urban infrastructure. They exercise influence over the nature of infrastructure renewal and expansion, and they have the ability to promote greener and more sustainable urban centres.

Despite relevant good practice examples of mature spatial planning systems that incorporate a GI approach, there is still great uncertainty in planning practice on how, and at which scales and in which phases of the planning process, to make use of the GI approach. It can also be unclear how best to benefit from the approach's integrative capacity for supporting sustainable development. This policy brief aims to help European, national, regional and urban authorities to better understand how GI in urban areas can be created, managed and enhanced.

KEY POLICY MESSAGES

- Between 2006 and 2012, many cities throughout Europe have lost green spaces, mainly because of unsustainable urbanisation. Continuous monitoring of GI development is key to identify areas where measures are required to protect green spaces from disappearing.
- Cities have the means to counteract the degradation and loss of natural capital and the ecosystem services that this capital can provide. Local authorities are responsible for planning and investing in urban infrastructure. They can make important choices concerning the nature of infrastructure construction, renewal or expansion, and they can promote greener, more sustainable cities.
- The biggest supporting factor in GI implementation is a strategic vision that is widely shared by policymakers and planners and is implemented through an integrated planning process that embeds different sector policies and different levels of governance.
- Strategic Environmental Assessment (SEA) can be used as a policy tool for incorporating GI into strategies, plans and programmes. Including GI in SEA could help to establish a common framework for implementing GI in all European Union Member States in which GI not only is promoted as a sectoral element of planning, but also contributes to enhancing strategic thinking and the positioning of ecological processes and their benefits as relevant planning criteria for more resilient territorial development.

1. Introduction

Green infrastructure (GI) has become prominent in spatial planning, policy and research over the last few decades. It is widely understood as a network of physical features that provides ecological, economic and social benefits to society through nature-based solutions (NBSs [1]), underpinning human well-being and quality of life. In urban areas, GI can be made up of green and blue spaces, such as parks, street trees, rivers and green roofs. These natural and semi-natural areas are strategically planned and managed to deliver a variety of ecosystem services. In cities and urban areas, potential benefits derived from GI can include the mitigation of urban heat island effects, flood risk reduction, the absorption of CO_2 in places where emissions can be extensive, the provision of sustainable transport options (e.g. walking and cycling lanes) and improved mental health and well-being.

More and more cities struggle with the challenges of unsustainable urbanisation and related human health issues; degradation and loss of natural capital and the ecosystem services it provides (clean air, water and soil); and climate change and an alarming increase in natural disaster risks. Given that, currently, more than 70 % of Europe's population live in cities and that this share is expected to increase steadily, the creation, conservation and management of GI in urban areas can play a key role in addressing these development challenges (Urban Agenda for the EU, Sustainable Use of Land and Nature-Based Solutions Partnership, 2018).

Cities have particular characteristics that act to exacerbate the impacts of climate change and extreme weather. The high proportion of impervious surfaces in urban areas increases flood risk because of the increased volume of rainwater run-off and speed at which it reaches watercourses, which are themselves often heavily modified and channelised, reducing their capacity to deal with excess water. In addition, the built environment creates urban heat islands, which is projected to intensify with climate change. As cities also encompass a high concentration of elements at risk to climate and weather impacts, such as people, critical infrastructure and buildings, they are key to the adaptation agenda.

Local authorities tend to have the main responsibility for implementing GI in Europe because of their remit of planning and investing in urban infrastructure. In many cases, local governments have authority over the selection of infrastructure projects at the municipal level. Therefore, they exercise influence over the nature of infrastructure renewal and expansion and have the ability to promote greener and more sustainable urban centres (Merk et al., 2012). This offers important opportunities for municipal stakeholders to leverage their cities' development potential for advancing environmental quality by implementing green solutions.

This ESPON policy brief promotes a GI approach in spatial planning that not only connects different elements of nature, but also crosses ecological and political boundaries and links sector policies. The policy brief further aims to support discussions surrounding the implementation of GI at intergovernmental level during the Croatian Presidency of the Council of the European Union's (EU's) first semester of 2020.

1 NBSs are "… solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions" (https://ec.europa.eu/research/environment/index.cfm?pg=nbs).

2. The territorial pattern of potential green infrastructure in European cities

The ESPON GRETA project (GReen infrastructure: Enhancing biodiversity and ecosysTem services for territoriAl development) conducted an assessment of urban GI that includes all available green and blue areas (i.e. whatever is "green" and "blue" is part of the urban GI network). The most relevant land cover/land use data set for this analysis of cities and their immediate hinterland (peri-urban space) is the Urban Atlas layer provided by the European Copernicus programme. The Urban Atlas spatial data complement the city statistics collected by Eurostat in the framework of the Urban Audit programme.

In the Urban Audit, cities are represented at three spatial levels:

- The ***core city*** is a local administrative unit (LAU) in which the majority of the population lives in an urban centre of at least 50,000 inhabitants.
- The ***functional urban area (FUA)*** adds the commuting zone to the city.
- The greater city approximates the urban centre when this stretches far beyond the administrative city boundaries.

The Urban Atlas maps the FUAs of almost 700 cities or city agglomerations across Europe.[2] The core city is, for the most part, a subset of the FUA in which it is located. To reflect the green (and blue) urban areas, all Urban Atlas classes that represent green and blue urban areas are aggregated into one class of "green urban areas" (GUAs) and their proportion in relation to the total area of the reference units is calculated.

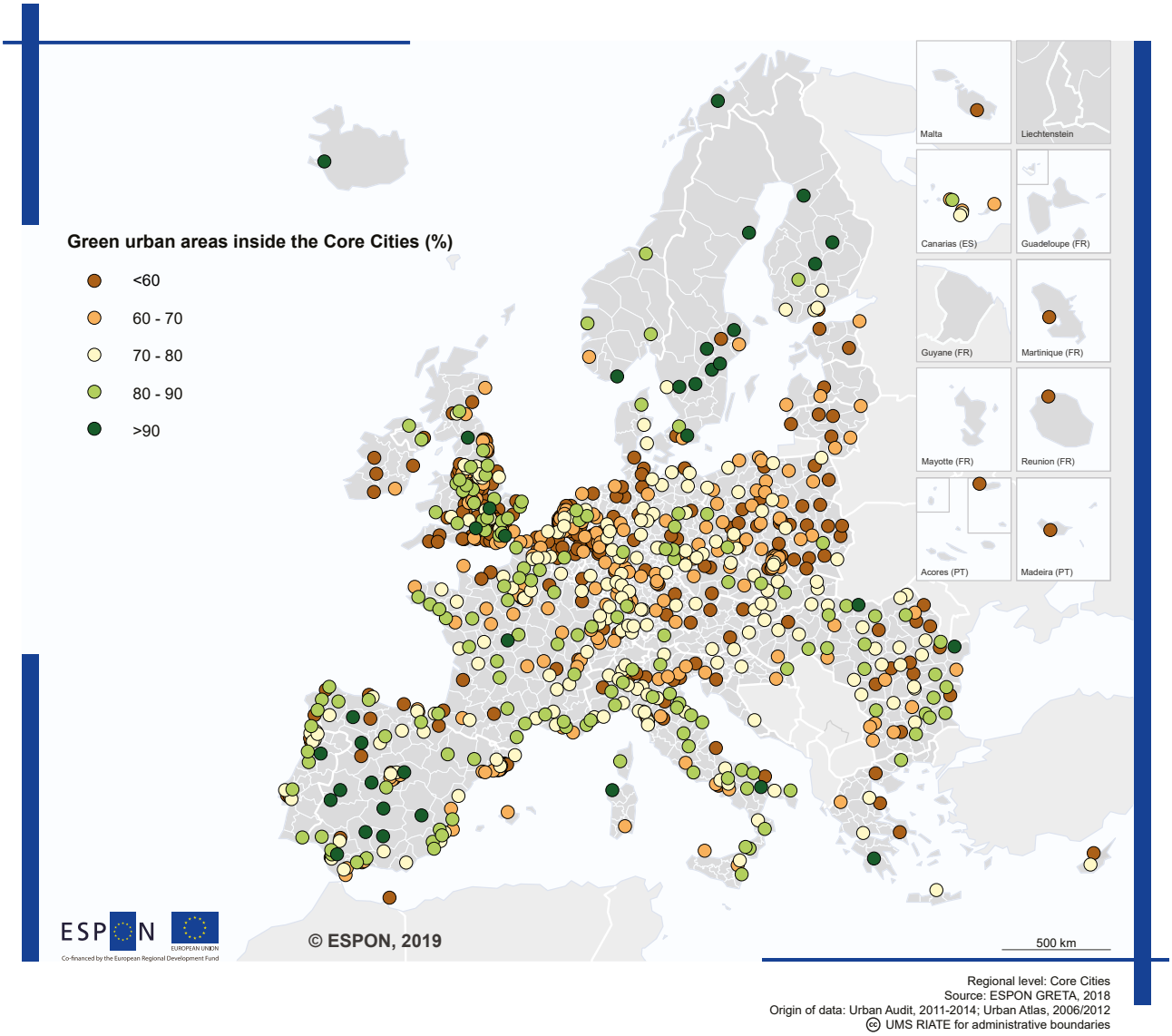
Hence, to provide an overview of the status of urban GI, the following parameters and indicators were calculated and mapped:

- share of GUA within (1) the core city (representing the city level), (2) the entire FUA (representing the entire reference unit) and (3) the FUA without the core city (representing the peri-urban space alone; all values in %); and
- ratio of the share of GUA inside the core city to the share of GUA inside the entire FUA (unitless ratio).

Map 1 shows the share of green (and blue) urban areas for all core cities in Europe. It is clear that many European cities (including their commuting zones) are relatively green, possessing more than 80 % green areas. In terms of the distribution of values, there is a concentration of core cities with lower shares of green (and blue) urban areas in a corridor from the UK, over the Benelux countries, to Germany and the north-eastern part of Europe (Poland and the Baltic countries). Other clusters of low values are visible in northern Italy and Romania. The highest shares of green (and blue) urban areas inside core cities are recorded in Spain and the Scandinavian countries.

2 ***Issues regarding spatial coverage:*** At the city level, the Urban Atlas is the main source of information for the indicators informing about GI. The Urban Atlas is a EU product that, in its first version in 2006, mapped cities in the then EU-27 territory. In the newest Urban Atlas (reference year 2012), the EU-28 and the four European Free Trade Association (EFTA) countries, Iceland, Liechtenstein, Norway and Switzerland, i.e. the entire ESPON space, are covered. Consequently, 32 countries can be analysed for the reference year 2012. However, to enable analysis of changes from 2006 to 2012, cities from the EU-27 were assessed (see Map 3).

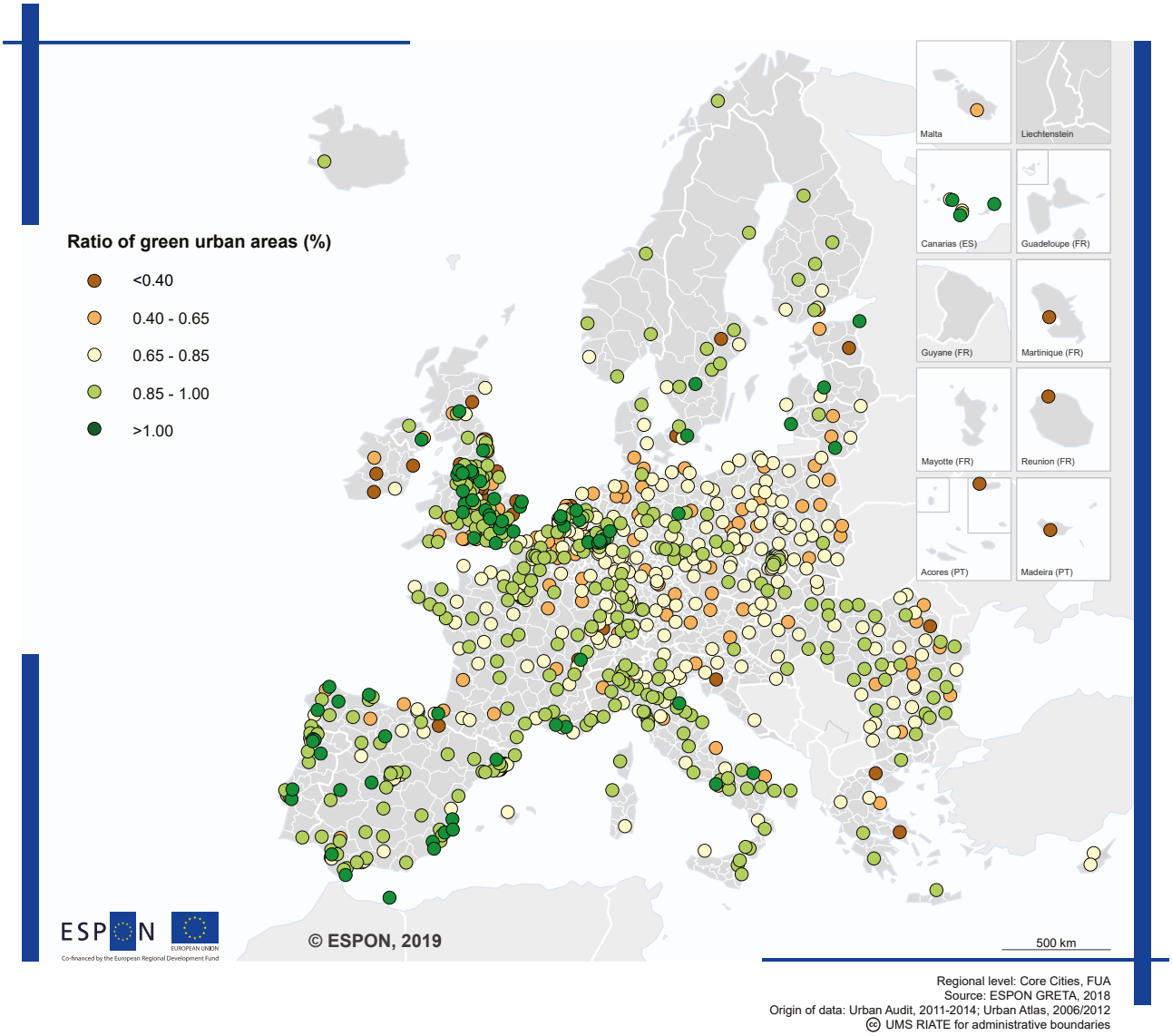
Map 1
Green urban areas inside the Core Cities



Source: ESPON GRETA, 2018.

To allow for an analysis of the urban hinterland's significance in providing green spaces, the ratio of the share of GUA inside the core city to the share of GUA inside the FUAs (see Map 2) was calculated. A value of 1.0 means that both core city and FUA have the same share of GUA; values below 1.0 indicate that there are more green spaces in the urban hinterland than in the core city; and values above 1.0 mean that there are more green spaces in the core city than in the hinterland.

Map 2
Ratio of green urban areas inside the Core Cities compared to the FUA

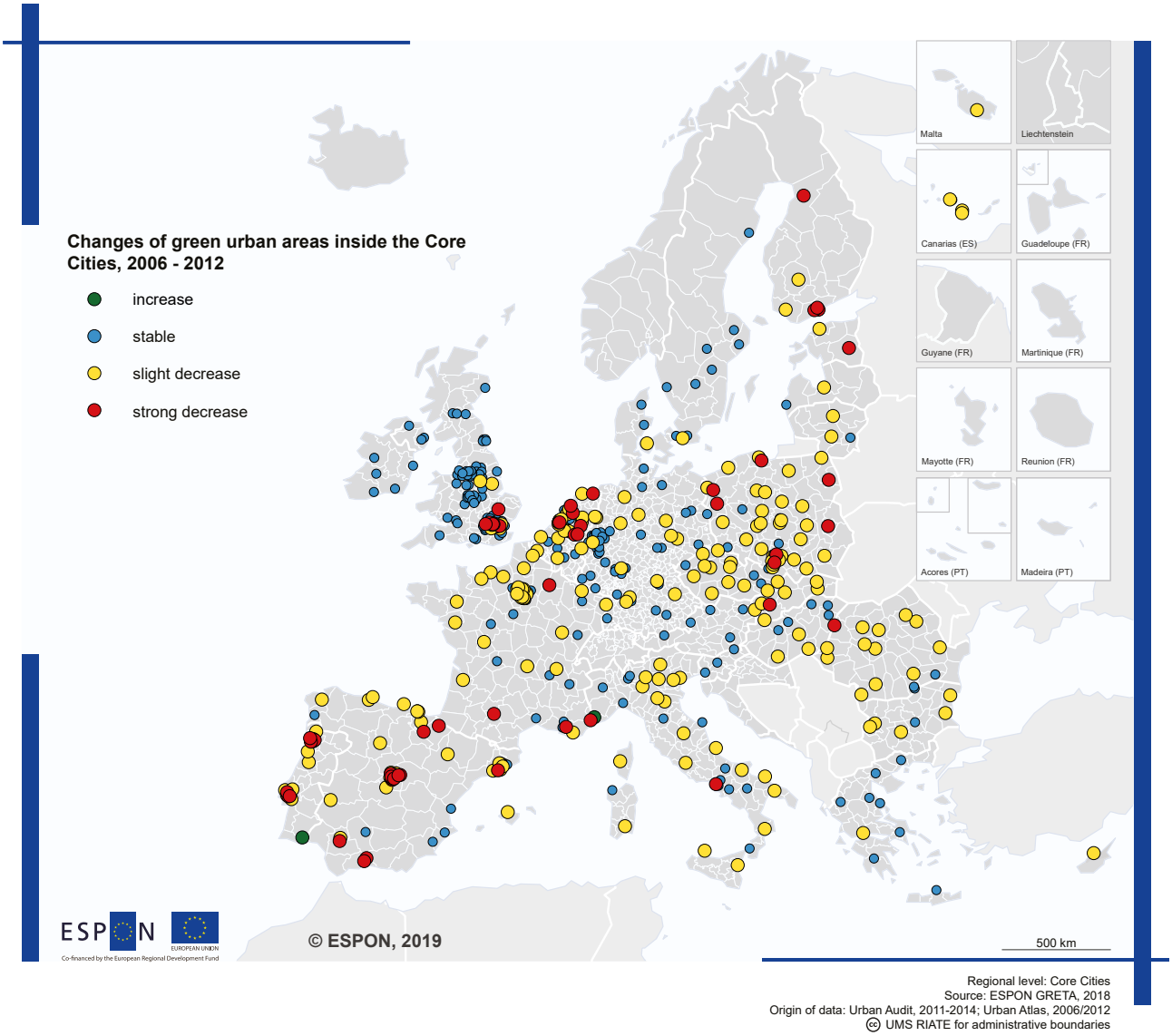


Source: ESPON GRETA, 2018.

Unsurprisingly, in general, European cities have more green spaces in their surroundings than within them. For around 100 cities, the core city value equals the FUA value, meaning that there is no difference between them. Cities with a value of over 1.0 are distributed across several European countries, with most located in the UK or Spain.

Map 3 illustrates the changes in the share of urban green spaces between 2006 and 2012. Blue dots represent core cities in which the share remained rather stable (i.e. a change of less than 0.5 % in a positive or negative direction); orange and red dots indicate cities that experienced a decline in green spaces of more than 0.5 %, subdivided into a slight decrease (0.5–2 %) and a strong decrease (over 2 %), respectively; and green dots show cities with an increase in green spaces of more than 0.5 %.

Map 3
Changes of green urban areas inside the Core Cities



Source: ESPON GRETA, 2018.

As a general pattern, it can be observed that cities with stable or decreasing green spaces dominate the map. While a stable situation is more prevailing in central and north-western Europe (in particular Belgium, Germany and the UK, but also in the Alpine countries), a large proportion of decreasing green spaces can be observed in eastern and southern European countries, as well as in the Netherlands and Finland. The Spanish cities of Pamplona (–7.8 %) and Getafe (–7.6 %) experienced the strongest decreases in urban green spaces, followed by the Communauté d'agglomération de Sophia Antipolis in France (also –7.6 %). Only three cities showed an increase in urban green spaces: Faro (Portugal, 3.3 %), Nice (France, 2.3 %) and Capelle aan den IJssel (the Netherlands, 0.7 %). In eastern and southern European countries, the most likely reason for a decline in urban green areas is urbanisation as a result of economic development after joining the EU (eastern Europe) or because of growth in tourism (southern Europe). Key features of urban transformation in eastern Europe in the 1990s and 2000s include, but are not limited to, the commercialisation, regeneration and densification of inner-city areas and a dynamic expansion of built-up space, largely driven by private actors in the re-established land markets. One essential spatial outcome of this process is suburbanisation, a phenomenon that was largely suppressed in central eastern European countries before 1989. The relatively compact urban form of the socialist city was, thus, gradually replaced by a more decentralised and dispersed urban structure. Suburbanisation has led to a strong

increase in urbanised land, as well as reductions in urban density (Taubenböck et al., 2019). This underlines the value of both compact cities that allow easy access to services using sustainable transport modes and open, non-built-up spaces in core cities and their hinterland.

CASE STUDY 1

Urban strategy for biodiversity in Lisbon (PT)

Lisbon lost green urban areas in the period from 2006 to 2012, but the city has understood that there are significant benefits to improving and restoring GI elements within the confines of the metropolitan area. Together with partners, the city council embarked on a programme to define a strategy for biodiversity in Lisbon for 2010–2020 to increase urban biodiversity by 20 % by 2020. This strategy was put into practice by a local action plan that defines clear actions and approaches to reach the goals. Among the tasks for implementing the biodiversity strategy were an increase in public green spaces and their physical connections, an increase in the total length of naturalised water courses, promotion of the conservation of natural areas, and awareness raising for biodiversity through environmental education. The city's GI programme set out to implement nine green corridors to be completed by 2020. This is a vital contribution to tackle habitat fragmentation and climate change, providing soil permeability and attenuating the heat island effect. In addition, Lisbon applied the City Biodiversity Index, took part in the MAES (Mapping and Assessment of Ecosystem Services) urban pilot and acted as a city lab in the EU Joint Research Centre's EnRoute project. Although more recent data are not available from the Urban Atlas, it can be assumed that the share of urban GI might already have increased as a result of focused and well-conceived spatial planning and local decision-making. The city was rewarded for its efforts by being selected as the European Green Capital for the year 2020.

Source: ESPON GRETA, 2019.

It is important to note that the assessments and maps presented here are based purely on European-wide spatial data that do not take into account single or small-scale local measures, such as green roofs, walls or green strips along roads. The reason for this is that these European data sets are based on remote sensing data with a specific spatial resolution (2.5 m pixel size in this case). Therefore, smaller objects, in particular vertically oriented ones, cannot be mapped using this approach. Only larger changes from green to non-green space or vice versa are included in the maps, e.g. conversion from agricultural land to residential uses or re-greening of old industrial sites by converting them into urban parks or recreational zones. These maps are therefore not suitable as a basis for developing strategies at a local level; rather, they allow comparisons at a European level. Nevertheless, the hotspot indicator is particularly relevant for decision-making, as it gives an indication of where action might be required or would be of the highest value in order to protect green spaces from disappearing and to preserve the health and well-being of citizens (European Environment Agency, 2019). Further research could attempt to analyse the location of such hotspots in GI hubs or links at the landscape level and therefore provide further insight for spatial planners.

3. Supporting and limiting factors for harnessing the green infrastructure development potential in European cities

According to a stakeholder survey conducted within the framework of the ESPON GRETA project, the **biggest supporting factor in the process of implementing GI is a strategic vision**. Ideally, stakeholders involved in the GI implementation process agree on common goals and an integrated planning process, which ensures that planning, implementation and maintenance of GI are well coordinated. This requires that stakeholders have sufficient knowledge of the cost–benefit ratio in employing NBSs compared with the use of traditional approaches. It further requires political commitment at all scales of governance to ensure that policy objectives will not be substantially modified with a potential change in government after elections.

As GI has been integrated in spatial planning only recently, there is not yet much long-term practical experience that could serve to systematically guide stakeholders through the planning, implementation and maintenance process for GI. As part of general education in spatial planning, **training measures could be very helpful to enable young professionals, as well as more experienced planners and policymakers, to fully tap the potential for GI development** in their respective locations. These measures should explain the functioning of ecosystems to stakeholders across different sectors, which is important because GI is a cross-sectoral concept. Furthermore, training measures should help raise stakeholders' awareness of the use of economic valuation methods for GI in planning and decision-making.

Financial incentives are scarce and, when funding opportunities are available, they are mostly focused on the conservation of green areas. **What is needed is a functional approach that aims to preserve certain ecosystem services**, such as improving ecological resilience or increasing public health outcomes. **The mere conservation of green areas is not sufficient**.

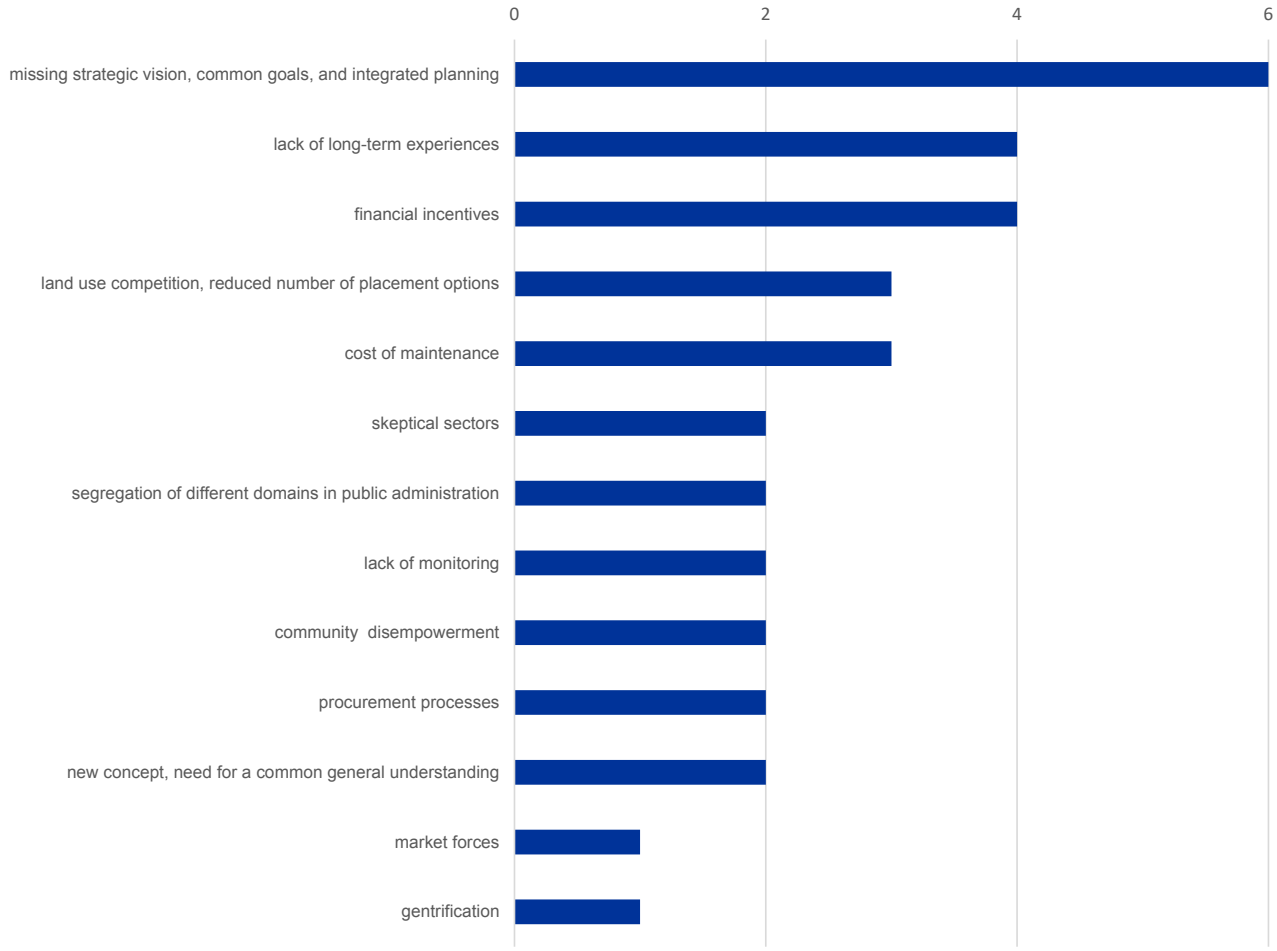
GI development requires space, which is often scarce in urban areas and in intensely developing regions in general. A lack of space may jeopardise the implementation process. **GI development may therefore add pressure and increase land use competition, and hence become a driver for territorial inequalities**. For example, attention should be paid to the potential displacement of long-term historical residents as a result of an eco-gentrification process.

An increase in GI can lead to an increase in land and property values, which may result in the displacement of long-term residents who can no longer afford to live in the developed area. This **can, in some cases, foster socio-spatial segregation**.

One of the basic prerequisites for preserving and restoring networks of green and blue areas is to have **geographical knowledge of the existing GI and its environmental qualities**. While information about the location of protected areas is readily available in most European countries, georeferenced information on the environmental quality of these areas is not perceived to be easily available at national levels. Continued mapping of land cover and land use patterns (e.g. protected areas, forests, agriculture, level of fragmentation, ecological networks) and the environmental quality of land and waters is an important action for GI implementation. The available knowledge could be increasingly used as a basis for decisions in spatial planning on where to locate new housing, commercial areas, industries, roads and waste disposal sites, which would enhance GI in Europe.

Figure 1 provides an overview of the most frequent barriers and challenges in the implementation of GI.

Figure 1
Most frequent barriers and challenges in the implementation of Green Infrastructure



Source: ESPON GRETA, 2019

There is no general rule as to who should lead the process of GI implementation. This largely depends on the existing policy or project targets, where the project is being developed and who is promoting it, i.e. regional or national government, local municipalities or the private sector. Ideally, it should be a cooperative process in which local authorities are the main stakeholders but in which communities of interest and communities of practice are vital if GI is planned to be extended. Interdisciplinary teams guided by professionals should ensure the integration of knowledge from different domains. **A combination of bottom-up and top-down approaches is probably the best option for effective GI implementation processes at the local scale**.

CASE STUDY 2

Integrating conservation of urban GI into spatial planning policy in Finnish cities

The Finnish approach of National Urban Parks (NUPs) provides an example of how conservation work for urban GI can be integrated into spatial planning policy in a consistent way. NUPs are established to preserve the beauty of a cultural and natural landscape and to maintain ecological corridors, biodiversity, and cultural and natural heritage in urban areas. The Finnish Ministry for Environment coordinates the development process and has defined four criteria for potential NUPs: (1) the park must contain natural areas with valuable biodiversity and cultural elements relevant to the history of the city, and parks and green areas with architectural or aesthetic significance; (2) the park should cover an area that is big enough to allow people to walk from one part of the city to another by crossing the park; (3) the park should function as an ecological corridor, allowing species to access and interact with green and blue nature areas outside the city; and (4) the park should be located in the city centre or the immediate surrounding area.

Currently, nine Finnish cities have implemented NUPs: Hämeenlinna, Pori, Heinola, Hanko, Porvoo, Turku, Kotka, Forssa and Kuopio. All are committed to the park action plans, which are prepared in consultative cooperation with the Ministry for Environment.

Source: ESPON GRETA, 2019.

A more explicit approach to GI at the national level of governance could facilitate further implementation of the European GI strategy. **In countries that do not have a national GI strategy, clearer top-down communication about the GI concept and its principles could facilitate GI integration in policy sectors where it is not yet prevalent** (i.e. finance, health, social services). Nevertheless, for GI implementation to take off, a core recommendation of the EU's GI strategy is to develop GI-specific policies at the national level.

4. Approaches to financing green infrastructure in cities

Cities are key actors in stimulating GI, and urban finance is an important means for achieving GI implementation. Municipalities are key investors in infrastructure with green potential, such as buildings, transport, water and waste. Their main revenue sources, such as property taxes, transport fees and other charges, are based on these very sectors. They thus have great potential to green their financial instruments, such as through congestion charges, variable parking fees and toll lanes. However, budgets specifically for nature and green space are usually insufficient. These constraints call for mobilisation of new sources of finance. A partial solution is for local authorities to find creative ways of channelling funding from other relevant public authorities. For example, cities could pool funding from different departments within the city administration to deliver GI projects with cross-sectoral benefits (e.g. urban forest management).

The private sector also has an important role to play in GI investment and the development of innovative "green" technologies in general. However, GI projects are complex and are often perceived as risky by investors, particularly in the early stages of development. Specific financial instruments (such as risk-sharing practices) can help reduce the risks associated with GI projects. The European Business and Biodiversity (B@B) Platform[3] showcases innovative GI projects carried out by businesses and provides a wide range of resources to facilitate business innovation in biodiversity and help businesses better account for their impacts on natural capital (European Commission, 2013a).

In addition, partnerships between public authorities and the private sector can provide opportunities for GI implementation. Certain conditions need to be put in place in order to attract and capture private sector investments, with the three main conditions being (1) the presence of markets for green urban investment projects, (2) likelihood of a good return on investment and (3) limited risk (Merk et al., 2012).

In urban areas there are two main options for financing GI or NBSs, which can be, but are not necessarily, building blocks for GI:

1. Direct implementation or maintenance of relevant projects, especially on municipality-owned land. The municipality pays for the intervention, either through funds it already has or by obtaining loans and revenues to finance the project.

Types of instruments falling under this category include:

- **innovative use of public budgets**, such as pooling funding from different government departments or making use of previously untapped sources, such as the public health budget.

CASE STUDY 3

Pooling of public funding to introduce NBSs in Poznań (PL)

Within the City Hall of Poznań, Poland, the Project Coordination and Urban Regeneration Office has entered into an innovative collaboration with the Department of Education to introduce NBSs in the gardens of state-run preschools in the densely populated city centre area. Each year the Department of Education funds the renovation of up to 10 preschool gardens (there are around 120 preschools in the city). The Project Coordination and Urban Regeneration Office offered to "top up" the Department of Education grant with specialised landscape design services, technical support and resources to encourage preschools to unseal hard surfaces, introduce more biodiversity and create nature-based gardens connecting with other urban green corridors. After a successful pilot in 2018, this programme was rolled out in 2019.

Source: Trinomics and IUCN, 2019.

3 https://ec.europa.eu/environment/biodiversity/business/index_en.htm

- **grant funding and donations,** including: EU funding; grants from regional and national public bodies; philanthropic contributions; and crowdfunding.
- **instruments generating revenue** (including value-capture mechanisms), such as revenues from land sales or leases; taxes (aimed at cost recovery); user fees; developer contributions or charges; betterment levies; voluntary contributions from beneficiaries; sale of development rights and leases; funds linked to offsetting or compensation requirements; and other voluntary schemes that generate revenues.

CASE STUDY 4

Carbon footprint compensation scheme to finance tree planting in Bologna (IT)

The Green Areas Inner-city Agreement (GAIA), an outcome of a LIFE project, allows businesses to calculate their carbon footprint and compensate for it (voluntarily) by making donations towards tree planting. The city council agrees to plant the trees, covers any unexpected maintenance costs for the first 3 years and provides project progress updates. The private entity agrees to pay the chosen contribution, which covers the purchase, planting and ordinary maintenance of the trees for 3 years. By April 2016, GAIA had secured the planting of 1 405 trees in the Bologna city area.

Source: https://climate-adapt.eea.europa.eu/metadata/case-studies/gaia-green-area-inner-city-agreement-to-finance-tree-planting-in-bologna.

- **"green finance" (or debt-based instruments):** loans from public or private financial institutions; green bonds; and the Natural Capital Financing Facility (NCFF).

2. Indirect implementation of projects through the encouragement of other actors, e.g. residents, utilities, businesses, which do so on their private property. Local authorities could also contribute to the maintenance of existing GI in the public domain. In this case, they provide incentives to other stakeholders or stimulate private finance by other means.

Types of instruments covered by this category include:

- **market-based instruments** — user charges, taxes (as incentives rather than as a cost-recovery mechanism), subsidies, tax rebates, credit-trading systems, offsets for residual impacts on biodiversity/GI and payments for ecosystem services;

CASE STUDY 5

Scheme for the purchase of rainwater management installations in Bratislava (SK)

As part of the Bratislava Turn Green project, the municipality encourages households to contribute to protecting the city from pluvial flooding through a subsidy scheme for the purchase of stormwater management systems. Since 2016, private organisations and households are eligible to apply for a subsidy covering 50 % of the total costs of the installation for small-scale projects, with a maximum cost of EUR 1000. The scheme also offers consultancy services to applicants on their project's implementation and disseminates information about the projects to raise awareness. Subsidy applicants are assessed by a steering committee of the subsidy scheme (consisting of the Vice Mayor, Office of the Chief Architect, the Department of Strategies and Projects and the Department of the Environment).

The majority of successful applicants have installed rainwater catchment tanks, created rain gardens, replaced impermeable surfaces with permeable materials or installed green roofs.

Source: Trinomics and IUCN, 2019.

- developing **Business Improvement Districts** to finance and deliver improvements, such as GI improvements, to commercial and industrial environments;
- setting up **endowments**, e.g. through the donation of property or money, developer contributions, land sales or other finance sources, with the interest accrued from investment of the funds used to pay for GI maintenance, leaving the original endowment untouched;
- creating **public–private partnerships (PPPs)**, which have been used for a range of infrastructure services and can also be developed for the delivery and/or maintenance of GI;
- **revolving funds**, which are replenished through repayments of the loans drawn from the funds or by a constant flow of financial contributions;
- **community asset transfers**, i.e. local authorities may transfer to community organisations the management or ownership (usually via a long leasehold) of public land or buildings.

CASE STUDY 6

"Beyond a construction site" – community-based gardening in Ljubljana (SI)

In 2010, a cultural association (Obrat) in collaboration with the cultural organisation 'Bunker', approached the municipality (owner of the site) to gain temporary lease of land that was a derelict construction site and transform it into a community space intended for urban gardens, socialising, education and culture. The city agreed to lease the land for free (originally for 2 weeks and then extended to a 1-year rolling contract, which is still ongoing) and the area was transformed into an attractive community space with the help of residents. It is unclear whether any funds are used for maintenance; presumably, the garden is maintained by residents.

Source: https://naturvation.eu/nbs/ljubljana/urban-gardening-ljubljana

European cities, regions and countries differ with respect to their specific geographical context and their governance settings. This implies that some of the financing mechanisms mentioned here will be more appropriate for some urban areas than others.

5. Innovative policy solutions or tools for green infrastructure

The way that GI is being dealt with varies greatly across the EU. Some countries have particular GI policies in place at the national or regional level. In others, there is no specific national policy or strategy but GI is embedded in different sectoral strategies, although the term is not necessarily directly used. Including GI in existing strategies, policies and legislation is in line with the EU's GI strategy (European Commission, 2013b, p. 10), which states that GI principles can be implemented by using existing policy and financial instruments. However, for implementation to take off, a core recommendation of the EU GI strategy is to develop GI-specific policies at the national level.

Spatial planning tools used for including GI in territorial planning are diverse and include a wide range of approaches. The ESPON GRETA analysis of GI policy and planning in Europe defined good practice as "implementation of instruments and/or actions in a way that can be perceived to successfully increase connectivity and multi-functionality in green space" (ESPON GRETA, 2019). The 25 good practice examples identified by ESPON GRETA seek to describe how modern tools, policies and processes for implementing GI development are used by local or regional planning authorities, and how local and regional governments liaise with private sector actors and local stakeholders for successful GI implementation. Good practice elements include the creation of regional planning committees to show long-term political leadership for GI implementation (such as in the Reykjavik capital area, Iceland); implementing GI through a focus on recreation and health to ensure territorial planning in cross-border metropolitan regions (such as in Greater Copenhagen – Skåne); considering GI in urban planning via national criteria included in planning legislation and driven by bottom-up approaches (such as the NUPs in Finland, presented in Chapter 3); developing regionally adapted methods to ensure integration of ecosystem services in spatial planning (such as in the Tvarna region, Slovakia); utilising green areas as part of tourism-based development as one element of an integrated strategy for urban development (such as in the Alba Iulia Municipality, Romania).

CASE STUDY 7

Integrated planning for GI in London (UK)

The London Olympic Park provides a valuable and high-profile example of how to design GI within a dense and complex urban area. It also shows that **effective GI delivery cannot be fully realised without a clear strategic framework and high-level political commitment**.

When London won the bid to host the 2012 Olympic and Paralympic Games, work started to transform the brownfield area of east London's Lower Lea Valley into the Olympic Park. Plans to tackle the environmental, economic and social degradation of the area had not proved deliverable in the past. In 2006, the Olympic Delivery Authority (ODA) developed two revised Olympic Park Masterplans that were used as planning documents and hands-on tools by the many designers, contractors and operators working on the park.

Specific targets for biodiversity were established at the start of the project and a dedicated Biodiversity Action Plan was prepared, adopted through planning and monitored in the long term. Ecologists were embedded within design and construction teams, which helped to ensure that the park would fulfil the needs of people and wildlife. In 2007, the ODA published its Sustainable Development Strategy (SDS), which defined specific sustainable development objectives and targets for the games, including for biodiversity and ecology. A key aim was also the restoration of the river corridors within the parklands to ensure that ecological corridors created for the Olympics linked with adjacent aquatic and terrestrial areas and networks.

Some of the lessons learned in the context of biodiversity management include the importance of establishing specific targets for biodiversity at the start of the process. Protecting and enhancing biodiversity was a key commitment at the outset and the ODA's SDS then established a set of specific integrated targets to meet these commitments. This had direct impacts on integrating biodiversity within the planning, design and construction of the entire parklands. Moreover, embedding ecologists within design and construction teams proved to be very valuable. Much of the habitat creation for the parklands started from

scratch. Ecologists and sustainability professionals were involved throughout the master planning, detailed design, construction and management of the parklands to ensure that biodiversity targets were safeguarded in the design process and ecological objectives were delivered on site throughout construction.

Source: https://www.queenelizabetholympicpark.co.uk/

In addition to planning tools, actor-networks, such as Amsterdam Rainproof presented below, and projects monitor, establish and/or enhance the quality of the non-built-up environment, such as the Swiss Effectiveness of Habitat Conservation monitoring programme, which records biodiversity data. The programme forms part of the development of current governance practices so that GI can be preserved more systematically in Switzerland.

CASE STUDY 8

Collaborative multi-actor approach to greening the city of Amsterdam (NL)

In Amsterdam, the water company Waternet established the Amsterdam Rainproof platform, which is the result of a **collaboration between citizens, public servants and entrepreneurs**. The platform raises the awareness of both urban residents and policymakers of the consequences of soil sealing. It thereby helps to address the challenge of flooding from rainwater and encourages people to consider the possibility of extreme rainfall in the design of houses, gardens, streets and parks. There was a need in the city to design urban green spaces where rain could be retained and stored to avoid damage to the built environment.

Furthermore, the concept of "polder roofs" was introduced by a group of social entrepreneurs who call themselves "Roof Doctors". Their ambition is to improve urban health by transforming unutilised roofs into places for nature development, recreation, water storage, and food and energy production. The "polder roof" is the ideal foundation for green roofs, roof gardens and green roof parks.

Source: https://amsterdamsmartcity.com/projects/amsterdam-rainproof, https://dakdokters.nl/en/

The good practice examples presented here all had a direct or indirect positive influence on green and blue infrastructure. They are transferable to other places, meaning that they could be applied at any scale of governance.

CASE STUDY 9

Green space factor for implementing green and blue infrastructure in built-up environments in Malmö (SE)

The idea for a green space factor was introduced at a housing and planning fair in Malmö, Sweden, in 2001. Inspired by this idea, planning authorities in Malmö developed a formula for the development of greener housing blocks. Since then, planning authorities have used the green space factor in many projects and it has been included as part of the local authority's environmental building practice. It means that developers need to compensate every surface they want to seal with something else that is green or blue. The green space factor is meant to secure a minimum amount of green and blue spaces in new development areas. It measures how ecosystem services are produced by the green and blue environments. The tool has an emphasis on assessing noise and air pollution reduction and water purification, which are especially important ecosystem services in cities.

The comprehensive territorial plan for Malmö, approved by the political board in 2014, stated that Malmö shall be developed as a sustainable, dense, green and mixed city. One of the strategies used to develop a greener city is the green space factor.

Source: ESPON GRETA, 2019.

6. Integration of green infrastructure into the spatial planning and design of urban areas and best practices

The need for integrated territorial development is widely acknowledged across governance levels. In its proposal for a regulation on the European Regional Development Fund (ERDF) and the Cohesion Fund for the post-2020 funding period, the European Commission advocates integrated territorial strategies also for urban areas. ERDF support post 2020 will be concentrated on two policy objectives, one of which addresses a greener Europe, which should be achieved by, inter alia, "enhancing biodiversity, green infrastructure in the urban environment, and reducing pollution" (European Commission, 2018). This approach is also reflected in the European Green Deal, which outlines a strategy for Europe to become "the world's first climate-neutral continent by 2050" (European Commission, 2019).

The Organisation for Economic Cooperation and Development's (OECD) *Principles on Urban Policy*, which should help decision-makers "to deliver better policies and improve well-being in cities for all", can be seen in the same spirit, especially as they serve, among other things, to "prepare all cities for technological, demographic and environmental change" (OECD Centre for Entrepreneurship, SMEs, Regions and Cities, 2019).

Spatial planning is by its very nature a cross-sectoral discipline that integrates various thematic considerations to achieve balanced territorial development. It is hence well placed to integrate GI planning, implementation and management.

Local authorities can trigger GI implementation by private stakeholders, such as infrastructure developers and homeowners, through regulatory and planning instruments. For example, planning regulations may require that new residential neighbourhoods incorporate a certain percentage of green space. Another way for local authorities to improve GI is by leveraging existing regulatory requirements to enable investment in NBSs instead of grey solutions. Entities, particularly in the water management sector, face regulatory standards that require large investments, usually in the form of high-cost and energy-intensive solutions, such as wastewater treatment plans. GI alternatives can be implemented instead to meet environmental regulations (Trinomics and IUCN, 2019).

Despite relevant good practice examples of mature spatial planning systems that incorporate a GI approach (see the Basque Country case study below), there is still great uncertainty in planning practice on how, and at which scales and in which phases of the planning process, it is feasible to make use of the GI approach. It can also be unclear how best to benefit from the approach's integrative capacity for supporting sustainable development.

CASE STUDY 10

GI considerations for climate change adaptation in regional spatial planning guidelines, Basque Country (ES)

The Basque Country has a robust spatial and urban planning system that (1) is integrated, multi-scale and multi-sectoral through the articulation of planning instruments; (2) uses operative governance mechanisms; (3) includes complementary competence distribution between public administrations (regional, provincial, local); and (4) is characterised by a territorial management culture. It also includes strong consideration of natural capital protection and GI enhancement, with substantial activities in the field of NBSs and key complementary activities, e.g. consideration of health in urban design.

The Basque Country has also approved a solid climate strategy with explicit actions for mainstreaming adaptation into spatial planning and for deploying resources towards resilient urban development. The development of substantial information on climate hazards and impacts (climate projections, flooding risk maps, urban heat island studies, local vulnerabilities) has also been crucial to enable the cutting-edge operative consideration of climate adaptation in spatial and urban planning instruments.

The Basque Country Spatial Planning Guidelines stipulate the territorial model and development in the region and define the recommendations for comprehensive, sectoral and urban planning. These guidelines represent a pioneering and novel approach to integrating climate change into spatial planning, in which GI and NBSs are the backbone of climate change adaptation. They have been materialised in two pilot instruments: the Integrated Plan of Bilbao Metropolitan Area and the subsequent Master Plan of Bilbao City. Lessons learned from this process at the three levels of planning could serve as inspiration in other territorial contexts.

Source: ESPON GRETA, 2019.

A GI approach to planning looks for connections between different elements of nature in the geophysical area, between nature and people's quality of life, across ecological and political boundaries, and across policy sectors. This approach blends well with functional approaches to planning and governance that respond to the realities of growing interrelations between places instead of planning within administrative borders.

GI provides a range of environmental, social and economic benefits, looks at multiple uses, which increases land use efficiency, and can contribute to mitigating long-term environmental challenges, such as climate change and biodiversity loss. To enable this, proactive and strategic planning is needed. The ESPON GRETA project identified Strategic Environmental Assessment (SEA) as an example of a suitable policy tool for incorporating GI into strategies, plans and programmes. SEA is a tool based on an EU directive and there are minimum standards and provisions that have been transposed into national law across Europe. It is intended to ensure that environmental assessment is integrated into the preparation and adoption of all strategies, plans and programmes at the earliest opportunity to provide a high level of protection for the environment and encourage long-term sustainable practices. SEA is supposed to "identify, describe and assess in an appropriate manner, in the context of each individual case, the direct and indirect significant effects of a plan on the following factors:

a. population and human health;
b. biodiversity, with particular attention to species and habitats protected;[4]
c. land, soil, water, air and climate;
d. material assets, cultural heritage and the landscape;
e. the interaction between the factors referred to in points a to d (ESPON GRETA, 2019).

Including GI in SEA could help to establish a common framework for implementing GI in all EU Member States in which GI not only is promoted as a sectoral element of planning, but also contributes to enhancing strategic thinking and the positioning of ecological processes and their benefits as relevant planning criteria for more resilient territorial development.

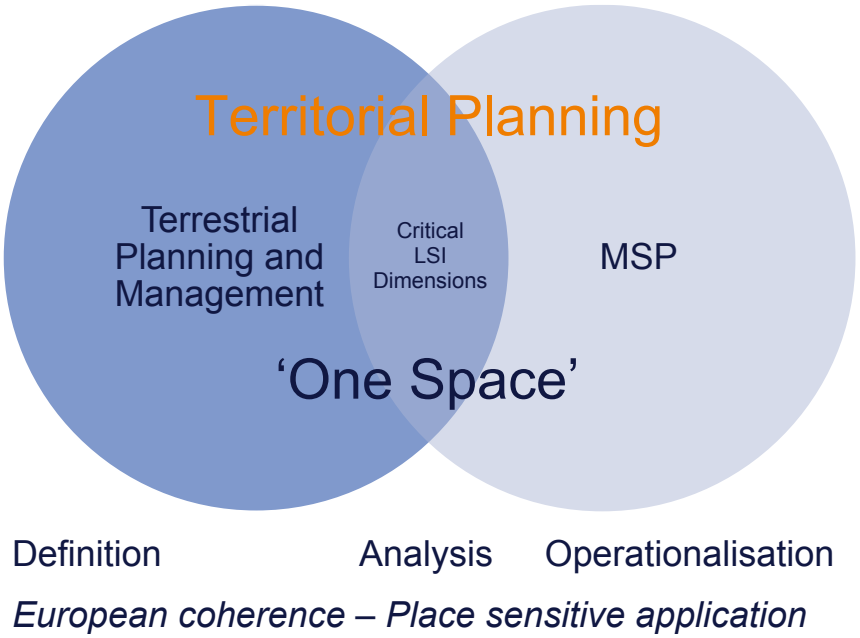
4 Under Directive 92/43/EEC and Directive 2009/147/EC.

7. Implementation of green infrastructure solutions in coastal cities

Cities in low-elevation coastal zones are confronted with rising sea levels due to climate change, which brings with it risks of coastal storm surges, coastal erosion and flooding. Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage. Blue and green spaces are key for maintaining mental and physical health and play important roles for many kinds of tourism, which in turn provides considerable economic benefits and is a vital source of income for many countries. Marine and freshwater systems also provide food for human consumption (Hansen et al., 2017).

Investments in coastal infrastructure are urgently needed to ensure community safety and prosperity. However, these investments should not jeopardise the ecosystems and natural resources that underlie economic wealth and human well-being. GI practices can hence play a critical role in making coastal communities more resilient to natural hazards and climate change. Furthermore, in this particular context, GI needs to be planned with the consideration of future climate change impacts in mind. This requires a dynamic approach to planning that systematically reviews changing contexts. Ideally, this planning approach integrates the maritime dimension in a "one space" perspective that considers land–sea interactions (LSI) and maritime spatial planning (MSP) (see Figure 2). In Poland, for instance, the Directors of the Maritime Offices can veto urban development plans that might potentially be damaging to coastal defensive systems and thereby increase risks of coastal flooding and raise concern over public health and wellbeing (ESPON MSP-LSI, 2019).

Figure 2



Source: ESPON MSP-LSI, 2019.

The Action Plan of the Urban Agenda for the EU Climate Adaptation Partnership noted a "lack of knowledge and understanding on the role and importance of biosphere, ecosystems and green infrastructure in urban adaptation to climate change" (Urban Agenda for the EU, Climate Adaptation Partnership, 2018). As noted above, it is nevertheless clear that marine vegetated habitats are effective at protecting coastlines from sea level rise and stormier weather conditions resulting from climate change. Marine plants are not only as efficient for coastal protection as cement-based solutions; they also have a number of other advantages. As living organisms they

can grow and adapt to changing conditions, as well as repair themselves. They do not produce CO_2 emissions during their installation but instead act as natural carbon sinks. Another important benefit is that they can provide important nurseries for commercially valuable fish, for example seagrasses (European Commission, 2013a).

Private actors can support public authorities in their adaptation efforts to combat climate change. The policy tool of compensating private landowners for water management exists in several Danish municipalities. In Copenhagen it is part of the public authority's climate adaptation strategy. Similar to Bratislava's Turn Green project (see Chapter 4), private households and organisations are compensated for investing in water management on their own properties. These types of measures are particularly important in coastal quarters of the city where the effects of climate change are most severe in terms of storm surges and coastal erosion.

Soft engineering structures for coastal management, such as replenishing coastal vegetation to stabilise beaches and sand dunes, are another means of maintaining and restoring coastal landforms and ecosystems.

CASE STUDY 11

Soft-engineering for coastal management in the Netherlands

The Dutch annual Delta Programme is intended to ensure that flood risk management and freshwater supply remain sustainable and robust beyond 2050, setting new flood protection and spatial adaptation standards and securing freshwater for cities and agriculture. A dyke system has always been used to reclaim and then protect land. In recent years this has provided an opportunity to implement NBSs, together with a smart spatial layout (soft approach). The Delta Programme has shown how soft engineering structures are more reliable in coastal management than grey infrastructure. Soft engineering coastal protection solutions involve a mix of beach nourishment, dune replenishment and the planting of vegetation to stabilise the newly replenished beach and dune. The Netherlands is now going through a process of "de-polderisation", a calculated retreat involving giving land back to the water.

Source: ESPON GRETA, 2019.

8. Policy recommendations for enhancing green infrastructure in urban areas

The ESPON GRETA analysis of urban GI (see Chapter 2) allows for identification of gaps and untapped potential in GI networks. Few cities in Europe have seen an increase in GI in the period from 2006 to 2012. This presents a critical opportunity for more joined-up, cross-sectoral planning, particularly in the face of the urgent need for climate change mitigation and adaptation action.

The following policy recommendations are relevant for GI management and implementation at the local scale but can also help decision-makers at any level of governance to plan and implement a connected and multifunctional GI network.

- **Adopt a GI approach in planning:** As outlined in Chapter 6, a GI approach to planning integrates different sector policies and different levels of governance and is proactive and strategic in the sense that decisions about conservation, protection and restoration of ecosystems incorporate information on how potential geographical areas fit within a network to optimise its functioning, and maximise its benefits, connections, complementarities and contributions to different sectors.
- **Identify existing assets and opportunities for GI:** The analysis of existing green and blue elements in the urban area in question is an important starting point.

Which green/blue areas could be restored, enhanced or created to be part of a GI network? Use existing available data to look spatially across the urban area for ways to connect these elements. Think creatively – are there rooftops or other structures that could have vegetation planted on them? Are there agricultural lands that could be enhanced by adding, for example, hedgerows, thereby providing habitats for wildlife and contributing to the management of water?

- I**dentify benefits and challenges of GI:** Planners and decision-makers should identify and quantify the main benefits and challenges of implementing GI for strategic planning and development, regardless of the scale of governance. This should be informed by the existing data and information and knowledge about the multiple benefits and challenges associated with GI. Using a "learning-by-doing" approach, based on scientific results and led by multi-disciplinarian scientific teams, can help identify these multiple benefits. One method for including GI benefits in decision-making is through cost–benefit analysis.
- **Create a shared vision:** It is important for stakeholders involved in the implementation of GI to have a shared strategic vision. Both policymakers and planners should agree on common goals, ensuring that the processes of planning, implementation and maintenance of GI are coordinated. Training may be needed to ensure that all stakeholders involved across different sectors have an adequate knowledge of the costs and benefits of implementing GI, as well as the processes of planning, implementation and maintenance of GI and the functioning of ecosystems. The spatial analysis methodology presented in Chapter 2 can provide the data needed to inform discussions and decision-making regarding the distribution of funding and subsidies for GI for territorial development.
- **Take the context into account:** The quantification of benefits and challenges related to GI should be adapted to the type of GI, its spatial configuration and other contextual specificities, which could include development goals, location, local climate, geology, geography, city or regional structure, governance, politics and local skills and knowledge.
- **Identify GI "hotspots"**: Planners and decision-makers should identify GI "hotspots" that require either increased safeguarding or restoration, informed by accurate and updated spatial data on potential GI networks. This should inform decisions on where to invest resources.
- **Combine private and public funding mechanisms for GI implementation:** Make GI a sustainable investment opportunity as part of the EU's integration of sustainability into financial policy frameworks, with accounting for social, environmental and governance considerations.
- **Monitor progress and adapt to change:** The relationships between GI, biodiversity and ecosystem services are dynamic and must be monitored and examined over long periods of time to develop effective and adaptive management measures. Previous efforts in ecosystem service evaluation and GI delineation can be used as a strong baseline to inform decision-making on monitoring.

It is broadly perceived that the responsibility for GI-related policy should be a shared duty between different levels of public administration and other actors. The ESPON GRETA project indicates that public administrations perceive themselves as the actors taking on the most responsibility (compared with research organisations, civil society organisations and businesses). To ensure GI implementation, this responsibility must be further shared between public administrations and other stakeholders.

The following policy recommendations are relevant for GI management and implementation at the regional scale:

- **Plan for GI implementation in adaptive cycles:** Consider 3-year timescales for decision-making and focus on a GI strategy based on regional and local assessments. In practice, such assessments can be carried out in the same way as in the ESPON GRETA project, by using the existing georeferenced data on land cover and land use to depict the connectivity between green and blue areas and to enable representation of areas with "connectivity opportunities". To continuously update the georeferenced data layers, it is crucial to ensure that land use changes based on monitoring are incorporated.
- **Take into account synergies and trade-offs between ecosystem services:** Ecosystem services often appear in bundles; under certain circumstances they are mutually reinforcing (i.e. they are in synergy with each other) whereas in other cases they can affect each other negatively (i.e. there are trade-offs between them). It is important to be aware of such relationships in order to prioritise their effects on the basis of the best knowledge available. When designing GI policies, it is important to consider these trade-offs and synergies.

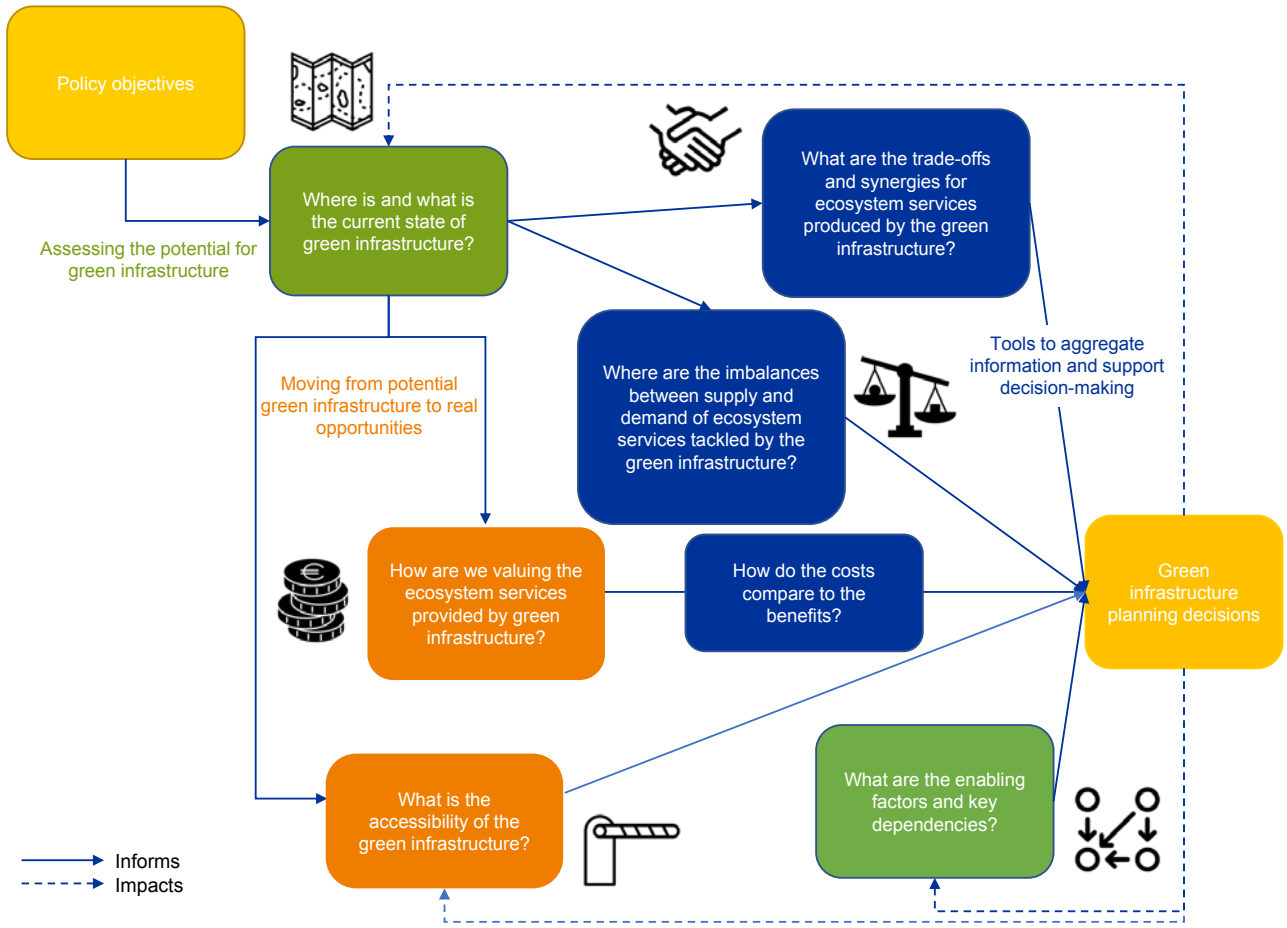
The following policy recommendations are relevant for GI management and implementation at the national scale:

- **Integrate GI across policy areas:** Including GI in existing strategies, policies and legislation is in line with the EU strategy on GI, as it states that GI principles can be implemented by using existing policies and financial instruments (European Commission, 2013b). In some ESPON countries, GI principles are already integrated in some policies beyond those related to biodiversity conservation, for example policies on flood management. However, the level of implementation of GI into different policy sectors varies between the different countries.

- **Develop national GI policies and action plans:** National GI policies and action plans could be created in each European country to facilitate the implementation of the EU strategy on GI in the national context. Currently, only 11 ESPON countries have specific national GI policies in place. GI implementation is more advanced in countries where such national GI strategies have been established.
- **Increase awareness about GI:** There is a need for increased awareness and communication between policy sectors to operationalise GI as a cross-sectoral concept. The analysis carried out in the ESPON GRETA project can be useful to inform the integration of GI principles into existing policies in countries that have low levels of integration. This can be achieved by cross-national and cross-regional learning.
- **Ensure the availability of data:** Accurate and updated spatial data on potential GI networks should inform evidence-based decision-making on spatial planning and on where to invest resources. Continued mapping of data on, for example, protected areas, forests, agriculture and level of fragmentation should be carried out.
- **Provide training on economic valuation and spatial analysis methods:** To ensure consideration in spatial planning and decision-making of the economic value of ecosystem services provided by GI, more training should be provided on the relevant methods (e.g. cost–benefit analyses) and on geographical information systems.

Figure 3 provides a summative visualisation of these recommendations.

Figure 3
Steps and methods used in the ESPON GRETA project to support practitioners in GI planning and decision-making



Source: ESPON GRETA, 2019.

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