

Green Infrastructure

**Sustainable Investments
for the Benefit of Both
People and Nature**

March 2011

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Contents

Introduction	2
1. What is green infrastructure and why do we need it?	3
1.1. Biodiversity and ecosystem services.....	3
1.2. Ecosystems must be able to adapt	3
1.3. Green infrastructure – the concept	4
2. EU policy in support of green infrastructure	9
3. How to build green infrastructure	11
3.1. Integrated planning needed.....	11
3.2. Mitigation measures	12
4. Financing opportunities	
for green infrastructure measures	14
4.1. Strategic approach supporting green infrastructure.....	18
Impact mitigation	18
Prevention and planning	18
Support for ecosystem services.....	18
4.2. Green infrastructure funds in Romania	19
5. Building a “green infrastructure”:	
good practice examples.....	21
5.1. Ecological restoration	
of Comana Wetland in Giurgiu County, Romania.....	22
Support by the Operational Programme	24
Ecological restoration measures.....	25
5.2. Restoring the Alpine-Carpathian Corridor	26
Reducing fragmentation	27
5.3. Beach nourishment in Liguria, Italy	28
Creating more durable coastal defence	28
6. Conclusions and recommendations.....	29
7. References.....	31

Introduction



The EU funding programmes include financial support for the preservation of Europe's precious natural assets and cultural landscapes. These programmes can complement those of the national, regional and local authorities in the EU Member States.

The current funding period 2007–2013 has shown great potential for financing such measures, within the Operational Programmes of the European Regional Development Fund (ERDF). Indeed, €3.8 billion has been allocated for nature investments across all ERDF Operational Programmes. However, the current project allocations of these funding opportunities vary enormously from country to country across the EU.

The variation in allocations led to the inception of the SURF-nature project – a partnership of fourteen public bodies from ten EU countries responsible for the implementation of ERDF funds or with experience of applying them: Austria, the Czech Republic, France, Greece, Italy, Poland, Romania, Slovenia, Spain, and the United Kingdom.

The overall objective of the project is to improve regional policies and practices for nature conservation and biodiversity by increasing the financing of respective measures through the ERDF, whilst increasing their impact. The project partners have agreed to work on five topics, for exchanging experiences in funding policies: green infrastructure, sustainable tourism, management of Natura 2000 sites, environmental education, forests and biodiversity.

In addition to analysing the Operational Programmes and collecting good practice examples on these topics, a series of thematic booklets have been produced and this booklet on *green infrastructure* is one of them.

Its main aim is to explain the basics of *green infrastructure* – a relatively new concept with many facets – relevant to Regional Policy. It also presents some approaches to this concept as identified in partner regions and describes the status of protected areas in Europe, the services that healthy ecosystem provide people with and the need to maintain their ecological coherence.

The EU policy on green infrastructure, general information on how to build a green infrastructure and examples from three countries partaking in the SURF-nature project are presented with the aim of showcasing important elements and acting as starting point for future discussions *green infrastructure*.

1. **What is green infrastructure and why do we need it?**

1.1 **Biodiversity and ecosystem services**

All living creatures – plants, animals, micro-organisms – live in interconnected webs of ecosystems and habitats. They form the biological diversity of our planet, what we today refer to as biodiversity.

Ecosystems, powered by the diversity of life within them, provide people with a stream of valuable, economically important goods and services on which human societies and economies fundamentally depend. Some of these include clear water – through water purification, healthy food – through soil fertilization or breathable air – through the carbon storage function of forests.

Healthy ecosystems also play a central role in adapting to climate change by protecting inhabited areas against floods and other negative effects of changing weather patterns. Intact floodplains, for instance, play an important role in alleviating floods by storing water and releasing it slowly back into streams and rivers. Forests act as carbon sinks and prevent soil erosion and wetlands absorb pollutants and improve the quality of freshwater supply, whilst contributing to climate change adaptation and mitigation.

1.2 **Ecosystems must be able to adapt**

These are not the only services that nature provides. Every ecosystem is a complex structure that is never static. Species migrate across the land or along a stream, breed in places away from their winter habitation, need different places to breed and feed and so require a complex set of linked habitats. Changing conditions in climate and water regime leads to a change in the habitats, which requires species to adjust their location and move to areas with better conditions.

Healthy ecosystems are resilient systems that can withstand changes (e.g. climate change) to a much larger degree than degraded ones. As human life also depends on ecosystem services, the coherence of the ecosystem and its resilience is also essential to our existence.

An essential condition for healthy ecosystems and the provision of their services is consequently the maintenance of ecological coherence. In Europe, this coherence is increasingly getting lost as a result of the massive expansion of urban zones and infrastructure development, fragmenting the landscapes.

In addition, traditional land-use practices have been replaced by more intensive, mechanised and industrial-scale activities,

especially in agriculture. As a consequence, species have difficulty in dispersing and moving to fulfil their needs and adjusting to environmental change. As a result, ecosystem functions are disrupted as they become isolated, even in protected areas, since these too have often been fragmented and become “islands”.

Green infrastructure describes all elements of an interconnected network of green spaces that conserves natural ecosystem values and functions and provides associated benefits to human populations.

It consists of natural and man-made elements, such as reforestation zones, green bridges, green urban areas, green roofs and green walls, high nature value farmlands or forest areas. It ensures efficient and sustainable use of land by integrating interacting functions or activities on the same piece of land.

By giving back space to ecosystems, green infrastructure can maintain and create landscape features which guarantee that ecosystems continue to deliver services such as clean water, productive soils and attractive recreational areas. It therefore supports economies and societies and makes an essential contribution to natural mitigation of and adaptation to climate change.

1.3 ■ Green infrastructure – the concept

Green infrastructure is a concept that aims at recreating a system, which is robust and enables species and their communities to move and adjust. Working with nature, a fundamental principle of green infrastructure, provides multiple benefits at comparatively low costs.

Investing in a green infrastructure also makes economic sense. Having to find man-made solutions to replace the services that nature offers for free is not only technically challenging, but also very expensive.

Putting valuable natural areas under nature protection is an important step towards maintaining ecosystems functions, but it is not enough. Only integrating protected areas into the broader land/seascape can create the necessary connectivity among sites, between sites and with the wider environment. Green infrastructure can therefore be regarded as the complementing element for protected areas. Such a robust multi-functional system of protected and unprotected green areas will strengthen ecosystems resilience and enable migration, dispersal and genetic exchange of wild species. Hence, it should increasingly drive decisions on land use planning and any investment related to built up infrastructures.

Green infrastructure key objectives

A green infrastructure concept in Europe can serve the following purposes:

- Combating biodiversity loss by increasing connectivity between existing natural areas and increasing their ecological coherence (elements such as hedgerows, wildlife strips in fields, small watercourses, “eco-ducts”, green urban areas and habitat patches could help in this respect).
- Strengthening the functionality of ecosystems for delivering goods and services.
- Increasing the resilience of ecosystems by improving their functional and spatial connectivity, constituting an “insurance policy”, which is vital in the face of global change, including climate change.
- Promoting integrated spatial planning by identifying multi-functional zones or by incorporating habitat restoration measures and other connectivity elements into various land-use plans and policies.
- Contributing to developing a greener and more sustainable economy by investing in ecosystem services instead of purely technical solutions, and mitigating adverse effects of transport and energy infrastructure.
- Reconstructing or adjusting existing or planned infrastructures (e.g. in the field of water management or transport, urban development) to mitigate barrier effects and create ecological corridors.

The multiple uses and multiple benefits of green infrastructure are some of its major assets. Healthy, interconnected green spaces, for example, can provide mitigation of and adaptation to climate change. In terms of adaptation, green infrastructure increases ecosystem resilience by:

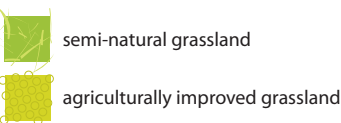
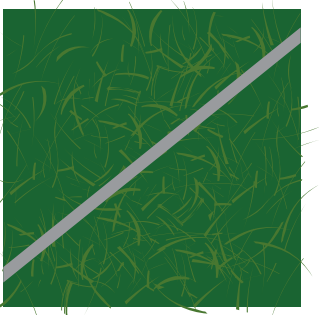
- **Managing high temperatures** – particularly in urban areas, where evaporative cooling and shading provided by green infrastructure can ensure that towns and cities continue to be attractive and comfortable places to live, work, visit and invest.
- **Managing water supply** – green infrastructure can provide places to store water for re-use and allow water to infiltrate into the ground by sustaining aquifers and river flows. It can catch sediment and remove pollutants from the water, thereby ensuring that water supply and quality is maintained.
- **Managing riverine flooding** – green infrastructure can provide water storage and retention areas, reducing and slowing down peak flows, and thereby helping to alleviate river flooding.
- **Managing coastal flooding** – green infrastructure can provide water storage and retention areas, reducing and slowing tidal surges, and thereby helping to alleviate coastal flooding.
- **Managing surface water** – urban green infrastructure can help to manage surface water and sewer flooding by reducing the rate and volume of water runoff; it intercepts water, allows it to infiltrate into the ground, and provides permanent or temporary storage areas.

- **Reducing soil erosion** – using vegetation to stabilise soils that may be vulnerable to increasing erosion.
- **Helping other species to adapt** – providing a more vegetated and permeable landscape through which species can move northwards to new “climate spaces”.
- **Managing visitor pressure** – providing a recreation and visitor resource for a more outdoors lifestyle, and helping to divert pressure from landscapes which are sensitive to climate change.

In relation to climate change mitigation, green infrastructures can contribute to the reduction of greenhouse gases by storing carbon in soils and vegetation or reducing the need to travel by car by providing local recreation areas and green travel routes that encourage walking and cycling.

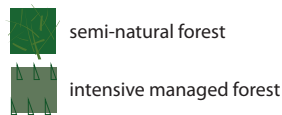
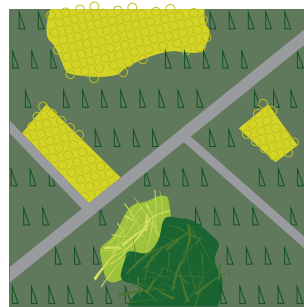
Figure 1: A diagrammatic representation of a hypothetical progression in habitat fragmentation

Construction of a road across an area of continuous semi-natural ancient forest



Impacts: No significant direct habitat loss, but the creation of some edge habitat. Some disturbance impacts may reduce effective habitat size for some disturbance sensitive species, fragmentation of forest habitat for some species (e.g. some invertebrates) that cannot cross roads.

Intensification of forest and agricultural management



Impacts: Widespread habitat degradation leading to habitat loss for many species. Reduced connectivity between forest fragments due to reduced permeability of the surrounding matrix. Only semi-natural forest and grassland remained. Overview impact is the substantial reduction of species diversity.

Source: adapted from IEEP & IUCN Report, Guidance on the maintenance of landscape connectivity features of major importance for wild flora and fauna, 2007.

Impacts of habitat fragmentation on biodiversity

- The term **fragmentation** is generally used to describe either loss or change of habitat and the breaking up of the remaining habitat into smaller units (although the term is commonly used to describe only the latter process). Impacts resulting from fragmentation vary amongst habitats and species, but generally start to appear when around 70% of the original habitat has been lost. Such impacts can include changes in species composition, community structure, population dynamics, behaviour, breeding success, individual fitness and a range of ecological and ecosystem processes.
- In Europe, the most outstanding natural areas are protected through national legislation and are part of the Natura 2000 Network which contains 26.000 sites and covers almost 20% of the EU territory. But action also needs to be taken within the remaining 80% of the territory to reduce fragmentation and reconnect habitat patches and species populations across the landscape, to enable wild plants and animals to move, migrate, disperse and exchange populations between protected areas, ensuring their survival in the long term.
- Habitat fragmentation in-and outside Natura 2000 is caused by a whole range of different factors linked to changes in land use, including urban sprawl, transport infrastructures and intensified farming or forestry practices. In certain cases, land abandonment can also lead to biodiversity loss. This is the case for example, when extensive farming practices have created a more structured, diverse habitat pattern or low-input fish ponds have provided better conditions for migrating birds. If this type of land use is subsequently abandoned, the natural value of these areas decreases.
- Recent statistics from the European Environment Agency illustrate just how significant these trends are. Some 8.000 km² were concreted over during the 1990s, representing an increase in artificial areas of 5% in just 10 years. In addition, 15.000 km of new motorways were constructed within the EU between 1990 and 2003.
- Figure 1 illustrates a hypothetical situation where habitat fragmentation progresses initially as a result of the construction of a simple road with insignificant habitat loss, to the habitat deterioration, which reduces functional connectivity across the habitat matrix.

Fragmentation impacts are likely to be exacerbated by the effects of climate change and may reduce the resilience of habitats and species populations to climate change impacts. It may also limit the ability of some species to move to new areas that have suitable climatic conditions.

Landscape fragmentation may also lead to degradation of water resources. Reduction or loss of wetlands and riparian zones reduce their capacity to soak up excess water and therefore control floods, trap sediments, filter out toxins and excess nutrients, and support wildlife and plant species.

Green infrastructure vs. grey infrastructure

Habitat fragmentation and loss of connectivity caused by the development of **grey infrastructure** – e.g. roads, urban settlements, hydropower plants – pose significant threats to ecosystem coherence. Today's infrastructure decisions will shape Europe's landscape for at least the next fifty years. The traditional infrastructure planning arrangements cannot cope with the new challenges and need to integrate environmental aspects.

While **grey infrastructure** refers to the technical interconnected structures that support a society, such as roads, railways, water supply, sewers, power grids, telecommunications, **green infrastructure** is an interconnected network of green space that conserves ecosystem values and functions and provides associated benefits to society. It is clear that we need both and have to find ways of making the two types of infrastructure complement each other.

Sometimes, certain types of **grey infrastructure** measures are needed to support **green infrastructure**, for example hard structures to protect a valuable coastal habitat from erosion or a sluice to regulate the water regime in a wetland.

The added value of **green infrastructure** arises from its multifunctional use. Multifunctionality refers to the integration and interaction of different functions or activities on the same piece of land.

An urban edge river flood plain, for example, provides a repository for flood waters, acts as a nature reserve, provides a recreational green space, serves as fish nursery and can also be grazed by cattle. Urban green spaces cool the cities through shading and evaporation, filter the air, reduce water run-off, provide space for nature and increase the quality of life and the construction value.

So, on the one hand, nature can provide services for free, that in other cases **grey infrastructure** can provide only after large investments. On the other hand, **green infrastructure** measures, such as habitat restoration and maintenance, also create jobs and fuel the economy, just as **grey infrastructure** activities do, but in a more sustainable manner.



EU policy in support of green infrastructure

The development of the green infrastructure concept started in the mid-1990s in the context of land use planning. In the EU context, it gained prominence with the workshop “Towards a green infrastructure for Europe – integrating Natura 2000 sites into the wider countryside” in March 2009 in Brussels. The main aims of the event were to determine an appropriate Community response to habitat fragmentation and to identify the actions that would be most effective at EU level.

In early 2010, the European Commission published a **Communication on combating biodiversity loss beyond 2010**. It concludes that habitat loss, degradation and fragmentation have been by far the biggest drivers of terrestrial biodiversity loss at EU level. Although the most important core natural areas for key species and habitats have been protected by the Natura 2000 network, which covers almost 20% of Europe’s land area, this will not be enough to meet the EU biodiversity target. According to this Communication the development of and investment in green infrastructure can help connect the Natura 2000 “islands” in order to improve comprehensive nature conservation and enhance further benefits in EU territories in- and outside the Natura 2000 network.

Europe should now invest massively in the greening of the cities, the construction of green bridges, tunnels, fish passes and the removal of obsolete infrastructure in rivers, as well as in the maintenance and restoration of ecosystems. Suitable habitats should be restored and protected both in rural and urban landscapes, former industrial sites should be greened and farmland enriched by hedgerows, tree lines and ponds. These investments will provide jobs and business opportunities.

Acknowledging the need for the development of, and investment, in green infrastructure, the Communication on biodiversity loss pledges action to promote and support exchanges of best practices as a basis for an EU strategy on green infrastructure, to be developed after 2010. This has been endorsed by the Council of the European Union in March 2010. In addition the EU White Paper on Adaptation to Climate Change and the Economics of Ecosystem and Biodiversity (TEEB) study call for an increase in ecosystem coherence.

The White Paper on Adaptation to Climate Change indicates that the impact of climate change must also be considered in the management of the Natura 2000 network in order to ensure the diversity of and connectivity between natural areas and allow mitigation and survival of species when climate conditions change. The paper also considers the possibility of improving policies and developing measures which address biodiversity loss and climate change in an integrated manner to fully exploit the co-benefits and avoid ecosystem feedbacks that accelerate global warming. Ecosystem-based approaches to adaptation and mitigation are examples for such integration. **The CBD COP 10 decision on Biodiversity and Climate Change** highlights the multiple benefits of ecosystem-based approaches and the consecutive **Environmental Council Conclusions** recommend the development and use of ecosystem-based approaches to adaptation and mitigation.

The **EU Integrated Coastal Zone Management (ICZM) Recommendations** (2002/413/EC), and the **ICZM Protocol** concluded by the EU for the Mediterranean (2010/631/EU) promote the approach of “working with nature”, which is also a key concept of green infrastructure.

Green infrastructure will play a decisive role in integrating biodiversity into other EU policies, such as agriculture, forestry, water, marine and fisheries, regional and cohesion policy, climate change adaptation and mitigation, transport, energy and land use policy. It is also an important tool for existing environmental Directives in particular the **Water Framework Directive** and the **Habitats and Birds Directives**, which form the legal basis of the Natura 2000 network. Article 3 of the Birds Directive indicates that habitat conservation and restoration measures should be taken inside and outside protected areas and Article 10 of the Habitat Directive states that Member States should develop policies for improving the ecological coherence of Natura 2000 network by ensuring the connectivity between protected areas.

Furthermore, Green infrastructure should be part of **environmental impact assessments** for plans and projects following the relevant Directives (EIA, SEA) but also incorporated in the development of Trans European Networks such as **TEN-T**.

The **EU Biodiversity Action Plan** (COM 2006/216) places a high priority on enhancing the coherence and connectivity of protected areas, incorporating both Natura and non-Natura 2000 sites.



3.

How to build green infrastructure

One of the most effective ways to build up green infrastructure is to adopt an integrated spatial planning approach to improve spatial interactions over a large geographical area, from local to regional level. This approach can guide future grey infrastructure developments away from sensitive sites, and help prevent further habitat loss and fragmentation.

Integrated spatial planning can also help identify barriers for wildlife in existing infrastructures, as well as find ways to spatially reconnect remaining natural areas. This could be, for instance, by encouraging habitat restoration projects in strategically important places or by integrating elements of ecological connectivity (e.g. eco-ducts or natural stepping stones) into new development schemes. Also in urban areas, multi-functional green spaces can be created with the help of spatial plans.

3.1 ■ Integrated planning needed

Integrated planning can bring different sectors together, in order to come up with “win-win” or “small loss, big gain” combinations. These can deliver multiple benefits not just to those using the land (farmers, foresters, tourism providers, etc.), but also to society at large through the provision of valuable ecosystem services such as water purification or soil improvement and the creation of attractive “breathing spaces” for people to enjoy.

However, an extensive cropland (Figure 2), which can be part of a green infrastructure, and is explicitly managed or restored to maintain other ecosystem services, may be able to support a broader portfolio of ecosystem services. This can be ensured through e.g. safeguarding hedgerows, wildlife strips along field margins or small watercourses, and through the introduction of wildlife friendly agriculture and forestry practices.

How does it work? Natural ecosystems (Figure 2) are able to support many environmental services at high levels, except for food production in most cases. In contrast, intensively managed cropland (centre picture) can produce food in abundance, but at the cost of diminishing other ecosystem services.

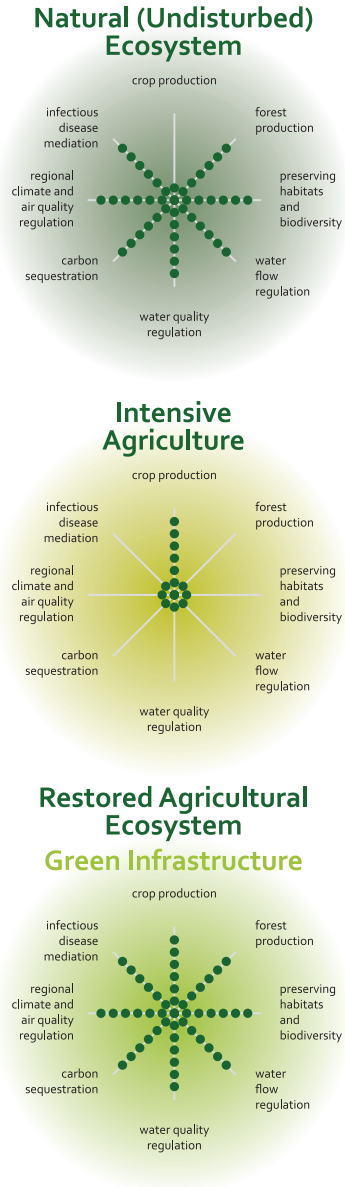
3.2 ■ Mitigation measures

The transport sector has a significant impact on biodiversity and landscape ecology within the EU. Roads and railways lead to fragmentation and permanent habitat losses, alter habitat conditions (e.g. hydrological regimes), disrupt patterns of wildlife movement and can be major causes of disturbance and wildlife mortality. For many species, and particularly invertebrates, roads and railways are insurmountable barriers to movement. Thus, the transport sector has a major role to play in avoiding further fragmentation of landscapes.

To some extent, fragmentation of landscapes due to transport infrastructure can be mitigated by implementing specific measures that reduce barrier effects. For example, artificial pathways such as wildlife bridges and tunnels (Figures 3, 4) improve 'the permeability' of road and rail networks. Such measures can reduce wildlife mortality rates and enable some species to cross roads and railways they would not otherwise be able to. However, artificial passages need to be well-designed, located in appropriate positions (according to scientific studies of connectivity needs) and appropriately managed and monitored if they are to effectively support the movement of species within fragmented landscapes.

River dams created for hydropower generation or for improving the navigability of inland waters, as well as bridges and channelized crossing, often hamper migration of fish and other freshwater organisms with severe consequences for river ecology. The creation of well-designed fish passes enabling fish to migrate up and down stream can mitigate these effects (Figure 4).

Figure 2: Comparison of ecosystems provision on different land uses.



Source: adapted from European Union report, LIFE Building up Europe's green infrastructure – addressing connectivity and enhancing ecosystem functions, 2010. Adapted from Foyle et. al., 2005.

Figure 3:
A tunnel for wildlife in the
Het Aardhuis wildlife park,
the Netherlands.



Source:
IUS Weibel & Ness GmbH

Figure 4a:
A channelized crossing with
unfavourable conditions
for animals to migrate
before reconstruction



Figure 4b:
The same crossing
as Figure 4a after
reconstruction
with appropriate
ecological conditions
while even improving
the capacity of the
overlying bridge



Source of Figure 4a,b photos:
Biologische Station im Kreis Euskirchen
e. V. showing an investment by ERDF
Objective 2 project "River Passages".

4.

Financing opportunities for green infrastructure measures

There is a whole array of possibilities for funding green infrastructure measures.

The private sector has started applying biodiversity offsetting measures on development schemes as part of its corporate social responsibility programmes. Payment for Ecosystem Services schemes can be a feasible way for business to maintain the flow of ecosystem services, e.g. clean drinking water. Ecological compensation schemes are another funding mechanism for ecosystem restoration.

The EU approach to financing Natura 2000 promotes the integration of nature conservation measures into all EU funds. Green infrastructure measures can be co-financed under the EU LIFE+-Biodiversity Programme which can provide funding for projects such as the improvement of functional connectivity of wildlife habitats or of the movements of species between protected areas such as Natura 2000. LIFE+-Environment also offers possibilities to fund green infrastructure elements in urban and peri-urban areas and support projects that establish linkages between forested areas. In addition, it can co-finance projects that promote integrated planning initiatives.

The European Agricultural Fund for Rural Development (EAFRD) supports a number of measures (e.g. forestry, agri-environment) that can be used to promote connectivity within rural landscapes.

The aim of the EU regional policy is to promote coherent development within the EU and reduce gaps between the poor and rich regions within the Community area. Traditionally, the Community's regional policy has paid little attention to issues related to nature conservation and biodiversity.

Furthermore, the initiatives supported by Structural and Cohesion Funds have frequently been criticized for having negative impacts on biodiversity (see WWF report: *Conflicting EU Funds: Pitting Conservation against Unsustainable Development*, 2006). These negative effects include issues related to the fragmentation of landscapes, for example, as a consequence of the development of transport networks and construction of infrastructure for irrigation (e.g. dams and channels).

Figure 5: River restoration builds green infrastructure.
Reconnected river oxbow on Vesselina River, Bulgaria.



© Ivan Hristov/WWF

4.1 ■ Current opportunities for financing green infrastructure

The EU regional policy is supported by three specific funding instruments: the European Regional Development Fund (ERDF), the European Social Fund (i.e. the Structural Funds) and the Cohesion Fund, from which the ERDF and the Cohesion Fund are the most relevant for funding green infrastructure projects and Natura 2000.

As analysed in the SURF nature project, many Operational Programmes for the Regional Development Fund provide co-financing for managing Natura 2000 and implementing measures that support ecological coherence and connectivity in the context of regional development. These measures are often funded under the budget line for promotion of biodiversity and nature protection. However, they can also be linked, for example, to risk prevention and the development of transport networks. In addition, support is also provided for transnational initiatives.

Expenditures for green infrastructure measures could and should be included in all transport projects under the Cohesion Fund in order to avoid or minimise fragmentation effects.

The following table illustrates a number of possibilities provided by the current framework of ERDF regulation including possible links to the funds categories of expenditure. This overview shows potential opportunities only. The actual availability of funds and relevant measures is based on the regional or national Operational Programmes (OP).

The SURF nature OP analysis of fifty programmes has shown that in practise the uptake for green infrastructure measures linked to adaptation or risk prevention is rather low and most frequent measures are related to conventional infrastructure investments or restoration measures.

Article	Possible application for green infrastructure projects	Categories of expenditure which could already cover the investments for GI
4(4)	<ul style="list-style-type: none"> • Environment, including investments connected with water supply and water and waste management. • Wastewater treatment and air quality. • Prevention, control and fight against desertification. • Integrated pollution prevention and control. • Aid to mitigate the effects of climate change. • Rehabilitation of the physical environment, including contaminated sites and land and brown field redevelopment. • Promotion of biodiversity and nature protection, including investments in NATURA 2000 sites. • Aid to SMEs to promote sustainable production patterns through the introduction of cost-effective environmental management systems and the adoption and use of pollution-prevention technologies. 	<ul style="list-style-type: none"> 47 Air quality 48 Integrated prevention and pollution control 49 Mitigation and adaption to climate change 50 Rehabilitation of industrial sites and contaminated land 51 Promotion of biodiversity and nature protection (including Natura 2000) 54 Other measures to preserve the environment and prevent risks
4(5)	<ul style="list-style-type: none"> • Prevention of risks, including development and implementation of plans to prevent and cope with natural and technological risks. • Creating natural habitats patches though large-scale tree planting of native species that have low fire risk. 	<ul style="list-style-type: none"> 53 Risk prevention (...) 54 Other measures to preserve the environment and prevent risks
4(8) and 5(3)a	<ul style="list-style-type: none"> • Transport investments • Construction of underpasses/overpasses for existing transport infrastructure, e.g. roads, rail corridors. • Development of vegetation corridors along cycling tracks, e.g. hedgerows to enhance the diversity of landscape. • Intelligent ways of sediment management in order to reduce dredging in ports and waterways with additional benefits for nature. 	<ul style="list-style-type: none"> 16 Railways 17 Railways (TEN-T) 20 Motorways 21 Motorways (TEN-T) 22 National roads 23 Regional/local roads 24 Cycle tracks 30 Ports 31 Inland waterways (regional and local) 32 Inland waterways (TEN-T)
5(2)a and 5(2)b	<ul style="list-style-type: none"> • Environment and risk prevention, and specifically: stimulating investment for the rehabilitation of contaminated sites and land, and promoting the development of infrastructure linked to biodiversity and investments in Natura 2000 contributing to sustainable economic development and/or diversification of rural areas. • One-off sediment removal or building of a sluice to regulate water flow in and out of a wetland. 	<ul style="list-style-type: none"> 50 Rehabilitation of industrial sites and contaminated land 51 Promotion of biodiversity and nature protection (including Natura 2000)

Article	Possible application for green infrastructure projects	Categories of expenditure which could already cover the investments for GI
5(2)e	• Environment and risk prevention, and specifically: developing plans and measures to prevent and cope with natural (e.g. desertification, droughts, fires and floods) and technological risks.	
	• Prevent erosion in vulnerable areas by maintaining forest cover to protect mountainous areas from avalanches.	53 Risk prevention (...) 54 Other measures to preserve the environment and prevent risks
6(1)b	• Development of cross-border economic, social and environmental activities through joint strategies for sustainable territorial development: encouraging the protection and joint management of the natural and cultural resources, as well as the prevention of natural and technological risks.	
6(2)b	• Establishment and development of transnational cooperation: actions may include protection and management of river basins, coastal zones, marine resources, water services and wetlands. • Fire, drought and flood prevention. • The promotion of maritime security and protection against natural and technological risks. • Protection and enhancement of the natural heritage in support of socio-economic development and sustainable tourism, water management, with a clear trans-national dimension, including protection and management of river basins, coastal zones, marine resources, water services and wetlands.	
	• Cross-border and transnational initiatives to support ecological connectivity within landscapes, including riverbed restoration through sediment replenishment or removal of river dams to facilitate fish migration.	51 Promotion of biodiversity and nature protection (including Natura 2000) 53 Risk prevention (...) 54 Other measures to preserve the environment and prevent risks 81 Mechanisms for improving good policy and programme design, monitoring and evaluation...
8	• Sustainable urban development: strengthening economic growth, the rehabilitation of the physical environment, brown-field redevelopment, and the preservation and development of the natural and cultural heritage, the promotion of entrepreneurship, local employment and community development, and the provision of services to the population taking account of changing demographic structures.	
	• Within urban areas, could support redevelopment of Natura 2000 sites or the linkage of gardens and parks.	50 Rehabilitation of industrial sites and contaminated land

Source: WWF own interpretation based on categories of expenditure provided by implementing regulation ((EC) No 1828/2006)

The above analysis shows that there is high potential for strengthening the integration of green infrastructure aspects into the existing framework of European Regional Development funding. However the analysis also shows that the opportunities are very

fragmented across different sections of the regulatory framework and lack a clear strategic foundation in the regulation and the related categories of expenditure.

4.2 ■ Strategic approach supporting green infrastructure

Traditionally, the EU Cohesion Policy has a strong focus on conventional infrastructure investments that pose the risk of negative impacts on biodiversity through fragmentation, air pollution, or soil degradation. It should and could expand its portfolio to support green infrastructure.

The future Cohesion Policy should develop a more strategic approach in support of green infrastructure investments in three key categories:

Impact mitigation

Where existing infrastructure has negative effects on biodiversity, EU funds should invest in ecological improvements and reconstruction to minimise them. All transport investment projects for improving and upgrading existing transport networks should include adequate measures to avoid or mitigate fragmentation effects. Examples include construction of eco bridges, underpasses or the restoration of coastal shore lines, ecological reconstruction of waterways with improved migration possibilities for fish, or the rehabilitation of degraded sites to recover their ecological functions.

Prevention and planning

New infrastructure plans should integrate green infrastructure needs from the beginning, including investment in measures to avoid or minimise negative effects. This should also include a revision of the risk prevention planning under the Cohesion Policy.

The aim is to move away from technical solutions of risk prevention and towards an ecosystem based approach, where maintaining or restoring green infrastructure is seen as a tool to avoid negative impacts. The risk of forest fires, for example, can be reduced through strips of natural vegetation adapted to local climatic conditions. By maintaining or restoring natural floodplains, flood risk can be reduced. Green areas in strategic locations contribute to improving air quality and mitigating climate change effects by creating beneficial micro climates.

Support for ecosystem services

Structural Funds should invest in direct measures to create or maintain green infrastructure, in particular the connectivity and robustness of natural areas on land and in water, to safeguard the provision of valuable ecosystem services such as water purification or erosion control. These activities should be seen as a part of measures directly related to the promotion of biodiversity and as supporting measures for the Natura 2000 network.

Currently, often direct and indirect biodiversity measures under the Cohesion Policy are programmed in the same category of expenditures, which makes it difficult to analyse and monitor spending and impact. Measures with direct benefit for biodiversity are, for example, the development of Natura 2000 management plans or river restoration activities. The improvement of information services in protected areas is an example of indirect measures.

The current and the future Cohesion Policy should develop a more strategic and targeted approach to include green infrastructure in its main fields of activities. It is therefore important to learn lessons from current

spending, especially in the field of transport investments, and the extent to which this has included green infrastructure investments.

It is also important to initiate a shift from current risk prevention spending based on technological solutions towards a risk prevention approach that includes green infrastructure solutions. Finally, further good practice is needed to understand the wider benefits of biodiversity spending and the provision of ecosystem services through green infrastructures.

4.3 ■ Green infrastructure funds in Romania

The programming of Structural and Cohesion Funds gives Member States considerable freedom to develop policies and measures that suit their national and regional needs. Consequently, the actual level and types of funding in support of Natura 2000 and ecosystem health in individual countries depends on decisions taken at a national level. It is therefore important to ensure that these types of activities are reflected by priorities of Member States for Cohesion funding, i.e. in their national strategic plans and Operational Programmes.

In Romania, for example, there are many funding opportunities for green infrastructure initiatives through Cohesion Policy funds. The total sum of the EU's Cohesion Policy funding for Romania amounts to almost €20 billion – €20.5 billion under the Convergence Objective and €455 million under the European Territorial Cooperation Objective – from which about €172 million are allocated to implementation of adequate management systems for nature protection (management of Natura 2000 Network).

Romania has a high level of flora and fauna species diversity. However, many plants and animal species are under pressure because of habitat fragmentation and excessive resource exploitation linked to economic development. Amongst EU-27 and candidate countries, Romania belongs to the countries with the highest number of endangered species.

The EU requests Romania to ensure the establishment of the Natura 2000 network in accordance with the Birds and Habitats Directives and to prepare relevant protection measures. As a consequence, Natura 2000 sites cover about 17% of the national territory.

Within its Sectoral Operational Programme Environment funded by ERDF and Cohesion Fund, Romania has foreseen measures that address the enhancement of spatial connectivity and restoration of natural ecosystems.

One of the specific objectives of the Sectoral Operation Programme "Environment" (SOP ENV) in Romania is to protect and improve biodiversity and the natural heritage by supporting protected areas management, including the implementation of Natura 2000.

In order to develop the management framework for the protected areas, including Natura 2000 sites, there is a need to initiate and/or further develop several actions, such as:

- improvement/setting up of adequate administrative structures
- development/review of management plans for protected sites
- development of the specific infrastructure (green infrastructure)
- establishment of monitoring systems
- development of specific studies, inventories, maps, information and public awareness campaigns

The table below presents the possibilities of financing green infrastructure projects by the Sectoral Operational Programme Environment: **SOP ENV**.

Axis	Objectives	Key Area of Intervention	Possible application through green infrastructure projects
Priority Axis 4 "Implementation of Adequate Management Systems for Nature Protection"	Conserve biological diversity, natural habitats, wild species of fauna and flora.	Development of infrastructure and management plans to protect biodiversity and Natura 2000	<ul style="list-style-type: none"> • Ecological restoration of habitats and the reinforcement of species population. • Construction and improvement of infrastructure of national protected areas and Natura 2000 sites (building of visitors' and informational centres and information panels, risk management – fire prevention and control, etc.). • Biodiversity support: reducing impact of infrastructure improvements on species affected by fragmentation of landscape (realization of measures designed to overcome barriers on rivers and motorways).
	Ensure efficient management of protected areas, including Natura 2000.		

5.

Building a “green infrastructure” – good practice examples

Many EU Member States have already implemented measures towards strengthening and building green infrastructure although these investments have often not been financed through the ERDF. However an increasing number of ERDF projects exist, which show good practice in financing green infrastructure. All these pilot projects have in

common that they not only help species to move and adjust, but that they also restore ecosystem services such as sustainable flood management, provision of recreational spaces or carbon sequestration.



5.1 ■ Ecological restoration of Comana Wetland in Giurgiu County, Romania

The Natura 2000 site Comana Wetland is situated in Giurgiu County, Romania. It is one of the most important natural areas in Southern Romania and even in the Danube region. Comana is also part of the Lower Danube Green Corridor, which is a network of protected Natura 2000 sites linking four countries: Romania, Bulgaria, The Republic of Moldova and Ukraine.

The richly structured landscape with wetlands, forests, lakes, agricultural land and rural settlements provides an area of high natural value. The large areas covered with reeds, alternating with lakes and forests with *Querco-Carpinetum* (oak forests) and fish farms have created excellent conditions for birds providing habitats for feeding, breeding and wintering. The region therefore is one of the most important areas for 2/3 of Romania's bird fauna.

Because of its area and biodiversity, this region is currently the third most important "wetland" in Romania, after the Danube Delta and Braila Small Pond. Comana is considered an extremely complex aquatic ecosystem, situated along one of the main routes of migratory birds and is an important nesting place for many rare species.

However, water management projects aiming to increase the surface area of arable land, that carried out before 1990 in the basin of the Danube tributaries Arges and Nejlou and these caused dramatic ecological changes. Surface and groundwater levels dropped, and as a consequence led to significant changes in the structure of plant communities. Even farmers faced disadvantages as grasslands dropped in quality and therefore became of little economic use.



Figure 8: Path within the lacustrine zone of protected area.



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Support by the Operational Programme

In 2009, Giurgiu County Council in partnership with Comana Natural Park and Comana Local Council started the project **Ecological restoration of Comana Wetland in Giurgiu County**. The aim of this initiative is to restore and conserve biodiversity, natural habitats and wild plant and animal species through wetland restoration and efficient management of the ecological network Natura 2000 on an area of about 1.180 ha.

The project is financed by the Sectoral Operational Programme "Environment", Priority Axis 4: "Implementation of Adequate Management Systems for Nature Protection, Key Area of Intervention – Development of Infrastructure and Management Plans to Protect Biodiversity and Natura 2000". Its main expected outcomes are a strengthened green infrastructure and raised awareness among local people about the benefits of green infrastructure.

The measures related to ENV OP that have been used are:

- Ecological restoration of habitats and the reinforcement of species population.
- Setting up monitoring systems for the Natura 2000 sites and protected areas, including infrastructure and equipment for monitoring the natural habitats and the conservation status of flora and fauna species.
- Construction and improvement of the infrastructure of the national protected areas and Natura 2000 sites (building of visitors' and informational centres and information panels, risk management – fire prevention and control etc.).
- Preparation of information and publicity materials, awareness raising regarding the issues of protected areas and Natura 2000.

Figure 9: Ornithological observer site.



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Ecological restoration measures

Comana wetlands are situated along an important migration corridor for birds. A mix of reed fields next to lakes, hornbeam and oak forests and fish farms have created excellent conditions for feeding, breeding and overwintering for birds, many of them rare.

Because of the water management measures taken before 1990, banks became overgrown by reeds and rushes and only $\frac{1}{4}$ of the area remains flooded by water. Consequently, the area was transformed from an aquatic to a predominantly terrestrial environment. In addition, the remaining wet areas provide worse conditions for aquatic birds and especially for fish than before. The objective of the project is to re-connect the floodplain and the rivers, raising water level in stagnant water areas and increasing the surface of lakes and channels.

At the heart of the project lies the construction of a dam with a sluice on the Neajlov River, downstream of Comana Lake. Its purpose is to increase and maintain a constant level of water in the floodplain area. The depth in the river area is expected

to increase by more than 1.50 m, which will extend the water surface to 490 ha and maintain a considerable area of shallow water with depths below 0.50 m.

For fish populations and their invertebrate prey, the new conditions such as oxygen concentrations, changing water levels and their daily fluctuations will improve the quality of habitats and species richness.

In order to avoid aquatic habitat fragmentation and disruption of the migration route of some species of fish, the project builds a fish pass downstream of the dam. It also helps to recreate feeding and breeding habitats for fish and birds.

Some temporary new jobs will be created during the construction of the dam. More permanent economic benefits can be expected from establishing the area as an outstanding territory for ecological research in cooperation with scientific institutions in the nearby capital Bucharest and other cities.

5.2 ■ Restoring the Alpine-Carpathian Corridor

Both the Alps and the Carpathian mountain ranges are important habitats for wildlife such as the brown bear, red deer and lynx. The exchange between these two biodiversity nodes along the traditional migration route of the Alpine Carpathian Corridor is however blocked by a number of traffic routes and areas of intensive land use. The route is also threatened by an increasing demand for built up land between Vienna, Bratislava and Budapest in the Danube and Morava valleys.

In 2001, the University of Natural Resources and Applied Life Sciences (BOKU), on behalf of the Austrian Federal Ministry for Traffic, Innovation and Technology carried out a first examination of the barriers within the national motorway network and wildlife corridors. A broad partnership was afterwards concluded between Austrian and Slovakian organisations, which joined forces to construct and preserve a coherent green corridor from the Alps to the Carpathians. In a feasibility study with Austrian and Slovakian partners, key actions to re-establish and maintain the corridor have been identified.

Figure 10: The Alps-Carpathians corridor map



Alps-Carpathians corridor supports the aims of the Alpine Convention and constitutes, besides the Danube and the Green Belt along the former "iron curtain", a major migration route of European importance.



Figure 11:
Greenbridge on the Austrian highway A6.



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Figure 12:
A bridge providing space to maintain the corridor functions of the underlying habitat.



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Reducing fragmentation

In 2009, the Alpine-Carpathian Corridor Project, a three year cross-border and cross-sectoral project, was started under the European Territorial Cooperation Objective of the European Regional Development Fund (ERDF). Scientific data is prepared and implementation measures planned within the framework of this project. Austrian and Slovak project partners from nature conservation, spatial planning and transport work together with a broad network, representing such diverse stakeholders as agriculture and forestry, hunting, tourism and the communities involved.

The cornerstones of the project are to mitigate the fragmentation effects of motorways, by building “green bridges” over highways at key points, as well as to create suitable habitats to reconnect existing stepping stones, which are needed as resting and feeding places for migrating animals. To guarantee the effectiveness of these measures, the ecological network should be integrated into spatial planning. In this way, the corridor dataset can also serve existing planning and study instruments such as environmental impact assessments.

These measures will help to attain the overall goals of the project which are:

- to safeguard the ecological connectivity between the Alps and the Carpathians
- to enable migration of wildlife and exchanges between populations
- a sustainable development in the region that benefits man and wildlife

5.3 ■ Beach nourishment in Liguria, Italy

A 1.5 km stretch of coast of the Italian region of Liguria is subject to erosion. In former times, it was nourished by the Roja River sediments. At the turn of the 20th century, the construction of dams for flood control and generation of electricity caused a general reduction in river sediments transported to the beaches. The erosive process has been also increased by the deployment of the railway along the coastline and increasing urbanisation.

Throughout the 20th century, and particularly after the Second World War, various protective measures were taken. Almost all the interventions on the coast involved hard measures, in particular parallel breakwaters.

Creating more durable coastal defence

The main objectives of a project supported by the European Regional Development Fund (ERDF) were to create a more efficient and durable form of coastal defence, able to withstand coastal erosion, and to ameliorate the natural landscape.

The reconstruction works involved the removal of parallel breakwaters and other artificial reef structures and their replacement by 13 large semi-submerged groins using rocks from the previous structures. In addition, the beach has been nourished by 2.100.000 m³ of dredged material from the Roja River.

The initiative has given the opportunity to link the protection measures of the coastline with the Roja River Basin Plan which proposed dredging the river bed, in order to restore the hydrological regime in different sectors of the basin.

The dredged material formed the Roja River has been used to nourish the beaches within the physiographic unit, allowing significant cost reduction of works.

Local people both appreciate the landscape improvement and the fact that the beach has been able to sustain the high energy storm events which have occurred over the past few years.



Figure 13: Fiume Roja estuary in Liguria.

Source: Wikipedia.

Conclusions and recommendations

Healthy, coherent ecosystems provide humans with vital goods and services such as clean air and fresh water. In Europe, this ecosystem coherence is being increasingly threatened, in particular by habitat fragmentation caused by unwisely planned grey infrastructure development. Examples are roads cutting through landscapes or river dams and bridges blocking migration routes of fish.

The green infrastructure approach aims to reconnect habitats and strengthen biodiversity “hubs”, thereby contributing substantially to the conservation of Europe’s biodiversity and ensuring the provision of ecosystem services. The approach supports and complements EU environmental legislation, in particular the Water Framework and Floods Directives and the Nature Directives.

Working with nature and the application of ecosystem-based approaches to climate change adaptation and mitigation bring multiple benefits at comparatively low costs. Investments in green infrastructure provide jobs as well as business opportunities and help to build partnerships.

Within the EU, the green infrastructure tools that have already been applied include the construction of green bridges, wildlife tunnels, fish passes, habitat restoration, structural elements of farm landscapes such as hedgerows or tree lines. Wise, forward-looking planning has been shown to prevent further fragmentation and thereby avoid costs. While all of these tools have been tested, it is now a matter of disseminating experience and scaling up efforts.

Such a comprehensive and integrated approach needs the involvement and shared responsibility of all land users and policy sectors from an early stage. Europe should now invest massively in green infrastructure, in order to increase ecosystem resilience to climate change and other pressures.

Examples have shown that current EU financing instruments can support a variety of green infrastructure measures. LIFE+, the Rural Development Funds and the Regional Development Funds provide interesting opportunities for investments, but there is an overall lack of a strategy. Future work should provide the basis for a coherent green infrastructure strategy that broadens the range of investments.

The green infrastructure measures shown in this brochure are, in principle, eligible for funds from the current Cohesion Policy. However, these measures often do not directly match the objectives of the funding mechanisms and are therefore not funded. A more strategic inclusion in regulation articles is required.

While designing the EU budget and its instruments for the period 2014 to 2020, green infrastructure aspects should be integrated from the start and in particular future EU Cohesion Policy should include budget lines well suited for supporting green infrastructure measures. This new approach could address the basic features of green infrastructure, firstly to improve the situation where existing fragmentation is a barrier to biodiversity, secondly to avoid the degradation of existing green infrastructure features through new developments and thirdly, to directly support ecosystem services.

In order to strengthen the green infrastructure concept in current and future Regional Policy the SURF-nature project recommends:

- The European Commission to develop a green infrastructure strategy outlining the different funding needs as well as defining the contribution of different funding instruments to green infrastructure
- DG Regio to develop guidelines for different beneficiaries explaining the different dimensions of green infrastructure in the framework of infrastructure investments, planning and risk prevention as well as to biodiversity and ecosystem services.
- DG Regio to analyse the current legal framework and include green infrastructure as a distinct funding article in the proposal for the future regulations.
- EU Member States to analyse current programmes, identify existing green infrastructure projects and make better use of existing opportunities of EU funds.
- To better promote the benefits from and the necessity of green infrastructure among all stakeholders, e.g. city dwellers, planners or engineers.

Finally it needs to be stressed that the SURF-nature project focuses on regional policy, which naturally limits the scope of these recommendations to Regional Policy. The authors are fully aware that many important aspects of green infrastructure measures and funding mechanisms, especially those provided by LIFE+ and Rural Development, are consequently not covered by this publication.

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Figure 14: Oxbows at Notec river in Western Poland key elements of natural river dynamics.



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