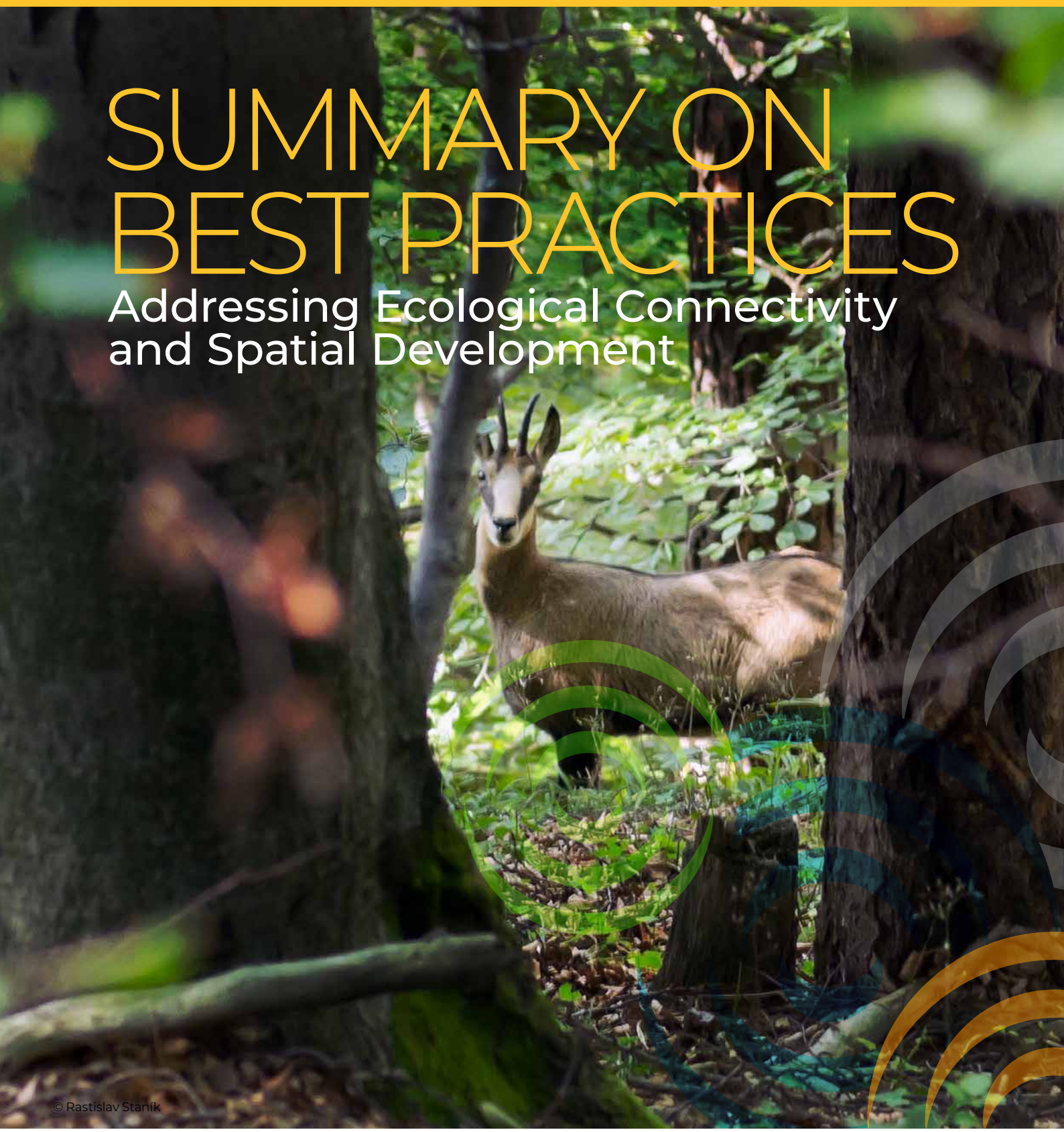
SUMMARY ON BEST PRACTICES

Addressing Ecological Connectivity and Spatial Development



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Interreg
Danube Transnational Programme
ConnectGREEN

EUROPEAN UNION

Project co-funded by European Union Funds (ERDF, IPA)

Summary on Best Practices Addressing Ecological Connectivity and Spatial Development

Deliverable 3.3.3

ConnectGREEN Project – “Restoring and managing ecological corridors in mountains as the green infrastructure in the Danube basin”

Danube Transnational Programme, DTP2-072-2.3

This document was elaborated within the frame of Work Package 3 “Knowledge source base”.

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Introduction

The ConnectGREEN project connects partners from different countries and various fields of activity (spatial planning, research, government, biodiversity conservation) to increase capacity to identify and manage ecological corridors and to overcome the conflict between infrastructure development and wildlife conservation in the largest, last remaining stronghold for large carnivore species in Europe of the Danube-Carpathian region.

In the frame of the ConnectGREEN Project, the present study summarizes the most important aspects related to ecological connectivity and collects best practices and examples from all over the world on improving or restoring ecological corridors and reducing landscape fragmentation. We focused and collected soft measures, planning tools in different landscape types: urban areas, agglomeration zones, and rural areas. We summarized examples from the field of spatial planning (large scale) and finally on a local scale: hard measures. We carried out a comprehensive literature review and collected best practices from the partner countries.

The reduction of natural and semi-natural areas and the breaking up of large patches of native vegetation into smaller and isolated patches have been sources of conflict for centuries. Nowadays, rapid population growth and increased demand for natural resources cause landscape fragmentation to the extent that many species face extinction.

In addition to the growth of urban areas, intensive cultivation is also a leading cause as there is a growing need for food, fibre, etc. Agricultural practices often ignore the ecological character and carrying capacity of a landscape. In the entire developed world, there is a large proportion of intensive agriculture, and habitat patches have become small and often isolated. In Europe, we have a strong nature protection system with the Natura 2000 network as the largest network of protected areas globally. However, often the linkages and stepping stones between protected areas are missing and there is a high ratio of species and habitats in unfavourable conditions.

Ecological corridors and a stable network of natural and semi-natural areas provide a wide range of ecosystem functions and services. Ecosystems provide vital goods and services for humans through certain ecosystem processes (Costanza et al. 1997; MEA 2005). Figure 1 shows that connections between ecosystem functions and services, such as food and timber, (drinking) water, fresh air and temperature regulation, landscape amenities, and recreation areas, are especially important in our fragmented landscapes (Tobias, 2013).

For species survival, we must access resources that can sustain a viable population. A minimum viable population (MVP) is the smallest number of individuals required to sustain a population in the long-term. Populations of a species are more likely to survive

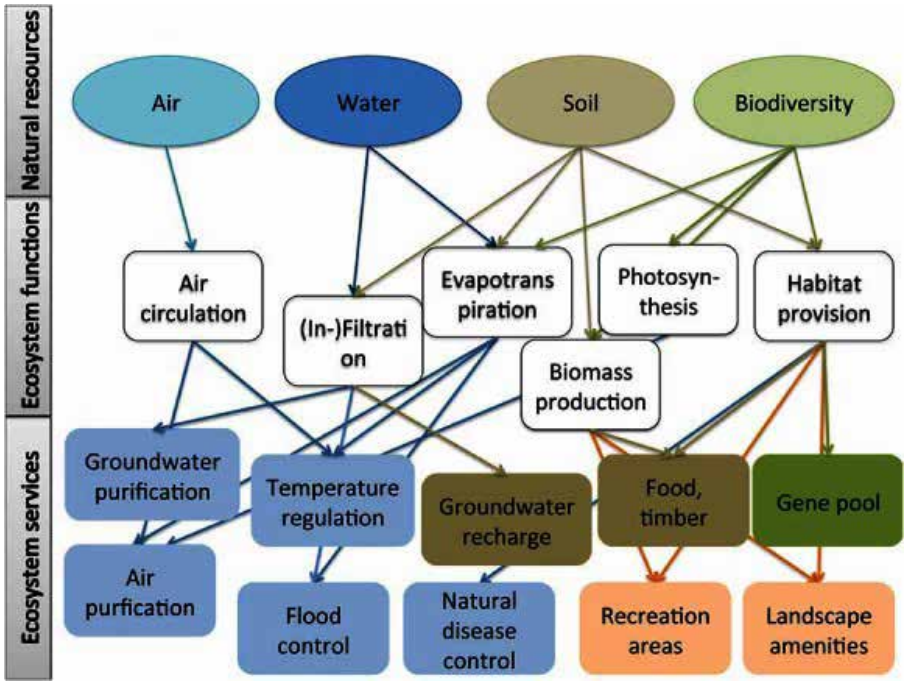

Figure 1. Relation between natural resources and ecosystem functions and services. © Tobias S. (2013): Preserving Ecosystem Services in Urban Regions: Challenges for Planning and Best Practice Examples from Switzerland (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3664025)

if immigration and colonization are facilitated by linkages between core habitats, such as corridors or "stepping stone" patches. Landscape fragmentation threatens the landscape's capacity to sustain healthy populations, as it leads to:

- **Loss of original habitat**
- **Reduced habitat patch size**
- **Increased edge and barrier effect**
- **Increased isolation of patches**
- **Decreased genetic exchange and gene flow**
- **Modification of natural disturbance regimes (United States Department of Agriculture Natural Resources, Conservation Service (2004): National Biology Handbook, Subpart B – Conservation Planning).**

In our fragmented landscapes corridors are of high importance. Corridors can be natural or the result of human activities. The structure of a corridor may be narrow (line), such as a hedgerow; wider than a line (strip), such as a multi-row windbreak; or streamside vegetation (riparian) (United States Department of Agriculture Natural Resources, Conservation Service (2004): National Biology Handbook, Subpart B – Conservation Planning).

The concept of ecological corridors as a conservation measure has become popular among planners, land managers and communities and a wide range of 'wildlife corridors', 'landscape linkages', 'dispersal corridors', 'green belts', 'greenways' and other forms of connecting features have been proposed, drawn into conservation plans, etc.

The term 'corridor' has a narrow focus, especially if we consider it in terms of landscapes. It is more suitable to discuss connectivity and use the wider term 'linkage areas'. Connectivity refers to what scale spatial arrangement and quality of elements in the landscape allow the movement of organisms among habitat patches (Merriam 1984, 1991; Taylor et al. 1993; Forman 1995, Bennett, 2003). Maintaining and preserving landscape connectivity is even more complex and difficult than focusing on corridor conservation only. A wide range of factors, including human activities, economic sectors, different policies, land ownership, and so on, influence landscape connectivity. Above all spatial planning as a tool of harmonizing the interests of all other economic sectors and nature protection has an inevitable role.

Landscape connectivity must be accepted in spatial planning documents (Valachovič 2018) and ecological networks as a representation of the biotic interactions in an ecosystem, in which species (nodes) are connected by pairwise interactions (Okániková et al. 2020).

The ecological network is a system of areas model that has been developed over previous years with the broad aim of maintaining the integrity of environmental processes. Based on this, the landscape should be zoned in such a way that intensively used areas are balanced by natural zones that function as a coherent, self-regulating units. The approaches that are usually classified as ecological networks share two generic goals, namely (1) maintaining the functioning of ecosystems to conserve species and habitats, and (2) promoting the sustainable use of natural resources to reduce the impacts of human activities on biodiversity and/or to increase the biodiversity value of managed landscapes. In achieving these goals, a number of elements can be discerned which together characterize all ecological networks. These are: (a) a focus on conserving biodiversity at the landscape, ecosystem, or regional scale; (b) an emphasis on maintaining or strengthening ecological coherence, primarily through providing connectivity; (c) ensuring that critical areas are buffered from the effects of potentially damaging external activities; (d) restoring degraded ecosystems where appropriate; (e) promoting the sustainable use of natural resources in areas of importance to biodiversity conservation. These functions are reflected in ecological networks as a coherent system of areal components:

- **Core areas, where the conservation of biodiversity takes primary importance, even if the area is not legally protected,**
- **Corridors (incl. stepping stones), which serve to maintain vital ecological or environmental connections by maintaining physical linkages between the core areas (CBD 2006).**

Several terms refer to corridors and connectivity. Andrew F. Bennett (2003) in his book "Linkages in the Landscape" highlights the importance of landscape connectivity as a more complex approach. He defined the following terms:

"Link, linkage: General terms referring to an arrangement of habitat (not necessarily linear or continuous) that enhances the movement of animals or the continuity of ecological processes through the landscape.

Linear habitat: A general term referring to a linear strip of vegetation. Linear habitats are not necessarily of indigenous vegetation and do not necessarily provide a connection between two ecological isolates.

Habitat corridor: A linear strip of vegetation that provides a continuous (or near continuous) pathway between two habitats. This term has no implications about its relative use by animals.

Stepping stones: One or more separate patches of habitat in the intervening space between ecological isolates that provide resources and refuge that assist animals to move through the landscape.

Landscape linkage: A general term for a linkage that increases connectivity at a landscape or regional scale (over distances of kilometres to tens of kilometres). Typically, such linkages comprise broad tracts of natural vegetation.

Habitat mosaic: A landscape pattern comprising a number of patchy interspersed habitats of different quality for an animal species" (Bennett, 2003).

In a complementary approach according Worboys et al. 2010 (in Okániková et al. 2020), in conservation science four major types of connectivity are commonly used:

- **Habitat connectivity – connecting patches of suitable habitat for a particular species or species group;**
- **Landscape connectivity – connecting patterns of vegetation cover in a landscape;**
- **Ecological connectivity – connecting ecological processes across landscapes at varying scales;**
- **Evolutionary process connectivity – maintaining the natural evolutionary processes including the evolutionary diversification, natural selection and genetic differentiation operating at larger scale.**

In Europe there have been several studies revealing the unstoppable fragmentation of the landscape. In 2015, on average, there were around 1.5 fragmented landscape elements per km2 in the European Union, a 3.7 % increase compared with 2009. According to the study approximately 1.13 million km2, around 28 % of the area of the EU, was strongly fragmented in 2015, a 0.7 % increase compared with 2009 (EEA, 2019)

As the European Union has a leading role in protecting European landscapes, raising environmental awareness, and harmonizing European landscape policies, we highlight the related EU policies and programs. In the following, we summarize general biodiversity-related EU programs.

The EU has created a continent-wide network of core habitats: the Natura2000 network (The Habitats Directive, Directive 92/43 on the conservation of natural habitats and of wild fauna and flora, amended by Directive 97/62). The network comprises 'Sites of Community Interest'/'Special Areas of Conservation' designated by Member States, and 'Special Protection Areas' classified pursuant to Directive 79/409 on the conservation of wild birds. With a total area of over 850 000 km2, this is the largest coherent network of protected sites in the world. The Habitats Directive aims principally to promote the conservation of biological diversity while taking account of economic, social, cultural, and regional requirements. The amended Birds Directive (Directive 2009/147) covers the protection, management, and control of (wild) birds, including rules for sustainable hunting.

In May 2006 the Commission adopted a communication entitled 'Halting the loss of biodiversity by 2010 — and beyond: Sustaining ecosystem services for human well-being', which included an EU action plan for achieving the necessary protection of biodiversity. As the EU was unlikely to meet its 2010 target

Landscape configuration	Local scale (1km)	Landscape scale (1-10s kms)	Regional or biogeographic scale (100-1000s kms)
Habitat corridor	hedgerows; fencerows; streams; roadsides; forest corridors; underpasses	rivers and associated riparian vegetation; broad links between reserves	major river systems; mounatin ranges; isthmus between land masses
Stepping stones	patches of plants; small woods; plantations; chains of small wetlands	series of small reserves; woodland patches in farmland; urban parks	chains of islands in an archipelago; wetlands along waterfowl flight paths; alpine habitats along a mountain chain
Habitat mosaics	patchily cleared vegetation in farmland; mosaic of gardens and parks in cities	mosaics of regenerating and old-growth forest in forest blocks	regional soil mosaics supporting different vegetation communities

Table 1. Landscape configurations to enhance connectivity at different spatial scales.
Source: *(Andrew F. Bennett (2003): Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation, IUCN – The World Conservation Union)*

of halting biodiversity decline, a new strategy was adopted by the Commission in June 2011 in order to 'halt the loss of biodiversity and the degradation of ecosystems services in the EU by 2020 and restore them... while stepping up the EU contribution to averting global biodiversity loss'. This represented a key strategy in European landscape policies.

The European Commission also developed the Green Infrastructure Strategy. This strategy aims to ensure that the protection, restoration, creation, and enhancement of green infrastructure becomes an integral part of spatial planning and territorial development whenever it offers a better alternative or is complementary to standard grey choices. The Green Infrastructure Strategy provides a framework for the development of the Trans-European Network for Green Infrastructure (TEN-G) (similar to the Pan-European Transport network, TEN-T) and integration of GI into sectorial policy areas such as agriculture, forestry, water, marine and fisheries, regional and cohesion policy, spatial planning, etc.

On May 22, 2020, they then accepted a far more proactive strategy: the Biodiversity Strategy for 2030 (Brussels, 20.5.2020 COM(2020)). It highlights the importance of building a "truly coherent **Trans-European Nature Network**" and states that "at least 30% of the land and 30% of the sea should be protected in the EU. This is a minimum of an extra 4% for land and 19% for sea areas as compared to today". Furthermore, the Strategy highlights that "in order to have a truly coherent and resilient Trans-European Nature Network, it will be important to set up ecological corridors".

The Council of Europe in 2000 adopted a unique strategy focusing on landscapes, formulating the European Landscape Convention (Council of Europe, 2000). This is dedicated to the protection, management, and planning of all European landscapes (and entered into force in 2004). The parties of the convention agreed to identify and evaluate landscapes, analyse their characteristics and the forces and pressures transforming them, and integrate landscape into spatial policies highlighting the importance of public consultation. Peri-urban landscapes in particular are under great pressure and play an important role in these areas to introduce effective co-operation methods, common green spaces, and green infrastructure planning tools for municipalities, and enhance public participation.

This study provides examples for best practices preserving natural structures, linkages, and the network of core habitats and corridors, within different landscape types. Instead of focusing on overcoming one single landscape barrier, it provides examples, best practices, and "soft" measures that improve connectivity on a regional scale.

1.1 Literature

European Environmental Agency (2019): Landscape fragmentation pressure and trends in Europe https://www.eea.europa.eu/data-and-maps/indicators/mobility-and-urbanisation-pressure-on-ecosystems-2/assessment

Tobias S. (2013): Preserving Ecosystem Services in Urban Regions: Challenges for Planning and Best Practice Examples from Switzerland https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3664025/

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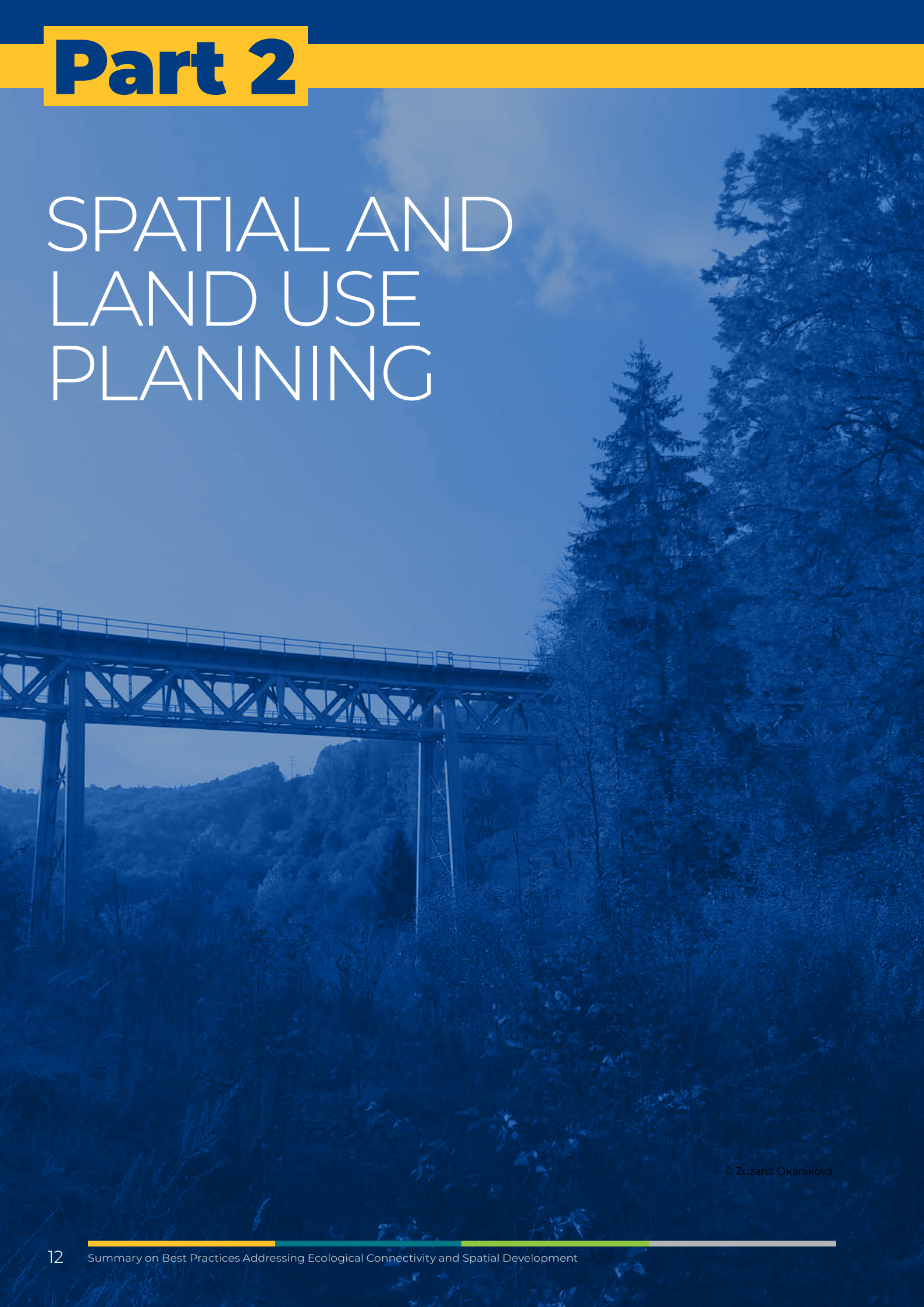
Part 2

SPATIAL AND LAND USE PLANNING



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2.1 General aspects, problems, suggestions

Spatial plans are highly important tools to find the appropriate placement of infrastructure corridors balancing the needs of the society and environment. In this chapter we give a general overview of spatial planning and give examples for best practices for using spatial planning tools to maintain ecological corridors, place infrastructure elements, and mitigate the negative effects of infrastructure. Spatial plans define the frames of territorial sustainability which "refers to an ordered, resource-efficient and environmental-friendly spatial distribution of human activities" (Camagni 2017). The complexity of the issue is reflected by the dimensions of territorial sustainability and forms the complexity of our landscapes:

- **"Territorial quality: the quality of the living and working environment; the relative homogeneity of living standards across territories;**
- **Territorial efficiency: resource-efficiency with respect to energy, land, and natural resources; competitiveness and attractiveness;**
- **Territorial identity: enhancing 'social capital'; developing a shared vision of the future; safeguarding specific cities, strengthening productive 'vocations' and competitive advantage." (Camagni 2017).**

Spatial planning is the most important tool for balancing the needs of society, the economy, and the environment. Spatial planning offers the institutional, technical and policy framework for managing the territorial dimension of sustainability, safeguarding the values of our habitats, ecosystems, and landscapes. The key role of spatial planning is to promote a more rational arrangement of activities. Spatial planning has a hierarchical system. The higher level of planning is binding for the lower level. Generally, higher-level plans are not very detailed, and mostly establish the spatial framework for developing defining principles and guidelines (national, regional). They usually do not include details related to issues of the local level and identify long- or medium-term objectives and strategies for territories. Spatial planning differs from one country to another, but there are major similar characteristics, where it:

- **Deals with land use and physical development,**
- **Is a distinct sector of government activity, and**
- **Has an important coordinating role between sectoral policies (Koresawa and Konvitz 2001).**

Spatial planning mostly covers two types of planning: a social-economic, strategic approach and land use planning. On the regional level strategic plans and land use plans are mostly parallel.

Regional level land use planning mostly focuses on the functional organization of the space determining the basic elements of the settlement structure and interrelations between them, and highlights areas and corridors of supra local importance, determining the requirements for their utilization, and coordinating the planning activities of municipalities.

The Council of Europe in 2000 adopted a unique strategy focusing on landscapes: the European Landscape Convention. It concerns the protection, management, and planning of all European landscapes (and entered into force in 2004). The main objective of the Convention is to identify and evaluate landscapes and analyse the forces transforming them. The Convention also highlights the need to integrate landscape planning into spatial policies, and the significance of public consultations.

The elaboration of strategies and land use plans is based on a detailed analysis of social, economic, environmental and landscape conditions. However, in most countries landscape planning does not occur as an independent planning activity as in Slovakia. Next to strategic and land use plans in Slovakia, the Landscape ecological plan is a document elaborated as a part of the procurement of land-use plans at a regional and municipal level with a focus on landscape ecological analysis, assessment, and optimization of functional use in harmony with landscape ecologic potentials and limits for development.

Recently, spatial planning faces major challenges related to intensive suburbanization, environmental and landscape issues, etc.:

- **Answering the challenges of climate change,**
- **Following and answering trends of landscape changes,**
- **Controlling urban sprawl, avoiding generalized impacts of globalization in spatial development,**
- **Green infrastructure planning and development,**
- **Restoring degraded ecosystems, development of ecological networks,**
- **Consideration of special conditions, different landscape character types,**

- **Harmonization of development and land use approach and tools to reach a more integrated spatial planning system,**
- **Stronger and better involvement of the public into the planning process.**

Stronger, multilevel integration of landscape issues would be necessary. There should not only be a focus on natural and landscape protection but on their development as well, integrating landscape issues from the very beginning of plan making. Landscapes are a highly complex system; a much stronger co-ordination is necessary between different sectors, as well as a more integrative and flexible approach. Among the best practices, we highlight spatial planning tools which help to protect the natural network in the development process.

2.2 EU policy framework

Spatial planning is not a community policy, but the EU has formulated several guidelines for balanced spatial development. The **European Spatial Development Perspective** (ESDP, 1999) marked great progress in the history of EU regional policy. Although it does not mean any new responsibilities for the member states, it formulated common objectives for the balanced and sustainable regional development of the entire territory of the EU and gave guidance for spatial planning in the member states. Unfortunately, this has mostly led to more uniformity and to the loss of biodiversity. Several guidelines of the ESDP outlined the protection and consideration of landscape values as resources for spatial development.

Main goals of the ESDP:

- **Development of a polycentric and balanced urban system and strengthening of the partnership between urban and rural areas, so as to create a new urban-rural relationship.**
- **Promotion of integrated transport and communication concepts, which support the polycentric development of the EU territory, so that there is gradual progress towards parity of access to infrastructure and knowledge.**
- **Wise management of natural and cultural heritage, which will help conserve regional identities and cultural diversity in the face of globalization.**

The **Territorial Agenda** of the European Union as a continuation of the ESDP was adopted in 2011. The Agenda as a short policy paper aims to mobilise European regions and cities for sustainable economic growth that accounts for economic, social, and environmental challenges.

There are several initiatives that help to analyse and monitor environmental trends:

- **The EU's infrastructure for spatial information (INSPIRE) - Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)**
- **Landscape fragmentation pressure and trends in Europe (EEA, 2019)**

As part of general obligations, several holistic rules intend to avoid or mitigate from the very beginning the negative effects of development projects, which include:

- **Assessment of the effects of projects on the environment (EIA)**
- **Assessment of the certain effects of plans and programmes on the environment (SEA)**

2.3 Worldwide examples

2.3.1. AMERICA

2.3.1.1. A greenways network for Maryland

Form	Programme
Type	Planning
Location	Maryland, USA
Scale	Regional (state)
Involved sector	Spatial planning
Type of countryside	All types *(mainly wetlands and forests)*
Phase	Planning
Financing	Government
Responsible institution	Institutions of State of Maryland

The State of Maryland has made a commitment to developing a state-wide network of 'greenways' as a community conservation initiative. A diverse range of linear habitats and natural linkages are envisaged together forming a state-wide network.

The purpose of the network is to provide habitat and pathways for wildlife, to provide recreational opportunities and open space for people, to buffer waterways and protect the wetlands and water quality of Chesapeake Bay, and to enhance the aesthetics of urban environments.

Protecting the environmental quality of the biologically productive Chesapeake Bay is an integral part of the plan and in 1984 legislation was passed to establish a resource protection program (Critical Area Program) for the bay. This includes several provisions directly relating to the establishment of a connected habitat network (Therres et al., 1988).

2.3.1.2. Bozeman Pass: Creating Habitat Connectivity in the Northern Rockies, USA

Form	Project
Type	Planning
Location	Bozeman Pass, USA
Scale	Regional
Involved sector	Spatial planning, Nature protection
Type of countryside	All
Phase	Planning
Financing	-
Responsible institution	-

There are fragmented wildlife habitats between the Glacier-Waterton national parks, Salmon-Selway wilderness areas of central Idaho, and the Greater Yellowstone Ecosystem. The intact ecosystems still host native wildlife of grizzly and black bears, wolves, bison, lynxes, mountain lions, wolverines, etc.

American Wildlands and partners used a least-cost model, focusing on three species (grizzly bear, elk, and cougar), four variables (habitat suitability, habitat complexity, weighted road density, and building density), road-kill data, track surveys, and remote camera data.

This finally resulted in the Bozeman Pass Wildlife Corridor between the cities of Livingston and Bozeman. It links the Bridger and Bangtail mountains with the Absaroka Mountains (approx. 908 km).

The study area is the Highway Interstate 90. It bisects the area between Bozeman to Livingston and the Montana Rail Link runs parallel to the freeway. Here lies a wildlife habitat fragmented by human development and transportation routes – a mosaic of residential, agricultural, and public lands. In these conditions the Bozeman Pass has been identified as an important wildlife corridor of linkages for wildlife habitats in the Northern Rockies, US. Carnivores here in particular have large home ranges and enormous areas required to sustain populations and individuals. Highways and other human developments accompanying new roads divide the landscapes into smaller pieces, removing portions of home ranges or forcing wildlife to cross busy stretches of roadway. Fragmented landscapes mean that wildlife populations are smaller and less stable, making them at risk of extinction and more susceptible to inbreeding and genetic defects.

This study offers new data for the three wildlife species (grizzly bear, elk, and cougar) and develops GIS tools to predict accurately movement routes and highway crossing sites. At the same time, the models developed by these projects identify probable movement routes for groups of species and help locate sites for the construction of crossing structures (underpasses, overpasses, elevated spans, or fences).

This project used field methods and GIS methods. The field methods (road-kill data, track surveys, and remote cameras) were used to collect data on the locations of animal-vehicle collisions and to determine as accurately as possible the routes that animals use as they attempt to traverse the highway.

2.3.2. EUROPE

2.3.2.1. National Ecological Network, The Netherlands

Form	Policy
Type	Planning, regulation
Location	The Netherlands
Scale	National
Involved sector	Spatial planning
Type of countryside	All types
Phase	Planning, monitoring
Financing	Government
Responsible institution	Governmental institutions

To prevent the growth of habitat fragmentation and protect the corridor from further development, the local administration put more than 2,000 acres of land under conservation easements. For 20,000 acres of land, they introduced building restrictions. The development of coalbed methane activity has been prohibited for 18,000 acres of land.

The aim of the National Ecological Network is to reduce the impact of the major causes of biodiversity decline, one of which is recognized as habitat fragmentation (Opdam et al. 1995). The spatial strategy for the National Ecological Network is to protect, buffer, and link the core areas and nature development areas for the entire Netherlands, including linkages across national borders with similar areas in Germany and Belgium (Ahern 1995). The provincial level of planning sets out the ecological network in greater detail, and also co-ordinates municipal level plans to ensure consistency with each other and with the national plan. Ecologists are using predictions and results from meta population models of species in fragmented landscapes to provide input into planning processes (Opdam et al. 1995). At the same time, a national defragmentation project was in place for 15 years and was completed in 2018 (https://www.iene2018.info, https://www.mjpo.nl).

2.3.2.2. Pan-European Ecological Network

Form	Programme
Type	Planning
Location	Europe
Scale	Transregional
Involved sector	Spatial planning, agriculture, forest management, nature protection management
Type of countryside	All types
Phase	Scoping, planning
Financing	Public

The Network was formed by the Council of Europe to increase habitat connectivity. To begin the process, a committee of experts is providing a framework to implement the Network, enabling analysis of existing related programs, and encouraging the creation of transnational and transboundary networks to ultimately create a coherent system of biodiversity conservation beyond national boundaries.

Approaches to building ecological networks differ both conceptually and methodologically according to differences in project objectives, which are influenced by human encroachment, social and economic conditions, and natural conditions and scales in various countries and regions (Cook and van Lier, 1994).

2.3.2.3. Moldova's Ecological Network Plan

Form	Programme
Type	Planning
Location	Moldova
Scale	National
Involved sector	Nature protection management
Type of countryside	All types
Phase	Scoping, planning
Responsible institution	BIOTICA Ecological Society

In 2001, BIOTICA Ecological Society, a national non-governmental organization, developed the Ecological Network of the Republic of Moldova with funding from the republic's National Ecological Fund to integrate a national corridor plan with the Pan-European Ecological Network (Andreev et al. 2002).

The components of the network, which include core areas for conservation and buffer zones, as well as biological corridors at the international, national, and local scales, were mapped at a 1:500,000 scale using GIS. An impressive amount of background information went into this process in order to prioritize components of the network.

The selected international corridors include some core areas and must pass along the entire length of the country to provide habitat connectivity with neighbouring nations, as part of the Pan-European Ecological Network. National corridors include core and buffer areas but do not join neighbouring countries. Local corridors connect core, buffer, and restoration areas and were primarily established based on hydrologic features, topography, and soils. Existing or projected tree plantations are included in some local corridors. All corridors are accompanied by buffer areas of 50–3,500 hectares, with the larger buffers reserved for national corridors (Hilty et al. 2006).

Estonia was the first country to develop the ecological network concept and to elaborate the model into a comprehensive plan and implementation pro-

2.3.2.4. The Green Network in Estonia

Form	Policy, programme
Type	Managerial, planning, regulation
Location	Estonia
Scale	National
Involved sector	Spatial planning, nature protection management, agriculture
Type of countryside	All types
Phase	Planning, construction, monitoring
Financing	Public
Responsible institution	Governmental institutions

gramme. The plans for implementing the network at county level throughout Estonia are now virtually complete. This plan would be described as a national sustainable development strategy. The Estonian ecological network has been developed as a spatial-planning tool for the purpose of balancing and integrating land uses.

In addition, the network has been the subject of policy papers such as the National Environmental Strategy (which includes an indicative map), the Environmental Action Plan and Estonia — Vision 2010. The National Agri-Environmental Programme further provides for the development of ecological networks at the local level as a way of supporting extensive farming practices. These influences have led to the development of a revised concept that focuses primarily on biodiversity conservation: the Green Network. As currently delineated, the Estonian Green Network covers about 50 percent of the country's territory and is structured to achieve a variety of objectives.

Under national legislation, each county is required to prepare a map of the Green Network at a scale of 1:50,000 as a framework for defining the conditions that are necessary to ensure sustainable development in the region. The process through which this is achieved involves local public hearings. These corridors are configured on the basis of data indicating the needs of species for dispersal and migration and the existence of natural linkages, including stepping stones in the landscape (Bennet and Mulongoy 2006).

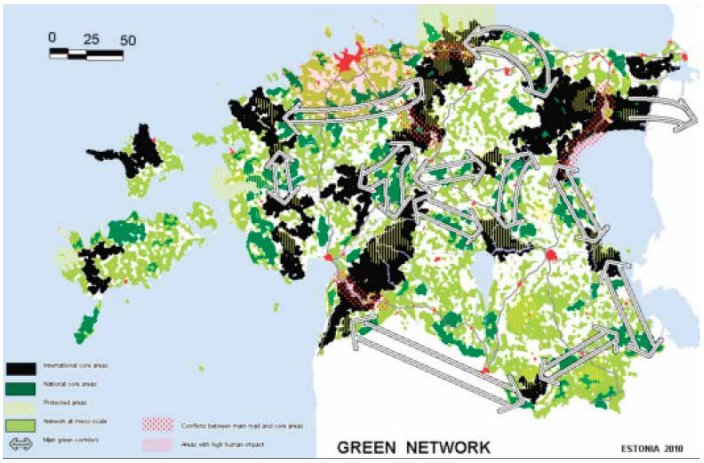

Figure 2. Green network of Estonia, © Estonian Ministry of Environment, 2010

2.3.2.5. The European Green Belt

Form	Programme, cooperation, projects
Type	Managerial, planning, cooperation
Location	Europe
Scale	Continental
Involved sector	Spatial planning, nature protection management, agriculture
Type of countryside	All types
Phase	Planning, construction, monitoring
Financing	Public, 2003- ongoing
Responsible institution	European Green Belt Association, national governments, civil organisations

The European Green Belt is crossing 24 countries, both within and outside the EU, and connects all the natural and seminatural areas preserved due to the Iron Curtain. The European Greenbelt is a wonderful example of cross-border cooperation on green infrastructure. It serves as a backbone of European green infrastructure as it links grassland fallow and wetlands, dry grasslands, and woodlands. It contains four major sections: the Fennoscandian, Baltic, Central European and Balkan Green Belt. Within each section, a wide range of projects and specific activities have been carried out or are ongoing in order to preserve this ecological corridor of continental scale.

European Green Belt website: http://www.europeangreenbelt.org/

Conclusions of the 9th Pan-European Green Belt Conference 31st October, 3rd November 2016, Koli, Finland. Available at: http://www.ym.fi/download/noname/%7BE8B9090B-5FA1-47FD-8FEF-232A4B718AA3%7D/122551

2.4. Partners' examples

2.4.1. TERRITORIAL SYSTEM OF ECOLOGICAL STABILITY

Country	The Czech Republic
Form	Policy
Type	Processual measure; Planning measure; Regulation measure; Organizational measure
Location	The Czech Republic
Field of harmonization	Ecological network and corridors in urbanized areas, agglomeration zones; Ecological network and corridors versus infrastructure corridors; Ecological network and corridors in forests; Ecological network and corridors in agricultural (arable land, grass land...)areas
Scale	Transregional
Binding of the measure	Binding according to the national law
Involved sector	Spatial planning; Transport infrastructure; Agriculture; Forest management
Phase	Planning; Design; Construction
Financing	State budget, regional budget, municipal budget
Responsible institution	Ministry of the Environment, Regional office, Municipal office

The TSES is the basement of ecological network in Czech Republic, which is included to the Act No. 114/1992 Gazett on the Nature and Landscape Protection, as amended later. According to the importance and wide spectrum of representative biogeographical units, the TSES is classified to the three spatial scale: Supra-regional, Regional, and Local. Components of TSES are: Biocentres (core areas), Biocorridors, Buffer zones, and Interactive elements.

Absent or outdated spatial planning documentation exists in several small municipalities. It is estimated that 60% of the L-TSES plans were elaborated based on the MR-TSES from 1990. Therefore, even after 15 years, there have not been up to date, high-quality TSES plans for the whole territory of the country. Conflicts with TSES elements occur in planning and implementation of linear structures without ensuring there is a corresponding technical solution to this conflict in all cases, although detailed methodology and a technical standard has been elaborated and published by the Ministry of Transport of the Czech Republic and Road and Motorway Directorate. There are inadequate mechanisms for conserving and restoring the composing elements of TSES at all levels.

Involved stakeholders: Ministry of Regional Development

https://www.mzp.cz/C1257458002F0DC7/cz/uzemni_system_ekologicke_stability/$FILE/OOOPK_Metodika%20vymezovani%20USES_20170330.pdf

2.4.2. COMPLEX APPROACH TO THE PROTECTION OF FAUNA OF TERRESTRIAL ECOSYSTEMS FROM LANDSCAPE FRAGMENTATION IN THE CZECH REPUBLIC

Country	The Czech Republic
Form	Programme; Methodology
Type	Processual measure; Planning measure; Regulation measure
Location	The Czech Republic
Field of harmonization	Ecological network and corridors in urbanized areas, agglomeration zones; Ecological network and corridors versus infrastructure corridors; Ecological network and corridors in forests; Ecological network and corridors in agricultural (arable land, grass land...)areas
Scale	Local; Regional; Transregional
Binding of the measure	Non-binding but recommendatory
Involved sector	Spatial planning; Transport infrastructure; Agriculture
Phase	Planning
Financing	Nature Conservation Agency of the Czech Republic (NCA CZ)
Responsible institution	EEA grants

2.4.3. SPATIAL PLAN FOR THE SPECIAL PURPOSE AREA OF THE MULTIFUNCTIONAL ECOLOGICAL CORRIDOR, TISA, SERBIA

Form	Policy
Type	Planning
Location	Vojvodina, Serbia
Scale	Regional
Involved sector	patial Planning, Nature protection
Type of countryside	All
Phase	Planning
Financing	-
Responsible institution	-

According to a study conducted by the Institute for Nature Conservation of Vojvodina Province, this spatial plan has established the ecological corridor of the Tisa River (water body of the river, undefended part of the floodplain, defensive embankments, and some parts of the defended floodplain) and three zones of corridor protection (up to 50 m, 200 m, and 500 m from the ecological corridor) with measures of protection for the ecological corridor and its protection zones.

These measures cover the land uses that support the protection of the ecological corridor and the habitat that it connects for agricultural and forest land; as well as covering the land uses that conflict with the protection of the ecological corridor, i.e., the regulation of watercourses and water management facilities, building settlements and working zones, facilities of infrastructure systems (transport and energy) and others.

Lessons learned: It is possible to harmonize the protection of the corridor with existing and planned land uses in order to provide effective protection of ecological corridors and to enable sustainable development in its protection zones.

An action plan was prepared during the project: Development of measures along Alps-Carpathian Corridor and their implementation in the Centrope region (Acronym: AKK Centrope), 2009-2012.

2.4.4 THE ALPINE-CARPATHIAN CORRIDOR, AUSTRIA-SLOVAKIA

Form	Policy
Type	Planning
Location	Little Carpathians, Austria-Slovakia
Scale	Supranational
Involved sector	Spatial Planning, Nature protection
Type of countryside	All
Phase	Planning
Financing	European Regional Development Fund
Responsible institution	BOKU Vienna (F. Suppan, Fredy Frey-Ross) in cooperation with AT and SK experts (WWF, Daphne, SNC SR, SPECTRA)

Methodology was prepared during the project: Baseline for establishment of Alps-Carpathian Corridor (Acronym: AKK Basic), 2008-2012.

Both projects were realized under the Program of transnational cooperation between Slovakia and Austria 2007-2013.

To recognize a current ecological network, a digital map was created according to remote sensing data. The landscape was analysed by GIS. According to the analysis, possible migration routes of red deer were identified as well as indicative species. Possible scenarios to improve permeability alongside the Alpine-Carpathian Corridor were also designed.

A special value was allocated to each type of landscape, which correlated with suitability for animal migration. These values were added to landscape in the whole research area with resolution 30 m x 30 m. According to this, a stress influencing migrating roe deer in concrete landscapes was defined. Low resistance was found in high permeable land and non-disturbed ecological networks. Forests and wetlands have low resistance values, while agricultural areas and streams have higher values. Urbanized areas and fences highways have the highest value of resistance.

2.5 Literature

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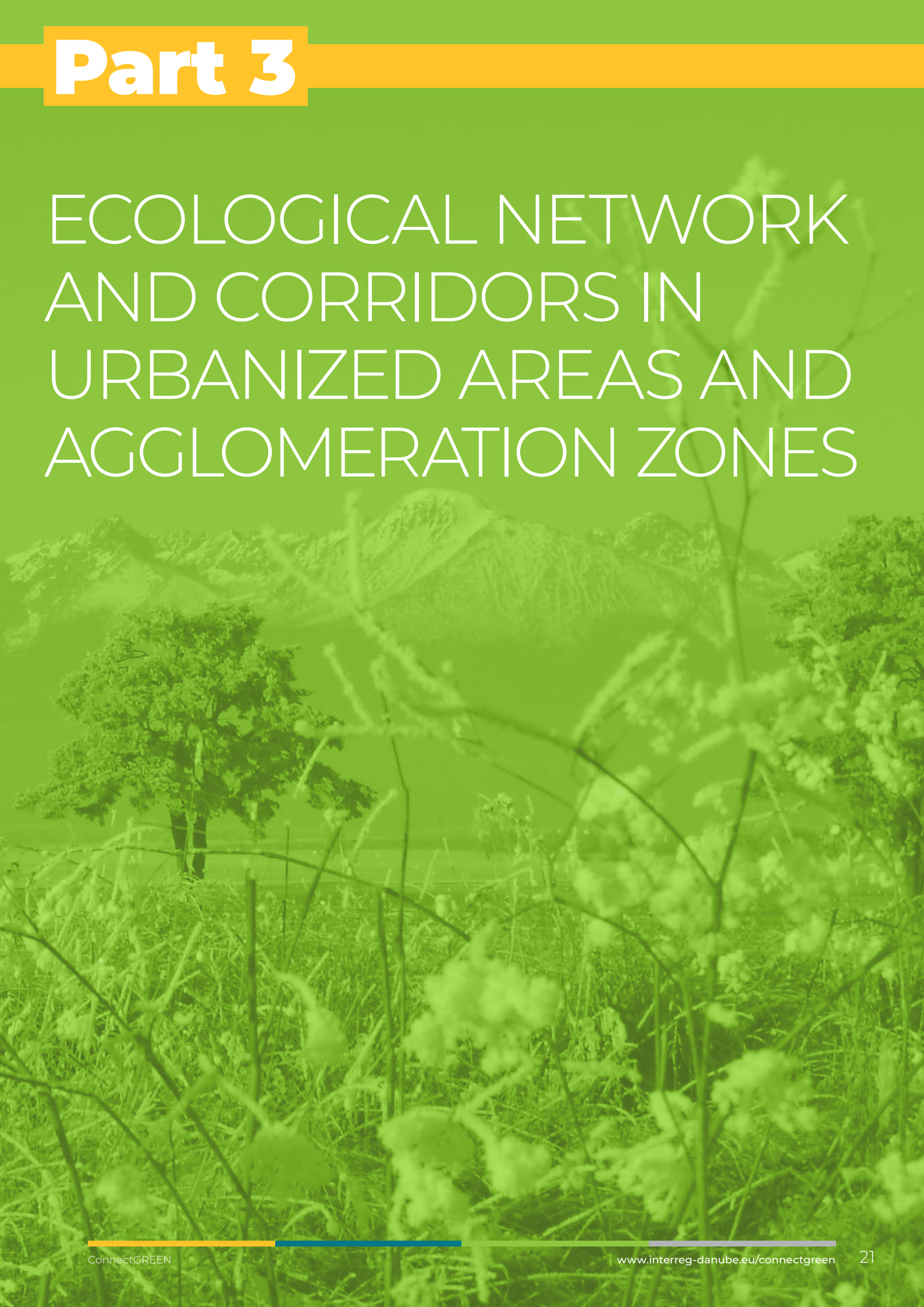
Part 3

ECOLOGICAL NETWORK AND CORRIDORS IN URBANIZED AREAS AND AGGLOMERATION ZONES



3.1. General aspects, problems, suggestions

Urbanized regions of the developed world are highly important to maintaining landscape connectivity. For decades the strong phenomenon of suburbanization has been consuming natural assets around cities. Several European strategies highlight the importance of controlled development and preservation of ecologic networks and connectivity. An important driving force behind urban expansion is, of course, the growth of the urban population and increased consumption. There is a strong demographic and economic pressure on the growth of urban areas, especially in large agglomeration zones. Hence, in the driving of maximum economic benefits, urban ecological corridors can be easily transformed into construction land. There thus is an extremely large pressure on the remaining ecologically valuable areas, and unbuilt areas in agglomeration zones.

As Nilsson et al. (2013) stated, based on the research of J. Ravetz, urban expansion is not a simple one-way process; it also generates responses and changes in the surrounding peri-urban and rural areas. In spite of a free-standing city in rural surroundings there is a wider regional urban system of inter-connected and polycentric settlement forms (Figure 3), where to maintain the ecologic network, several tools are necessary. Urban residents increasingly need recreational and ecological, green living open spaces. The term urban ecological corridor refers to a linear/ribbon/network of ecologically valuable areas and landscape units serving landscape connectivity, which has the functions of natural habitats, green open spaces, or human habitat isolation in the artificial eco-environment of the city or urban area, or in the surroundings of urbanized areas.

Several spatial planning, land use regulation, and landscape planning tools are applied in the practice to control urban sprawl and protect ecological networks. European countries follow different strategies for controlling urban sprawl, thereby protecting ecologic networks of metropolis regions under serious urban pressure.

In order to maintain quality of life amid the intensive development of urbanized areas, it is highly important to preserve an appropriate level of ecosystem services and maintain a critical level of ecological connectivity. What are the major tools and methods for that?

This extends the 'ecosystems services' approach to a wider view on 'services, linkages, functions, values': for integrated development policy in the rural-urban-region (based on Ravetz, 2011).

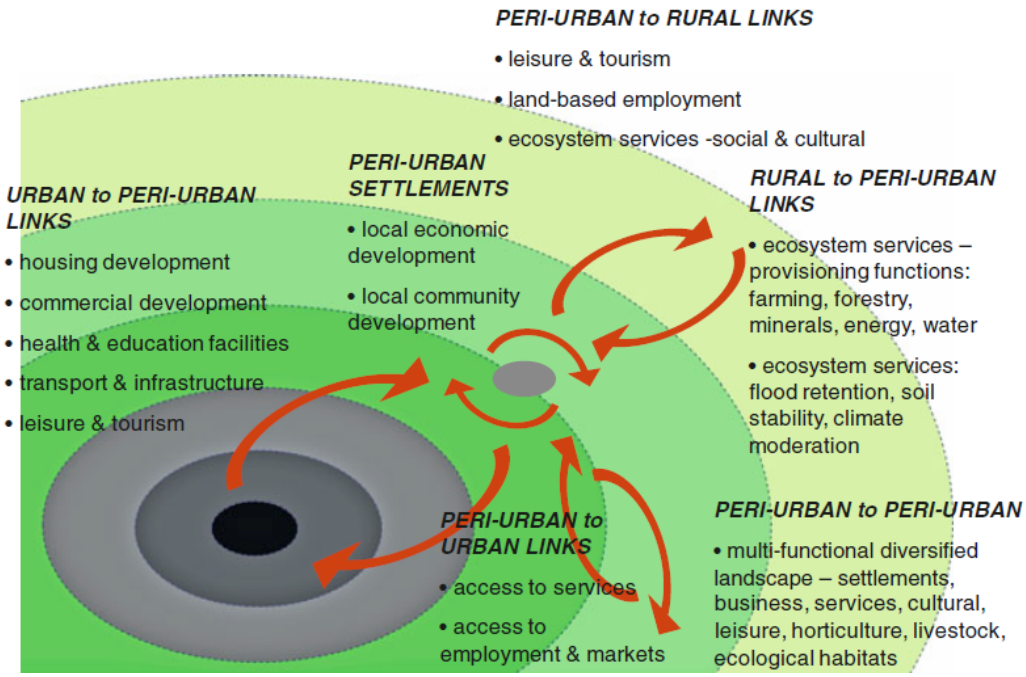


Figure 3. Dynamics of the peri-urban (Source: Nilsson et. al 2013, based on Ravetz 2011).

In urbanized regions there are several methods to preserve ecologic values and restore ecologic networks:

1) Setting limits on urban growth, strict regulations on controlling construction, and greenbelt planning as a specific tool;

2) Nature and landscape protection;

3) Green infrastructure planning and elaboration of regional ecological corridors, and greenway planning as a specific tool;

4) Encouraging intermunicipal cooperation on comprehensive planning with single focal points of development;

5) Specific compensation tools for loss of ecological values due to construction.

6) Setting limits on urban growth, strict regulations on controlling construction, and greenbelt planning as a specific tool

In agglomeration zones, peri-urban areas often have regulatory tools for controlling urban sprawl. Greenbelts, among the specific tools on controlling urban growth, are mostly unbuilt areas around cities with forests, agricultural areas, and recreational areas. Greenbelts are a very strong spatial planning tool in the UK, but in Germany metropolitan regions have also defined their "*Grüngürtel*" (Köln, München, Frankfurt am Main etc.) – albeit more as spatial tools for distinguishing open spaces than as strict land use regulations. Vienna has a dedicated greenbelt, which was one of the first in the world. As early as 1905, the city launched regulations to protect the Wienerwald, and the Viennese forest and meadows belts were established. On comparing different policies, Andreas Schulze Baing argues that the more centralized planning policy and the strong instrumentalization of green belts of the UK were more effective in controlling urban sprawl than German planning instruments (Schulze Baing, 2010).

In Hungary around Budapest there is not a dedicated greenbelt. Experts intended to formulate one before adapting the act on land use planning of Budapest agglomerations, but this has been inhibited due to strict regulations and controls on building (Filepné, 2018). In the case of Budapest, the problem is that before the act's adoption there was no moratorium and several local governments designated new development areas, and therefore there have until now been vast areas reserved for urban growth.

» Nature and landscape protection

Nature protection areas are important tools in the region of functional urban areas to control urban sprawl but due to the loss of natural values mostly urbanized regions lack ecologically valuable areas http://natura2000.eea.europa.eu/.

Around Budapest and Vienna there are large nature protection areas protected by national law and designated as National parks. They are also protected by European law, as they are mostly also designated Natura2000 sites (Figure 4).

» Green infrastructure planning and elaboration of regional ecological corridors - a specific tool is greenway planning

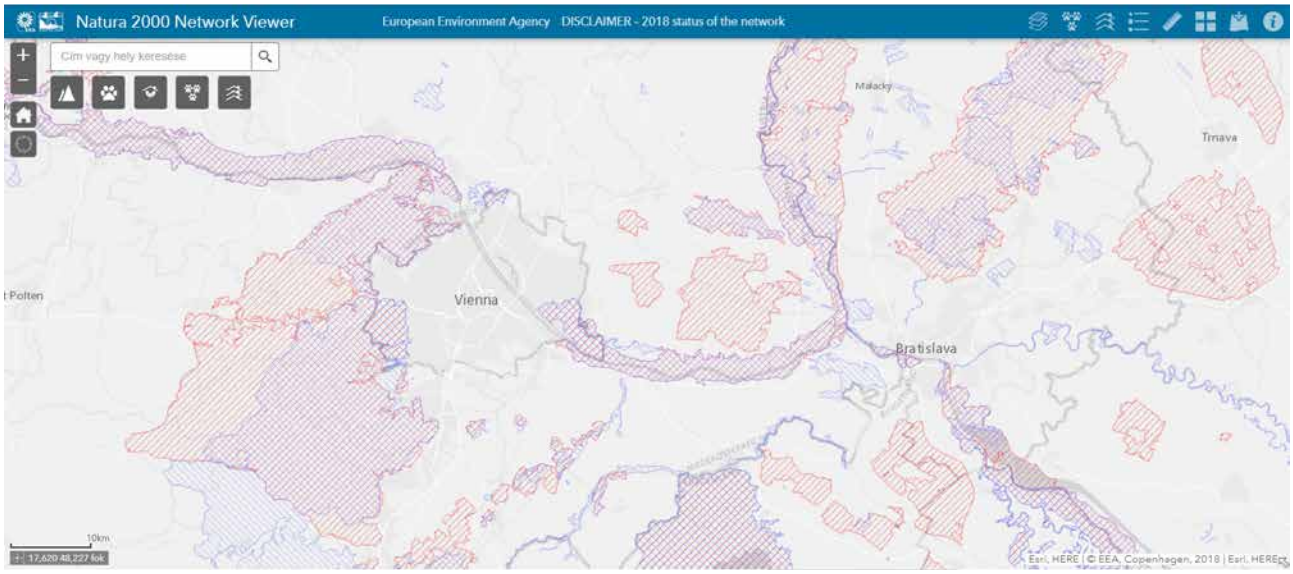


Figure 4a. Natura2000 network around agglomeration zones a, Vienna, Bratislava; b, Munich

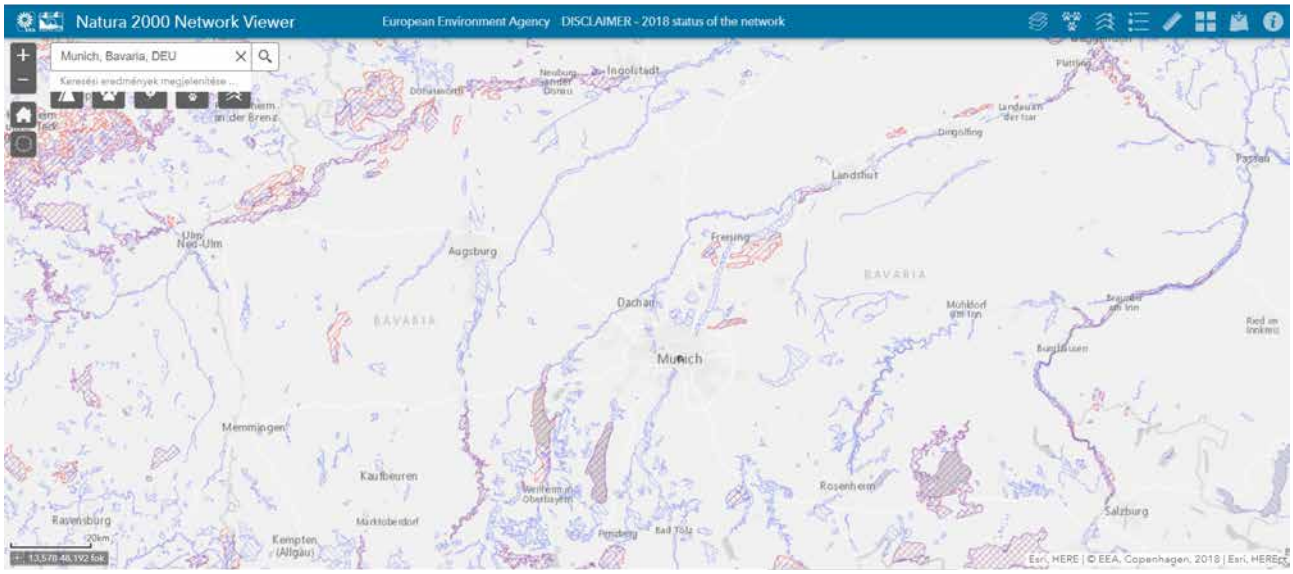


Figure 4b. Natura2000 network around agglomeration zones a, Vienna, Bratislava; b, Munich

The development and maintenance of green networks and green infrastructure planning are important ways to preserve ecosystem services, ecological functions, and ecological connections in agglomeration zones and peri-urban landscapes. The green infrastructure is a strategically planned network of natural and semi-natural spaces and represents a crucial approach in the maintenance and development of ecosystems and ecosystem services (Benedict, and McMahon, (2001). Green infrastructure covers a wide range of natural and semi-natural features as reserves, parks, recycled land, parks and open spaces, agricultural lands, forests, conservation corridors, landscape linkages, and greenbelts (Williamson K. S. 2003). The most important aspect is the preservation of multi-functional open spaces around fast-growing cities, offering the integration and interaction of different services and benefits (MacFarlane et al. 2006).

Regarding the concept of green infrastructure - or to be more precise, the concept of developing a network of natural and semi-natural areas - several countries have developed practices in this field. For example, the French 'trameverte et bleue' (Green and Blue Network, GBN) is a spatial planning tool to conserve and restore ecological continuities. Green and blue corridors are officially created by the 2010 Grenelle II law, which requires the linking of sites previously identified for their importance for biodiversity conservation to overcome French territorial fragmentation (Mazza et al. 2011).

From the Central-European region, we highlight the Czech and Slovak concept of Terrestrial System of Ecological Stability. The Terrestrial System of Ecological Stability of the Landscape (TSES) is the only nature conservation tool constituting an ecological network in the landscape of the Czech Republic. The nature conservation tool is integrated in the spatial planning system. Act No. 114/1992 Coll. as amended defines the TSES as an interconnected system of both natural and altered but still semi-natural ecosystems. The TSES consists of three basic elements – biocentres, biocorridors, and interactive elements (ConnectGREEN Deliverable 3.3.1 State of the Art eport).

In the Slovakia landscape, there are ecologic plans at the regional and municipal level. The landscape ecologic plan is a document forming part of the procurement of land-use plans at the regional and municipal level, with a focus on landscape ecologic analyses, assessment and optimisation of functional use in harmony with landscape ecologic potentials and limits for development. The plans of the Terrestrial Systems of Ecologic Stability align with the Law on land-use planning supportive documents. As defined in the Act No. 543/2002 Coll. on Nature and Landscape protection: The Terrestrial System of Ecological Stability is a spatial structure of interconnected ecosystems, including their constituents and elements, which provides a diversity of conditions and lifeforms in the landscape. This system consists of biocentres, biocorridors and interacting elements of supra-regional, regional, or local importance (ConnectGREEN Deliverable 3.3.1 State of the Art Report).

The European Union launched several studies that researched the green infrastructure of member states, analysing the GI of cities and agglomeration zones. (https://eea.maps.arcgis.com).

Figures 5 a-e. The factsheets for the capitals of partner countries from the interactive map of the European Environmental Agency. For all cities the factsheets show information and the values for main Urban GI indicators. The graph shows the relative importance of each of the nine parameters defining the clusters. Below, the interactive graphs show the distribution of selected city's Mean Effective GI along the peri-urban area. And, finally, a map shows the spatial distribution of Effective GI on the urban-rural interface.
Source: https://eea.maps.arcgis.com/apps/MapSeries/index.html?appid=42bf8cc04ebd49908534efde04c4eec8%20&embed=true

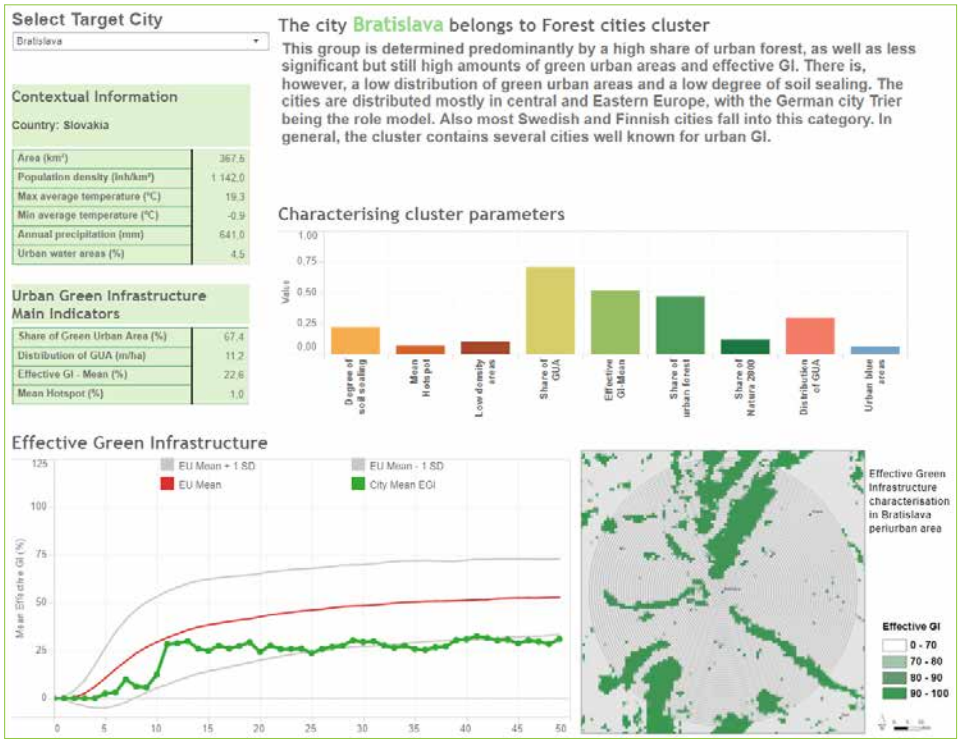


Figure 5a: City of Bratislava

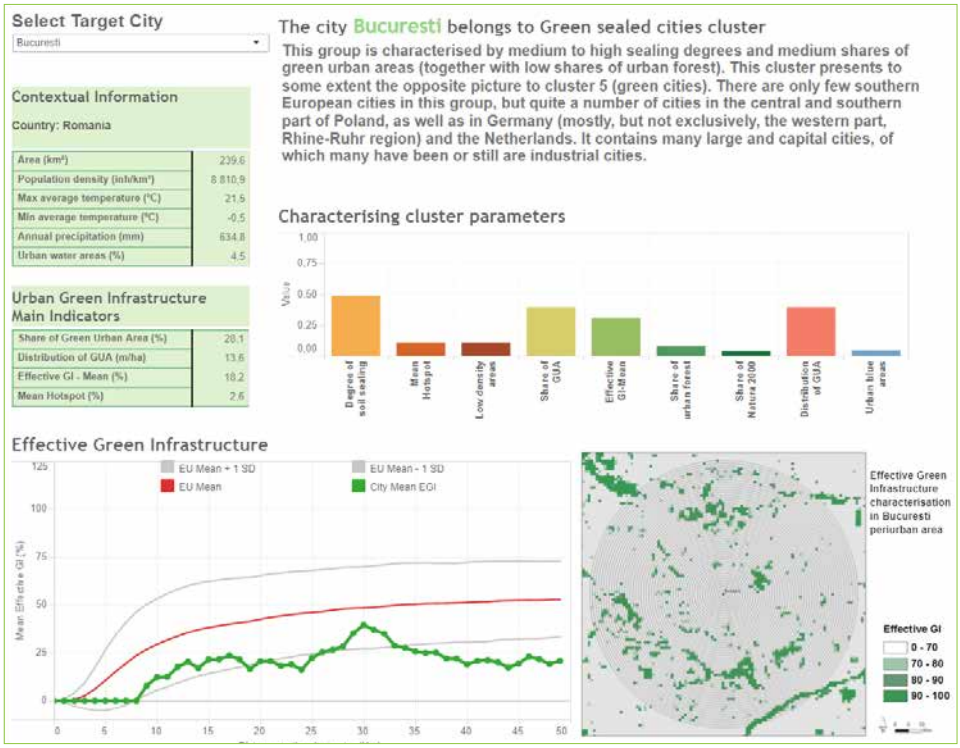


Figure 5b: City of București

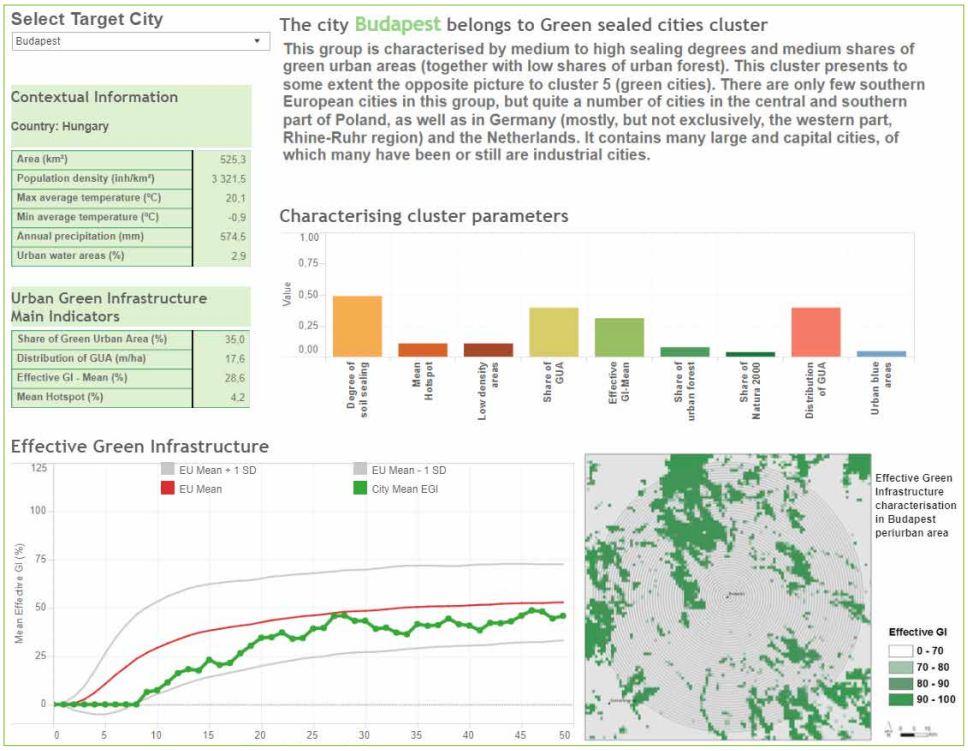


Figure 5c: City of Budapest

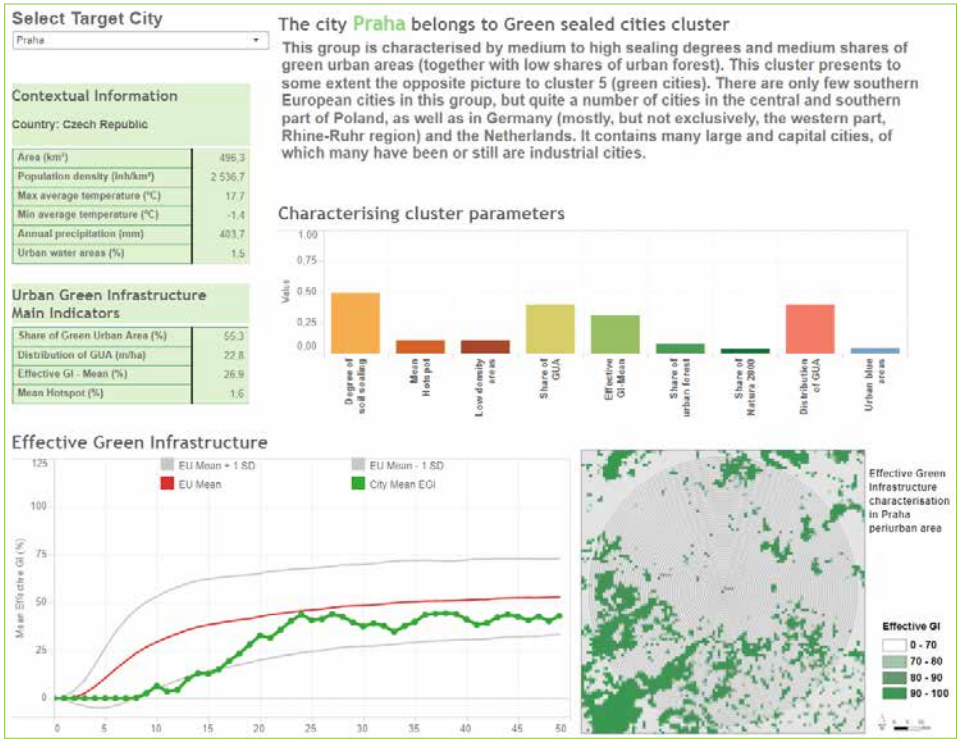


Figure 5d: City of Praha

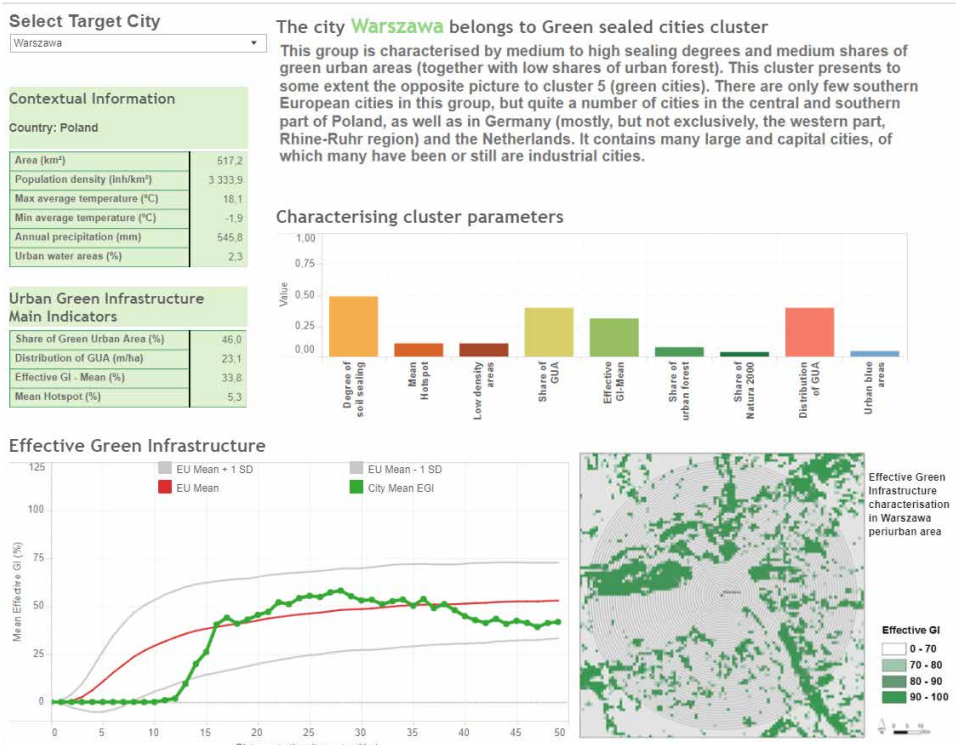


Figure 5e: City of Warszawa

Greenways are special tools for protecting and developing green corridors which serve ecological but also recreational and cultural purposes. Cities sometimes choose to preserve greenways in an effort to improve the quality of human life by limiting urban sprawl and providing opportunities for aesthetic enhancements and recreation. However, greenways may also serve as de facto connectors and biodiverse habitats.

» Encouraging inter municipal cooperation on comprehensive planning with general or single focal points of development

Nowadays there are different tools for the protection of ecological network in agglomerations under great development pressure. On the regional level a common platform must be created, or there must be cooperation to ensure harmonized spatial development. Cities need to look beyond their borders and need to cooperate with the municipalities in their functional area.

In the following (Table 2) we highlight a few examples on metropolitan governance systems and whether any supralocal policy had an influence on the land-use change decisions at the local government level (Tosics 2013; Filepné et al. 2019). The analysis of the PLUREL project has shown that the North-west European countries (e.g., Denmark, the UK and the Netherlands) show higher levels of potential control mainly because of their consolidated local government systems, while Southern European countries showing a higher potential (such as Cyprus, Greece or Portugal) have more fragmented local government systems, but stronger planning control at supra-local levels. Most new EU member states show a weak control potential (Tosics 2013).

We highlight a French example, as the French local administration system is highly fragmented. More than 36000 communities exist, but there is a stronger supra-local control. To reduce the disadvantages of this fragmented local system, inter-communal cooperation have long existed in France. 2600 supra-municipal cooperation function in the country, which is important in the field of spatial and landscape planning. The tasks and responsibilities of the supra-municipal

Spatial planning system: control from supra-local levels	Supra-local level of government deciding or influencing land-use changes (average size in millions)	Local level (average size in thousands of population)	Indicator of the strength of public control
Strong supra-local spatial policies	Large (>1m)	Any	7
	Medium-sized (0.5–1m)	Any	6
	Small (<0.5m)	Any	5
Medium level of control	Large (>1m)	Large (>30)	6
		Medium-sized (10–30)	5
		Small (<10)	4
	Medium-sized (0.5–1m)	Large (>30)	5
		Medium-sized (10–30)	4
		Small (<10)	3
	Small (<0.5m)	Large (>30)	4
		Medium-sized (10–30)	3
		Small (<10)	2
Weak supra-local level of control	Any	Large (>30)	3
		Medium-sized (10–30)	2
		Small (<10)	1

Value	Countries
7	
6	Denmark, Netherlands, Portugal, United Kingdom
5	Belgium, Cyprus, France, Germany, Greece, Ireland, Lithuania
4	Italy, Spain, Sweden
3	Austria, Bulgaria, Finland
2	Estonia, Latvia, Luxembourg, Malta, Poland, Slovenia
1	Czech Republic, Hungary, Romania, Slovakia

Table 2. Strength of public control over land-use changes according to the combined government and planning dimensions according to the PLUREL and the result of country level analysis (Tosics et.al. 2013)

cooperation are defined by legal rules. The most common forms of cooperation include:

- **Supra-municipal cooperation:**
  - **CU: communauté urbaine – urban supra-municipal cooperation.**
  - **CA: communauté d'agglomération – agglomeration supra-municipal cooperation.**
  - **CC: communauté des communes – rural supra-municipal cooperation.**
- **"Landscape units" ("pays").**

Most agglomeration regions are covered by several cooperation networks. We previously studied the system of Rennes, which has the status of pays created under the Voynet law in 1999. This means an area whose inhabitants share common geographical, economic, cultural, or social interests, and who therefore have a right to enter into communal planning contracts (Korom A. 2014). The region encompass 77 communities and an area of 1145 km², with 508761 inhabitants. It covers four smaller intercommunal cooperation and the intercommunal cooperation zone of Rennes (named Rennes Métropole). The functional urban area (FUA) covers an even larger area (3747.3 km2 with 719 840 inhabitants and 140 settlements (http://www.paysderennes.fr). In the case of Rennes, the whole pays and metropolitan inter-communal region have planning authority for adopting strategic plans and local planning regulations (Filepné et al. 2018).

Hungary, as a unitary country, has weaker regional controls. There are no powerful regional authorities, but the agglomeration of Budapest is a special case due to its national importance and Hungary's monocentric structure. Budapest's agglomeration zone is located in Pest County which shares the same area as the administrative region of Central Hungary. Budapest's urban agglomeration represents 2.7% of Hungary's entire land mass and its 2.5 million inhabitants make up one quarter of the country's total population. Budapest's agglomeration zone does not have any regional authority, but the state defined the agglomeration zone, and an act forms the framework for spatial development (Act LXIV on Spatial Planning in the Agglomeration of Budapest in July, 2005). The land use zoning plan tried to control the authority of local governments especially in the field of urban sprawl. Unfortunately, local governments lobbied successfully for their interests, stripping the regional plan of its original aims.

Special regional plans are also described in Serbia for the Belgrade Metropolitan Area, and for metropolitan areas in Romania – with peri-urban plans described for other major cities as well. The Regional Spatial Plan of the Administrative Area of the City of Belgrade is a planning document that represents the link between the Spatial Plan of the Republic of Serbia (higher order plan) and other lower order planning documents. Although it investigates and examines a territorial scope greater than the city area, the plan's jurisdiction is solely over the territory of Belgrade's 17 urban municipalities. The Metropolitan Area covers 3224 km2 and has 1.572.000 inhabitants.

The implementation of effective common planning strategies is mostly hindered by the fact that the administrative region's borders do not follow the metropolitan area. Strengthened regional governance could be an important tool, as in several cases we have seen a bottom-up approach that fosters stakeholder cooperation.

- **Specific compensation tools for loss of ecological values**

The construction of roads and other development is considered inevitable and necessary in a society, but often compensation is required for lost ecological

value. In Switzerland ecological compensation measures are compulsory for large construction projects to build roads, railway lines, and other infrastructure, and should consume something approximately 3% of the total construction costs. In this case, the compensation measure could be accomplished on land owned by the canton and no negotiations with private landowners were necessary.

A special tool in Germany are so-called eco-accounts (Ökokonto). Since 2004, German municipalities have been able to set up eco-accounts as a special land banking system to store and use offsets for address the impact of development impact. Based on the landscape program, local communities define pre-compensation areas where ecologic compensation and mitigation measures can be taken; in Munich, such areas include a fenland area in the northwest to restore wetlands and small streams.

3.2 EU policy framework

Europe's urban areas offer home to over two-thirds of the EU's population and produce up to 85 % of Europe's GDP. Urban areas face special environmental, social, and economic challenges. Therefore, for decades, regional policy has had an urban- spatial dimension and focus on the European Union. Several programs evaluate the strategies and projects of cities and agglomeration zones, with a focus on their spatial development.

The EU's environmental policy also marks the political importance of this issue, demonstrated by its inclusion in the 7th Environmental Action Programme (7EAP) under Priority Objective 8, entitled, "Sustainable Cities: Working together for Common Solutions". https://ec.europa.eu/environment/action-programme/objectives.htm

The **European Spatial Development Perspective**, as a non-binding document, highlighted the need for guided development as early as 1999; controlling urban sprawl, for example, by pursuing polycentric, compact settlement structures – and suggesting where cities should build partnership with the neighbouring municipalities (EC, 1999).

The **Leipzig Charter on Sustainable European Cities** (EC 2007) lists the common principles and strategies for urban development policy agreed by the EU Member States. The Charter considers the compact settlement structure as an important basis for efficient and sustainable use of resources.

The Council of Europe in 2000 adopted a unique strategy focusing on landscapes: the **European Landscape Convention** (Council of Europe 2000). It is dedicated to the protection, management, and planning of all European landscapes (entered into force in 2004). The parties of the convention agreed to identify and evaluate landscapes, analyse their characteristics and the forces and pressures transforming them and integrate landscape into spatial policies highlighting the importance of public consultation. Peri-urban landscapes are under particular pressure, and it is especially important in these areas to introduce effective co-operation methods, common green space, green infrastructure planning tools for municipalities, and to enhance public participation.

The cities can be analysed and developed more effectively within their surroundings and areas of influence, so the EU and OECD jointly define the functional regional units where the surrounding area (commuting zone) is highly integrated into the core city. The European Union and the OECD use population density and travel-to-work flows to define these **functional urban** areas (FUA) (OECD 2013).

The European Union's Strategy for the period of 2014-2020 has considerably reinforced the urban dimension of this cohesion policy. According to article 7.4 of its Regulation, Member States must allocate at least 5% of their national European Regional Development Fund (ERDF) to the support of integrated strategies for sustainable urban development. In particular, it aims to improve urban environmental quality and the efficiency of environmental management in EU urban areas.

In 2016, The EU launched the **Urban Agenda** – a multi-level governance framework for dialogue and collaboration to identify and tackle urban challenges, by bringing together Member States, cities, the European Commission, and other stakeholders. Sustainable land use is an important aspect, with the partnership highlighting the need to promote joint strategic and spatial planning of Functional Urban Areas.

The European Commission Environment Directorate General (DG Environment) is working on improving the urban environment in a number of ways:

» **Through the EU's general environmental legislation and integrated policy approaches, working to ensure — among other goals — that European citizens enjoy cities with clean air, water, and reduced exposure to excessive noise,**

and that cities deal properly with waste, protect their nature and biodiversity, and promote better green infrastructure

- **Through the European Green Capital and European Green Leaf initiatives, enabling cities to showcase their environmental performance**
- **Through the development of a new tool that will allow cities to benchmark their environmental performance, assessing progress in comparison with other similar cities, sharing best practices and experience and tracking improvement over time**

In line with the global Sustainable Development Goals, the EU aims to achieve 'no net land take by 2050' One clear way of limiting urban expansion is to make better use of existing urban space. Europe's spatial, especially urban, planners will need to play a key role in limiting urban expansion. This could mean designing compact but green cities, with key amenities within walkable distances, or mobility systems designed to reduce travel distances and times – or an extensive green infrastructure network that connects all natural areas across the continent. To turn such plans into reality, a wide range of stakeholders needs to be involved and key governance questions addressed (EEA 2019).

3.3 Worldwide examples

3.3.1. EUROPE

3.3.1.1. A greenbelt and greenway system of Rennes Metropole

Form	Programme
Type	Planning
Location	Rennes, France
Scale	Regional (state)
Involved sector	Spatial planning, nature protection, agriculture, forestry
Type of countryside	All types of land use forms in an agglomeration zone, urbanized region
Phase	Planning, monitoring
Financing	City of Rennes, regional government, state
Responsible institution	City of Rennes

Rennes Metropole has created a green belt to protect the agricultural lands. The city is growing with a polycentric model pursuing the goal of "Archipelago City". The Pays of Rennes has created a Green and Blue Network to protect natural heritage, the landscape, and the traditional landscapes of Bocage (a terrain mixed of pasture and woodlands) (Figure

Figure 6. Green and Blue Network Rennes (http://terresenvilles.org/wp-content/uploads/2016/11/TEV_CH2.1.4_TVBRennes_2009.pdf)

3.3.1.2. Metropolitan governance system of Munich

Form	Administrative and self-governance system
Type	Planning
Location	Munich, Germany
Scale	Regional (state)
Involved sector	Spatial planning, administration
Type of countryside	All types of land use forms in an agglomeration zone, urbanized region
Phase	Administration, planning, monitoring
Financing	City of Munich, regional government, state
Responsible institution	Metropolitan region Greater Munich

5). The city created a greenway, enhancing nature and recreational possibilities in the city, as well as ecological corridors between waterways and the river.

Munich is Germany's most productive urban centre. It counts 1,539,298 inhabitants within a total urban area of 310.71 km^2. The metropolitan region of Greater Munich is one of eleven metropolitan regions in Germany, consisting of agglomeration areas in Munich, Augsburg, Ingolstadt, Landshut, Rosenheim and Landsberg am Lech. The metropolitan region is notable for its very even wealth distribution between the City and wider region. Area: 27,700 km^2 (40% of the state of Bavaria), Population: 5,203,738 (42% of the Bavarian population). The Functional Urban Area (FUA) of Munich covers an area of 5,500 km^2 and in 2004 had 2,531,706 inhabitants. It covers the capital of Munich, all 185 cities, markets, and municipalities and the 8 counties in the region of Munich. The FUA is equal to the Regional Planning Association Munich (RPV), which is the legally planned association of municipalities (Growth Commission, 2016).

The planning can be more effective in cases where a metropolitan governance system exists with planning responsibilities in the agglomeration zone. This is the case in Munich, where the planning association is equal to the area of FUA, and in the case of Rennes, where there are two planning associations. The FUA is equal to the Regional Planning Association Munich (RPV), which is the legally planned association of municipalities. The main task of the RPV is to coordinate the spatial development of the Munich region across disciplines. It draws up a regional plan for this purpose and coordinates regional interests.

3.3.1.3. Conurbation planning in Switzerland

Form	Common planning
Type	Spatial planning
Location	Switzerland, Zurich
Scale	Regional (state)
Involved sector	Spatial planning, infrastructure
Type of countryside	All types of land use forms in an agglomeration zone, urbanized region
Phase	Administration, planning, monitoring
Financing	City, regional government, state
Responsible institution	Zurich city, canton

The conurbation projects in Switzerland represent an innovative approach for comprehensive planning and were launched by the federal government to support cities and the municipalities in solving problems such as traffic congestion in the urban fringes. The objective is to encourage municipal councils to think in terms of whole urban areas, and to coordinate their planning and development. In 2009, the Federal Office of Spatial Planning published a guide on concentrated development, which recommends beginning with the development planning by analysing open spaces with unsealed surfaces. This encompasses their location, extension, their importance to aesthetically pleasing views and nearby recreation, natural habitats (supporting services), and temperature regulation, as well as highlighting the importance of connectivity between these open spaces. The measures that can be taken include preserving greenbelts between different settlement units, upgrading the environs of open waters as seminatural habitats and recreation areas, and creating public parks in places where connectivity is interrupted (Tobias 2013).

3.3.1.4. Breaking up a country road as ecological compensation in the region of Zurich

Form	Administrative and self-governance system
Type	Ecological compensation
Location	Zurich, Switzerland
Scale	Regional (state)
Involved sector	Spatial planning, infrastructure
Type of countryside	All types of land use forms in an agglomeration zone, urbanized region
Phase	Administration, planning, monitoring
Financing	City of Zurich, regional government, state
Responsible institution	City of Zurich, government

A very interesting project in the Zurich region involved breaking up a country road, as a compensation measure for the construction of a new motorway. A country road connecting 2 villages in the greater urban region of Zurich became obsolete for transit traffic when a nearby motorway was opened in 1996. The motorway was able to carry much more traffic than the former country road and

served as a bypass road – relieving the former transit villages, which suffered from noise/air pollution and traffic congestion. The bypass required sealing of a 4 km stretch of agricultural land. As ecological compensation, 2 km of the old country road were subsequently dismantled between the 2 villages (Tobias 2013).

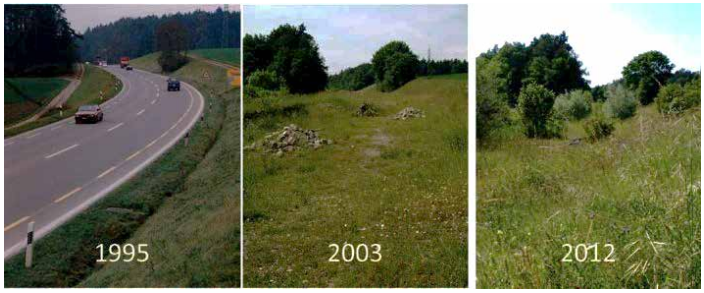


Figure 7. 1996, 2 km of this country road ca. 30 km north of the city of Zurich (left picture) was dismantled as an ecological compensation measure for the construction of a motorway on neighbouring agricultural land. The pictures to the right show the vegetation's development on the gravel parent material 7 and 16 years after restoration (47° 33.4' N; 8° 42.2' E). Photographs by M. Fries (1995) and S. Tobias (2003 and 2012).

3.3.1.5. Swiss Federal sectorial plan for crop rotation areas

Form	Restrictive planning instrument
Type	Planning tool
Location	Switzerland
Scale	Regional, state
Involved sector	Spatial planning, agriculture
Type of countryside	All types of land use forms, agriculture
Phase	Administration, planning, monitoring
Financing	Cantons, state
Responsible institution	Cantons

This restrictive planning instrument, which involves maintaining so-called crop rotation areas [CRA], is important not just to Switzerland's rural areas, but agglomeration zones as well. In 1992, the federal government determined a minimum of approximately 440,000 ha of arable land (so-called crop rotation areas [CRA]) in Switzerland to be preserved from being built over. It enacted the sectorial plan for CRAs that prescribes the quantity of crop rotation areas each canton has to preserve. Each canton determines the specific locations of the CRAs in the cantonal master plan, according to the criteria for assigning CRAs specified in the sectorial plan.

The general objectives became obsolete and outdated, so the federal offices of spatial planning, agriculture and environment evaluated the sectorial plan (and particularly the criteria to assign CRAs) in 2003. The evaluation revealed that the cantonal planning offices value the sectorial plan very favourably because it is the only restrictive planning instrument to limit the expansion of settlements and infrastructure on agricultural land.

The restriction shows interesting results in urbanised areas. It is highly difficult (or impossible) to maintain the prescribed quantity of CRAs in urban cantons with strong population growth. Therefore, cantonal planning offices have started to discuss ways of reducing the mandatory number of CRAs with the federal office, or of compensating for CRAs on highly productive soils in urban areas that have been built over by designating new CRAs beyond the urban fringes. In most cases, these new CRAs would have to be areas on less productive soils than the built-over CRAs. The cantons are thus considering balancing this by having larger areas classified as CRA than before (Tobias 2013).

3.3.1.6. Participatory approach to plan making: Case of Green River Plan, Netherlands

Form	Policy
Type	Planning
Location	Groningen province, Netherlands
Scale	Regional
Involved sector	Spatial Planning, Nature protection, NGOs, farmers, citizens
Type of countryside	All
Phase	Planning
Financing	Cantons, state
Responsible institution	BOKU Vienna (F. Suppan, Fredy Frey-Ross) in cooperation with Austrian and Slovakian experts (WWF Austria, Daphne, The State Nature Conservancy of the Slovak Republic, Slovak University of Technology in Centre of Excellence of EU)

This case study deals with the preparation of the restoration plan of an ecological water corridor in the northern part of the Netherlands. This plan was driven by development of Dutch policy to fund National Ecological Network according to the national nature policy document of 1989, the implementation of which provincial authorities were charged with from 1990 onwards. As a result, 900 corridors were planned for ecological networks in provincial schemes instead of the 200 intended in the national policy document (Visser 2006). In the province of Groningen, most attention was paid to wet corridors because of developments in national water management after 1990, such as the need to combine requirements for flood safety, water transport and nature conservation (Van der Windt and Swart 2008).

Developing from these policies, the Green River plan was proposed by a coalition of nature protection organisations. This plan aimed to restore brook valleys in the northern part of the Netherlands. The approaches of the stakeholders varied (the province and the city of Groningen considered that restoring riparian habitats to brooks could be the new approach, and also fulfil nature conservation, water management and landscape quality aims, while farmers and industrial parties wanted guarantees that such plans would not harm their interests. Some politicians were critical of the costs and the regional Water Authority was highly sceptical of the idea of water management through the restoration and construction of wet ecological corridors) (Van der Windt and Swart 2008).

To ensure commitment and form a consensus, the provincial authorities initiated a number of workshops with regional and local authorities and stakeholders, assisted by several consultancies (Kuiper Compagnons 2001; Tauw 2003 In: Van der Windt and Swart 2008). The Green River ecological corridor became linked to other issues within a rather complicated process of decision-making and different levels of government (community, province, region, and state) with different visions and responsibilities becoming involved (Van der Windt and Swart 2008).

Scientists played only a minor role and it is still uncertain whether this Green River corridor will be adequate for the migration and survival of species. Nevertheless, Green River appeared to be an appealing metaphor that could unite the interests and values of multiple actors because it could fulfil several functions (Van der Windt and Swart 2008).

3.3.1.7. Evaluation of railway corridors according to spatial ecological and geological criteria: MCA framework, case of urbanising area north of Stockholm, Sweden

Form	Procedure / method
Type	Planning
Location	Stockholm, Sweden
Scale	Regional
Involved sector	Spatial Planning, Nature protection, Transportation
Type of countryside	All
Phase	Planning
Financing	n/a
Responsible institution	n/a

The aim of the study by Karlson et al. (2016) was to develop methods for railway corridor planning, in which corridor design and location would be based on important ecological and geological sustainability criteria. The method, an MCA framework including both spatial and non-spatial MCA, was demonstrated on a railway planning proposition in an urbanising area north of Stockholm, Sweden. Alternative spatial alignments for 6 railway corridors were derived based on criteria representing biodiversity, resource efficiency and costs, developed from ecological and geological knowledge, data, and models. The method identified coherent ecological and geological sustainability criteria. The evaluation part of the methodology could furthermore identify uncertainties in the input data and assumptions and conflicts between ecological criteria. In order to arrive at a well-informed decision support system, the criteria as well as the decision rules employed could be further developed. Other relevant sustainability issues would also need to be integrated, such as cultural landscapes, recreation, and other ecosystem services.

The study area is located in Stockholm County, Sweden, in a peri-urban area about 20 km north of Stockholm City. The area is delimited to the west by the major highway E4 and to the east by a railway used for commuting. To the south of the study area, suburban areas are situated with a higher density of infrastructure in residential and commercial areas. North of the study area the landscape is

relatively open with a mix of forest and agricultural land, intersected by roads with average daily traffic volumes of a few hundred vehicles.

The outcome of the SMCA analysis was a set of railway corridors, which were designed with ecological and geological factors integrated and weighed from different perspectives. The resulting corridor alternatives were then evaluated using ecological and geological evaluation criteria in order to find the corridor with the best environmental performance ecologically, geologically, and neutrally. The study raises the issue of how to integrate and meet multiple sustainability objectives during infrastructure planning.

3.3.1.8. Urban green corridors network: Braga, Portugal

Form	Recommendations
Type	Planning
Location	Braga, Portugal
Scale	Local
Involved sector	Spatial Planning, Nature protection, Transportation
Type of countryside	All
Phase	Planning
Financing	n/a
Responsible institution	n/a

The study by Roach and Ramos (2012) was carried out with the aim of creating an urban green corridors network in the city of Braga, Portugal. One of the major goals is to allow some mitigation of the negative environmental impacts of the city and encourage people to enjoy leisure activities and practice sports on a daily basis. The study conducted in the city of Braga identifies the viability of creating the urban green corridors network to boost mobility by seeking soft ways and promote an improvement in the quality of the urban environment. Thus, it is possible to adapt the urban space to a new reality, rendering it more environmentally friendly.

The existence of quality green spaces from the perspective of urban sustainability can assume the role of "purification" of the environment. These spaces, however, are usually isolated and disjointed from the surrounding areas, eventually fading within the buildings. The urban green spaces are a fundamental support for the ecological and environmental sustainability of a city. Corridors should be connected to allow movement and contain extensive forested tracks, boost urban sustainability, and enhance urban ecological structures. At the same time, corridors mitigate the effects of one of the main urban pollutants – car traffic – by acting as a particle filter and air purifier. In addition, they contribute to the adoption of healthier lifestyles, promoting sports practice.

The aim of creating a network of parks and urban green corridors that conjoin parks is to design these spaces as possible ecological structures of the city of Braga. In addition, the green corridors network should promote urban mobility and serve as an alternative method of transport to the city centre, and increase vegetation density to improve the quality of the urban environment.

The proposed network of urban parks and green corridors to the city of Braga should be used by the city inhabitants. Though these spaces exist, their use in environmental and social terms is diminished due to disorganization and lack of connection with routine activities. Analysis carried out in the territory concluded that it is possible to adapt the concept of the urban ecological corridor, linking some systems that are compatible with a possible ecological structure. The layout of the network, given the location of the major equipment, services and business units within the study area, allows the movement of citizens by soft ways instead of using cars. The reduction of traffic is expected to decrease energy consumption and emissions of greenhouse gases, translating into a greener urban environment and improving quality of life.

3.3.2 ASIA

3.3.2.1. Habitat Evaluation Procedure (HEP), case study: the section between East Hongcheon and Inje, South Korea

Form	Procedure / method
Type	Planning
Location	Gangwon Province, South Korea
Scale	Regional
Involved sector	Spatial Planning, Nature protection, Transportation
Type of countryside	All
Phase	Planning
Financing	n/a
Responsible institution	n/a

The Habitat Evaluation Procedure (HEP) was used to quantify the long-term effects of a road construction project on an ecosystem. The water deer (*Hydropotes inermis*) was selected as the species of study since it uses an optimum habitat; water deer habitat data were collected regarding vegetation cover, stream water density, geographic contour, land use class, and road networks. Results showed that the environmental impact in the road construction project area would result in a net ecological loss value of 1211 without the installation of an eco-corridor, which reduced to 662 with an eco-corridor, providing a 55% increase in the net value after 50 years of the mitigation plan. Comparing the 13 proposed ecological mitigation corridors, the corridor that would result in the highest net increase (with an increase of 69.5), was corridor #4, which was regarded as the most appropriate corridor to properly connect water deer habitats. In sum, the study derived the net increase in quantitative values corresponding with different mitigation methods over time for a road construction project; this procedure can be effectively utilized in the future to select the location of ecological corridors while considering the costs of constructing them (Choi and Lee 2019).

Of the total distance of 89.70 km between Chuncheon and Yangyang, the section between East Hongcheon and Inje is 36.85 km; the width of the road along this stretch is 23.4 m with the road consisting of four lanes. The highway construction was ecologically based, since 13 ecological routes were laid out in which the goal was to reduce or avoid roadkill, especially of water deer (*Hydropotes inermis*). The time range for construction was 2006–2010, with a highway opening date of 2011 and an ecosystem target assessment of 2030. Eco-corridors were designed that were 40 m in width and 200–700 m in length, depending on the shape of mountain contour lines, and usually the top part was planted with the vegetation of species found in surrounding areas in order to minimize ecosystem structures' negative impacts on the local animals (Choi and Lee 2019).

Using the HEP, the study resulted in the selection of the most beneficial eco-corridor routes among various eco-corridor routes in the area. Six factors were selected for consideration: proximity to water and food, vegetation density, elevation, ratio of the developed areas, and distance to roads (Choi and Lee 2019).

3.3.2.2. Least-Cost Path Methods Based on the Value of Ecosystem Services: Case study of the city of Gwacheon, South Korea

Form	Procedure / method
Type	Planning
Location	Gwacheon, South Korea
Scale	Local
Involved sector	Spatial Planning, Nature protection, Transportation
Type of countryside	All
Phase	Planning
Financing	n/a
Responsible institution	n/a

The study by Lee et al. (2014) was aimed at designing the landscape corridors that maximize the value of ecosystem services in ecological infrastructure planning by exploring the optimal corridors to enhance the connectivity among landscape elements to design an ecological infrastructure for the city of Gwacheon, South Korea, as an example of a small urban area. The value of ecosystem services was calculated using standardized estimation indices based on an intensive review of the relevant literature and employed the least-cost path method to optimize the connectivity of landscape structural elements.

Therefore, the optimal configured dispersal corridors for wildlife were found from the riparian zones (source area) to the developed area open spaces (destination area) in the city. Several challenges remain for improving the estimation of the value of ecosystem services and incorporating these ecosystems in ecological infrastructure planning. Nonetheless, the approaches taken to estimate the value of ecosystem services and design landscape corridors in this study may be of value to future efforts in urban ecological infrastructure planning.

The study concludes with the following implications for planning:

» **The approach taken to estimate the value of ecosystem services in the study provided a useful example of assembling these values from a variety of spatial contexts;**

- **The study represents not only an exploratory step toward a better understanding of the ecological infrastructure planning process, but also a novel landscape corridor design that supports landscape connectivity;**
- **The small urban planning case explored in the study could help create and improve policies for a sustainable urban ecosystem. In most small urban areas, local governments can promote land use policies that would provide sustainable living environments for humans.**

3.3.3. AFRICA

3.3.3.1. Green infrastructure network in Alexandria, Egypt

Form	Policy
Type	Planning
Location	Alexandria, Egypt
Scale	Local
Involved sector	Spatial Planning, Nature protection, Transportation
Type of countryside	All
Phase	Planning
Financing	n/a
Responsible institution	n/a

The paper by Aly and Amer (2010) discusses the pivotal role of green corridors in urban areas in improving the quality of the environment. This is demonstrated on a study from Alexandria (Egypt), a historic and cosmopolitan city. Its annual rate of loss for green land is 0.67%, and should this rate continue, the area of green lands will face the risk of reducing by about 75% by the end of the 21st century. To protect the valuable green lands from this continuous risk, strong policies need to be accompanied by a reconsideration of profiting from the available natural resources and corridors to form the Green Network, which guides the city's growth towards suitable urban development.

It highlights the importance of Green Corridors to urban sustainability in facing environmental challenges in Alexandria and the effectiveness of incorporating these efforts in a broader area. The following recommendations may help in achieving this aim:

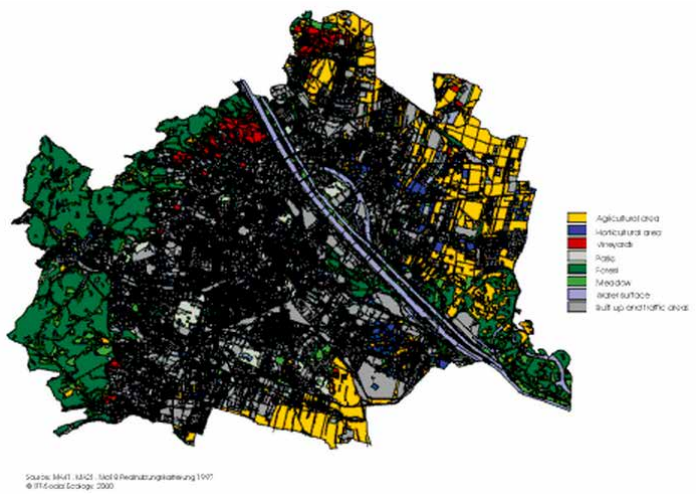
- **Planning policies should aim to facilitate the delivery of an integrated network of high-quality Green Corridors, linking open spaces together and providing opportunities for sustainable and alternative means of transport;**
- **Incorporating Green Corridors in the urban form of new communities and in the redevelopment of existing areas;**
- **Policy makers should alter the land use purposes of most plantations in project sites at all levels, thereby green areas will increase and the behaviour of citizens will improve as they show a greater consideration for sustainability;**
- **Qualitative improvements of Green Corridors should be considered as environmental issues, as well as recreational needs; in addition, enhancing access to Green Corridors will emphasise the role of outdoor recreation to integrate sustainable health objectives; and**
- **Policies for improving awareness and understanding the conservation values of the natural resources at all levels of the educational system should be established, consequently increasing the awareness of the future generation towards the importance of sustainability.**

3.4. Partners' examples

3.4.1. A GREEN BELT OF VIENNA

Form	Programme
Type	Planning
Location	Vienna, Austria
Scale	Regional (state)
Involved sector	Spatial planning, nature protection, agriculture, forestry
Type of countryside	All types of land use forms in an agglomeration zone, urbanized region
Phase	Planning, monitoring
Financing	City of Vienna, regional government, state
Responsible institution	City of Vienna

The city of Vienna has a strict green belt regulation which is one of the oldest greenbelts in the world. As early as 1905 the Viennese forest and meadows belt was initiated with the protection of Wienerwald. Afterwards, step by step, smaller green areas were protected and connected into the Viennese greenbelt which makes up half of the territory of the city. In the latest urban development plan ("STEP05") the conservation and further expansion of the green belt was expressed as a key objective.



As an additional tool, nature protection is strong in and around Vienna where there are large Natura 2000 areas and National Parks surrounding the city. The Donau-Auen National Park (1996) and the Vienna Woods were designated a Biosphere Reserve by UNESCO in 2005 and are core areas of the greenbelt around Vienna next to other landscape units as Bisamberg with its vineyards, "Heurigen," the Marchfeld landscape, which is "the granary and vegetable garden" of the city, the Danube Zone (Danube Chanel/ Danube Island, actual Danube stream, Old Danube), and the Terrace Landscape in South of Vienna (Goldberg, Laaerberg, Wienerberg) (Figure 8.).

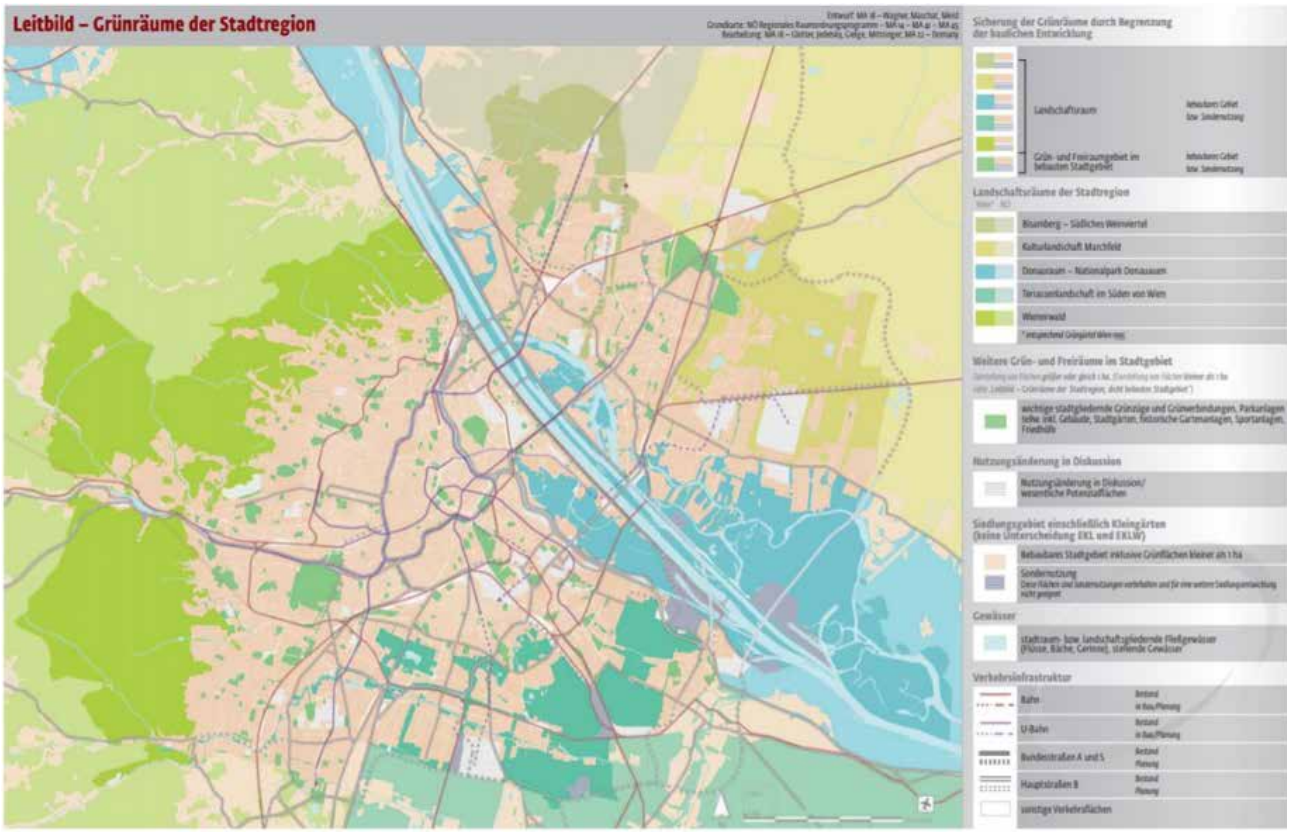


Figure 8 a. Vienna Greenbelt; b, City region green structure, Vienna (STEP 2005) (https://www.wien.gv.at/stadtentwicklung/strategien/step/step05/download/pdf/step-kapitel4-5.pdf)

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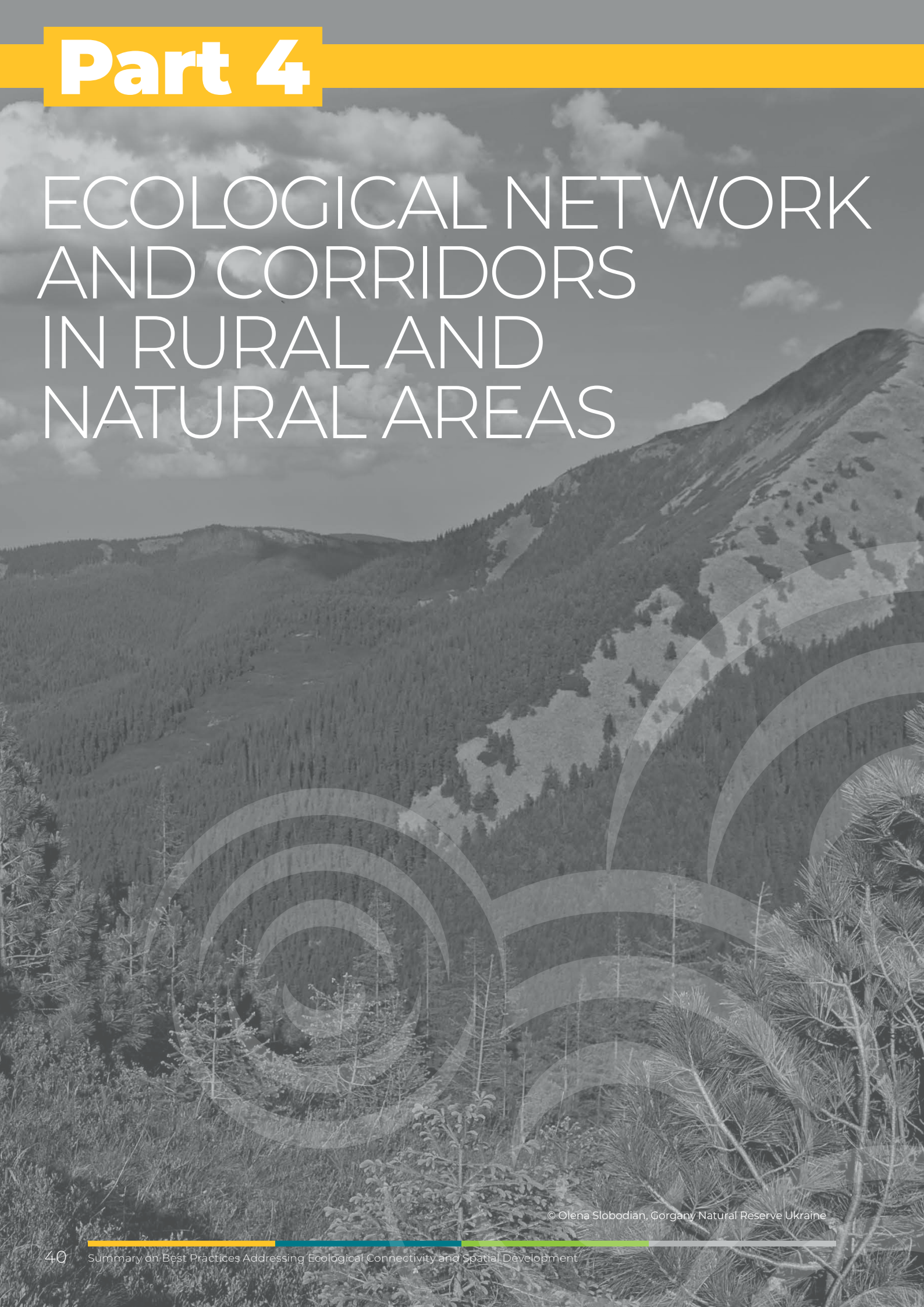
Part 4

ECOLOGICAL NETWORK AND CORRIDORS IN RURAL AND NATURAL AREAS



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4.1. General aspects, problems, suggestions

The overview of the best practices/examples are not only important from the urbanized areas/ agglomeration zones, but also from the rural areas (arable lands, grasslands, forests), since these types of land covers represent a significant percentage of the land.

In Western-Europe, intensive agriculture was encouraged by subsidies and other governmental support measures, such as the Common Agricultural Policy, which established rules and regulations for Europe's agricultural sector beginning in the 1960s. Subsidies were put in place that rewarded farmers according to the volume of crops they produced, creating a strong incentive for high-input, high-output agriculture (Donald et al. 2001). In the former Eastern Bloc, the socialist agriculture policy resulted even worse conditions in the agricultural fields. Therefore, the elements of ecological networks disappeared from these intensively managed landscapes. A widespread movement toward sustainable agriculture has arisen during the 1990s and 2000s, especially in Europe, and has gained traction worldwide during the last decades (Hilty et al. 2006).

While agriculture can clearly result in deforestation, it usually receives relatively little environmental regulatory oversight compared to forestry and commercial and residential development (Giusti and Merenlender 2002). Logging also continues to be a primary cause of deforestation. In tropical countries, deforestation is fragmenting the landscape, resulting in an increased number of remnant forest patches background (Bierregaard et al. 1992). In some places, especially in the northern latitude locations that were logged more extensively in the past than they are now, forest cover is increasing due to forest regeneration.

In most countries, forestry is regulated, in part for environmental protection. These regulations often include the retention of corridors, especially along water courses, but few generalizations can be made about the design and ultimate utility of these efforts (Simberloff 2001). Despite some efforts by industry to practice sustainable forestry and maintain connectivity, logging is still one of the primary causes of land-use change, leading to habitat loss and fragmentation in many parts of the world. In some cases, dense forest also can cause fragmentation problems that is why grazing and retaining a balanced mosaic in the landscape are also important issues.

In this chapter, we first introduce the EU policy framework related to the ecological networks in rural areas. We then analyse in depth about 30 case studies from all over the world. Finally, we highlight some good examples from the Carpathians region (from the partner countries of the project).

In all cases, we summarise the main aspects of each project: form; type; location; scale; involved sector; type of countryside; phase; financing; responsible institution. After this, we provide a brief overview of the projects (descriptions; main challenges and problems). Finally, in many cases, we also provide supporting figures and photos.

4.2. EU policy framework

The Common Agricultural Policy (CAP) highly influences the rural landscape. The EU in the frames of the CAP has strong intentions to improve ecological values and mitigate the significant intensification process and loss of biodiversity and has generally found success in this. As a result of several steps of CAP reforms, all farmers receiving direct payments are now subject to compulsory cross-compliance (according to Council Regulation No 1782/2003 and Commission Regulation No 796/2004). Farmers are now obliged to keep land for which they claim single payment support in Good Agricultural and Environmental Condition (GAEC), defined by the Member States. Good Agricultural and Environmental Condition (GAEC) include standards for soil protection, maintenance of soil organic matter and soil structure, and maintenance of habitats and landscape, including the protection of permanent pastures.

Further agri-environment measures (AEM) can improve the effectivity of landscape protection, which have been one of the most important mechanisms developed under the Common Agricultural Policy (CAP) to mitigate the impacts of agricultural intensification in the EU during the 1980s. Despite the fact that AEM schemes often target small scale farms or are generally designed not suited for local conditions etc., AEM schemes generally provide many biodiversity benefits, especially when they are appropriately targeted and designed.

AEM schemes cover the following actions:

- Natural handicap payments to farmers in mountain areas payments to farmers in areas with handicaps other than mountain areas;
- First establishment of agro-forestry systems on agricultural land;
- First afforestation of non-agricultural land;
- Natura 2000 payments such as restoring old growth forests;
- Restoring forestry potential and introducing prevention actions (prevention actions could include planting of native tree habitats where these are fire-resistant);
- Non-productive investments such as supporting the establishment of small, vegetated ponds in forest areas that could also contribute to increasing connectivity within the landscape;
- Conservation and upgrading of the rural heritage.

The most important recent CAP innovation in the present (2014-2020) programming period is 'greening'. It makes direct payments more environment-friendly, tries to strengthen the environmental sustainability of agriculture, and enhance the efforts of farmers. The Commission proposed to spend 30% of direct payments specifically for the improved use of natural resources. Farmers receiving an area-based payment have to make use of various straightforward, non-contractual practices that benefit the environment and the climate. They include:

- Diversifying crops;
- Maintaining permanent grassland;
- Dedicating 5% of arable land to 'ecologically beneficial elements' ('ecological focus areas') (SWD (2016) 218 final).

Unfortunately, several studies show that the greening measures are of limited success.

The **EU Biodiversity Strategy 2020** has also aspects related to agricultural production and forestry. The six targets of the EU Biodiversity Strategy 2020 cover:

Target 3: Increase the contribution of agriculture & forestry to maintaining & enhancing biodiversity

A) Agriculture: By 2020, maximise areas under agriculture across grasslands, arable land and permanent crops that are covered by biodiversity-related measures under the CAP so as to ensure the conservation of biodiversity and to bring about a measurable improvement in the conservation status of species and habitats that depend on or are affected by agriculture and in the provision of ecosystem services as compared to the EU2010 baseline, thus contributing to enhance sustainable management.

B) Forests: By 2020, forest management plans or equivalent instruments, in line with Sustainable Forest Management (SFM), are in place for all forests that are publicly owned and for forest holdings above a certain size (to be defined by the Member States or regions and communicated in their rural development programmes) that receive funding under the EU rural development policy so as to bring about a measurable improvement in the conservation status of species and habitats that depend on or are affected by forestry and in the provision of related ecosystem services as compared to the EU 2010 baseline.

In May 2020 the new **EU Biodiversity Strategy 2030** came into force, which contains also significant targets to the agriculture and forestry sectors. The strategy aims to ensure that Europe's biodiversity will be on the path to recovery by 2030. This should be done by improving and widening the network of protected areas (Trans-European Nature Network) and by developing an EU Nature Restoration Plan. The Strategy also highlighted that in order to have a truly coherent and resilient Trans-European Nature Network, it will be important to set up ecological corridors to prevent genetic isolation, allow for species migration, and maintain and enhance healthy ecosystems.

2 targets of the EU Nature Restoration Plan very relevant in the case of rural areas:

- Bringing nature back to agricultural land: To support the long-term sustainability of both nature and farming, this strategy will work in tandem with the new Farm to Fork Strategy and the new Common Agricultural Policy (CAP), including by promoting eco-schemes and result-based payment schemes. As set out in the Farm to Fork Strategy, the Commission will take action to reduce by 50% the overall use of – and risk from – chemical pesticides by 2030. To provide space for wild animals, plants, pollinators and natural pest regulators, there is an urgent need to bring back at least 10% of agricultural area under high-diversity landscape features. At least 25% of the EU's agricultural land must be organically farmed by 2030.

» Increasing the quantity of forests and improving their health and resilience: In addition to strictly protecting all remaining EU primary and old-growth forests, the EU must increase the quantity, quality and resilience of its forests. To make this happen, the Commission will propose a dedicated EU Forest Strategy in 2021 in line with our wider biodiversity and climate neutrality ambitions. It will include a roadmap for planting at least 3 billion additional trees in the EU by 2030. To gain a better picture of the health of European forests, the Commission will work with other data providers to further develop the Forest Information System for Europe.

Particularly of note is the 'Directive establishing a framework for the Community action in the field of water policy' (Directive 2000/60/EC), i.e., the EU Water Framework Directive (WFD), which fosters the establishment of an integrated EU-wide river basin management structure within which environmental objectives for inland water bodies, including ecological targets, will be set.

As a financial instrument the EU LIFE programme, introduced in 1992, contributed to several projects which aimed to enhance the ecological value of ecosystems, improve connectivity, and so on.

4.3. Worldwide examples

In 1988, the Nature Conservancy and the US Forest Service commenced acquisition of land to protect Pinhook Swamp that spans the distance between the two reserved areas (Okefenokee National Wildlife Refuge and Osceola National Forest). To date, around

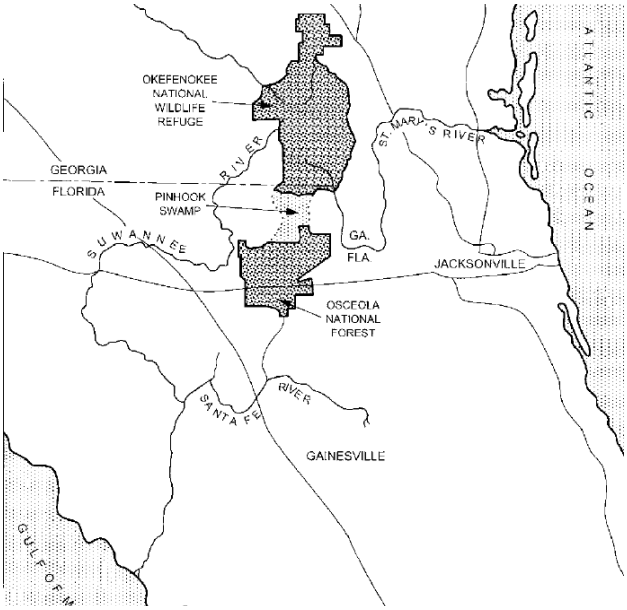

Figure 9. ©Bennet (2003) / redrawn from Smith (1993)

12 000 ha of land, the core of a linkage roughly 8 km wide between the reserves, has been purchased by the Nature Conservancy and resold to the Forest Service as an addition to Osceola National Forest (Smith 1993). To date some 12 000 ha of land, the core of a linkage roughly 8 km wide between the reserves, has been purchased by the Nature Conservancy and resold to the Forest Service as an addition to Osceola National Forest.

The system has further potential for incorporation into a wider habitat network in north Florida, linked by riparian corridors along the Suwannee, Santa Fe, and other rivers (Harris and Scheck 1991; Smith 1993; Bennet 2003).

4.3.1. AMERICA

4.3.1.1. Pinhook Swamp corridor, Florida

Form	Project, programme
Type	Managerial, processional, regulation
Location	Florida, USA
Scale	Regional
Involved sector	Nature protection management, forest management
Type of countryside	Wetlands
Phase	Planning, construction
Financing	Public
Responsible institution	Nature Conservancy, US Forest Service

4.3.1.2. Sonoma Valley and Mountains to Mangroves

Form	Project
Type	Managerial, planning
Location	Sonoma Valley, California, USA
Scale	regional
Involved sector	Transport, spatial planning, agriculture
Type of countryside	Arable land, vineyards, orchards
Phase	Planning, construction
Financing	Public, NGO
Responsible institution	Sonoma Ecology Centre

To increase connectivity in Sonoma Creek watershed, the Sonoma Ecology Centre, a non-profit watershed conservation group, is working to protect one of the last swaths of natural habitat that crosses the Sonoma valley floor as a wildlife habitat corridor. The proposed corridor is about 8 kilometres long and up to 1.6 kilometres wide, encompasses most of the region's habitat types, and connects isolated high-elevation natural areas to a major stream. Many of the properties within the proposed corridor have been inventoried to map existing fences, habitat, and wildlife movement, and likely barriers to animal movement have been identified.

The Sonoma Ecology Centre is trying to facilitate the removal or alteration of the fences most problematic for wildlife movement and enhance habitat by increasing appropriate native vegetation. The centre is working with willing landowners and local funders to try to secure long-term commitments from the primary landowners and agencies to manage the proposed corridor in perpetuity for wildlife and native plant communities. After the site is protected, the priorities will shift to management and restoration to maximize connectivity. Unfortunately, the adjustments that need to be made to protect this one corridor are expensive and require participation from the state transportation department as well as private landowners. Success depends on raising support and awareness of the issue beyond the local community (Hilty et al. 2006).

Landscape connectivity analysis can be a valuable decision tool for prioritizing restoration opportunities, helping to identify areas that hold the greatest potential for increasing

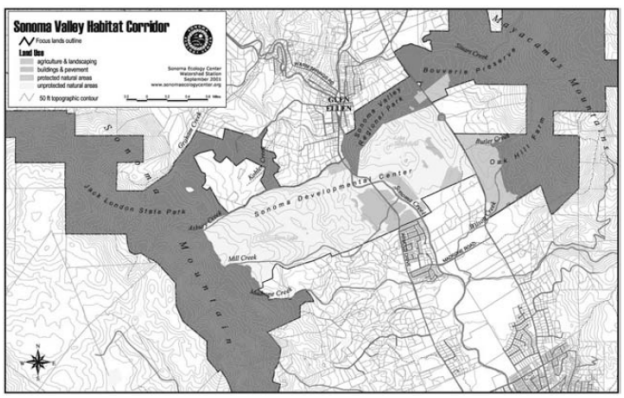

Figure 10. © Sonoma Ecology Centre

4.3.1.3. Evaluating Landscape Connectivity for Prioritizing Restoration Opportunities

Form	Project, tool
Type	Technical
Location	Mid-Atlantic region, USA
Scale	Regional
Involved sector	Nature protection management
Type of countryside	Wetlands, forests
Phase	Scoping, monitoring
Financing	Public
Responsible institution	Delaware Estuary Regional Restoration Work Group (DERRWG)

connectivity for focal species. Researchers modelled landscape connectivity for six candidate restoration sites under consideration by the Delaware Estuary Regional Restoration Work Group (DERRWG). The relative connectivity value for each habitat patch was determined through the calculation and comparison of three value parameters for each potential restoration site (production, dispersal, traversability). These landscape-scale measures of the species-specific ecological value of each restoration site were provided for consideration by the DERRWG in the evaluation of potential restoration sites across the Estuary (Rudnick et al. 2012).

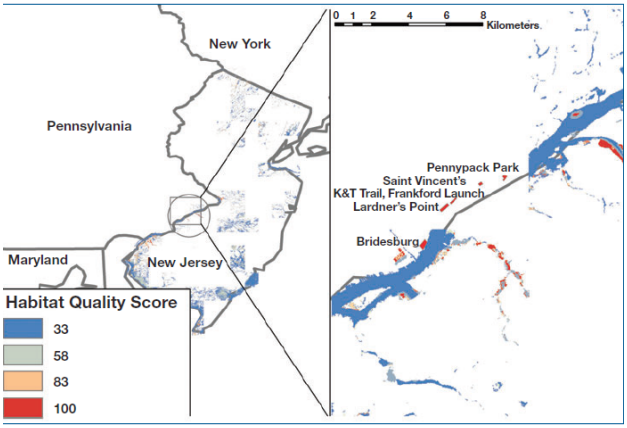

Figure 11. © Rudnick et al. 2012

4.3.1.4. Northern Appalachian/Acadian Ecoregion-Scale Connectivity Assessment

Form	Project, tool
Type	Technical
Location	Northern Appalachian/Acadian ecoregion, USA, and Canada
Scale	Regional
Involved sector	Forest management, spatial planning, nature conservation management
Type of countryside	Mainly forests
Phase	Scoping, monitoring
Financing	Public
Responsible institution	International consortium of 50 organizations, researchers

As development within the region continues, and the demand on forest resources continues to increase, the ecoregion faces the very real threat of large-scale landscape fragmentation. Two Countries, One Forest (2C1Forest), is a highly collaborative international consortium of 50 conservation organizations, researchers and foundations dedicated to using landscape conservation to protect and maintain the forests and natural heritage of the ecoregion. Recent efforts have focused on identifying priority linkages among key portfolio conservation areas within the ecoregion. As part of these efforts, Perkl and colleagues developed and evaluated landscape networks connecting target habitat areas arising from four plausible conservation scenarios for the Northern Appalachian/Acadian ecoregion. A graph-theoretic approach was used, applying the best available data on human settlement, access, land use change, and electrical power infrastructure, as a cost surface. Models indicated that while local connectivity was potentially retained at several sub-ecoregion scales, widespread ecoregional connectivity was not evident even in this extensive, forest-dominated region (Rudnick et al. 2012).

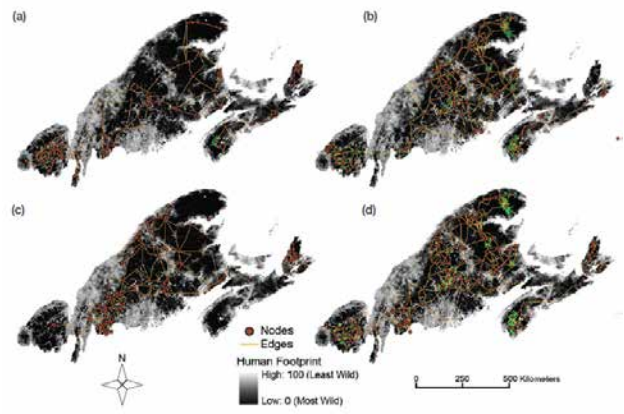

Figure 12. © Rudnick et al. 2012

4.3.1.5. The Atlantic Forest Central Corridor

Form	Project
Type	Managerial, institutional, planning, organizational
Location	Brazil
Scale	Regional
Involved sector	Spatial planning, forest management, agriculture, tourism
Type of countryside	All types
Phase	Planning, construction, monitoring
Financing	Public
Responsible institution	Brazilian Ministry of Environment

It was in these circumstances that a first proposal for the Atlantic Forest Central Corridor was developed by the Brazilian Ministry of Environment in 1998. The ecological network is located on the Atlantic coast in the states of Espiritu Santo and Bahia, extending for more than 1,200 kilometres from north to south and covering a total area of 86,000 square kilometres. This tract of land is biologically diverse: it is one of the main centres of endemism in the Atlantic Forest and supports several species threatened with extinction. However, protected-area management faces serious challenges. Human pressure on the sites is high and in most of the surrounding areas land use is not sustainable. The most serious threats include hunting, forest fires, uncontrolled tourism, illegal land occupation, and palmetto cutting. Moreover, within the protected areas, about 95 percent of the land is privately owned. The general objective of the Atlantic Forest Central Corridor is to improve the effective conservation of the Atlantic Forest's biodiversity. This is to be secured through establishing an ecological network in combination with a participatory socio-environmental

management programme. Implementation of the programme commenced in 2002. The initial phase involves the development of a management plan that specifies the strategies, actions, and resources for its implementation. The plans, which involve a more detailed analysis of ecosystem functioning, will define strategies for site management within the broader framework of the programme's objectives (Bennet and Mulongoy 2006).

Figure 13. © Bennet and Mulongoy (2006)

4.3.1.6. Corridors in the Barbas-Bremen-Cestillal region

Form	Project
Type	Planning, processional
Location	Colombia
Scale	Regional
Involved sector	Spatial planning, agriculture, forest management, nature protection management
Type of countryside	Forests, arable land, grassland, plantations
Phase	Scoping, planning, construction
Financing	Public
Responsible institution	Governmental institutions, local governments, landowners

The Central mountain range of the Colombian Andes system is the most deforested region in Colombia, with only 10 percent of the original forest cover remaining. Of these remnants, less than three percent are protected. Almost all of the fragments are to be found in the upper reaches of the mountain range (Arango et al. 2003). Habitat loss and fragmentation in the mountains (and also the rest of the Colombian Andes) is more widespread and serious in lower and medium elevations (1,500–2,500 metres). Today, pastures for livestock, coffee plantations, exotic tree plantations and urban areas are the dominant elements of the landscape. Nonetheless, the rural parts of the region still host rich biodiversity, including a large number of threatened species and those with a restricted distribution range.

The establishment of a corridor reconnecting the forest blocks could therefore facilitate the recolonization of the most important species in Bremen. The proposal to strengthen connectivity in the region was initiated by the Instituto Humboldt as part of the larger GEF/Netherlands Embassy/Colombian government project Conservation and Sustainable Use of Biodiversity in the Colombian Andes. The ecological-network proposal was elaborated in 1999 in collaboration with local and regional environmental authorities, and its implementation commenced in mid- 2001. Socio-economic studies concluded that local people have a high level of environmental awareness and are keen to be involved in conservation efforts. The establishment of corridors would also contribute to the scenic value of the landscape. The goal of the project is to establish forests between the Bremen Natural Reserve, the Barbas river canyon and the Cestillal canyon in order to connect these areas, both physically and functionally.

The physical establishment of the corridors started in 2003 and is progressing well. The majority of the actions can be undertaken with the participation of local people. However, the establishment of larger corridors will require the acquisition of land and taking valuable agricultural land out of production. The primary actors in the project are private landowners, the municipal government of Filandia, the regional autonomous corporations, two logging companies and local communities (Bennet and Mulongoy 2006).

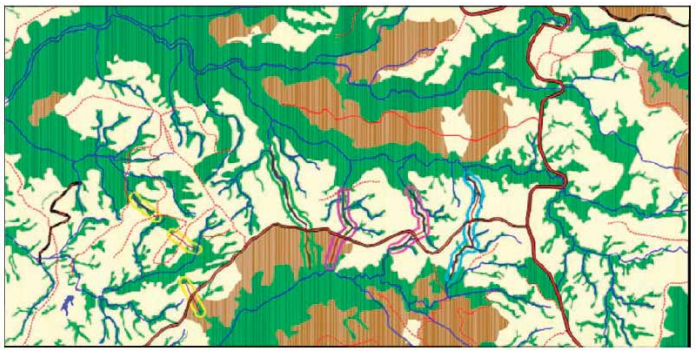

Figure 14. © Diana Patricia Ramírez

4.3.2. AUSTRALIA, NEW ZEALAND

4.3.2.1. National parks and reserves in the Central Highlands, Victoria, Australia

Form	Recommendations
Type	Planning, regulation
Location	Victoria, Australia (3 national parks)
Scale	Regional
Involved sector	Nature protection management, forest management, spatial planning, tourism
Type of countryside	Mainly forest
Phase	Planning
Financing	Government
Responsible institution	Environment Conservation Council (ECC), after the government (Victoria)

Recommendations for conservation reserves in Victoria, made by the Environment Conservation Council (ECC), incorporated the principle of protecting contiguous areas of habitat and retaining links between reserved areas. The function of the ECC is to carry out investigations and make recommendations to the government with respect to the balanced use of public land. In 2 national parks (Ash Rangers National Park and Dandenong Ranges National Park) forested links between the major blocks were created for mainly conservation, but also for recreational purposes.

The main purpose of the Warrandyte-Kinglake Nature Conservation Link (another created link) is to maintain the continuity of native forests along a topographic gradient between the Yarra Valley and Kinglake National Park (LCC 1994). This recommendation proposes that a number of different parcels of public land be managed co-operatively by government agencies, to maintain forest vegetation between two conservation reserves, a water catchment, and a major riparian habitat corridor (Bennett 2003).

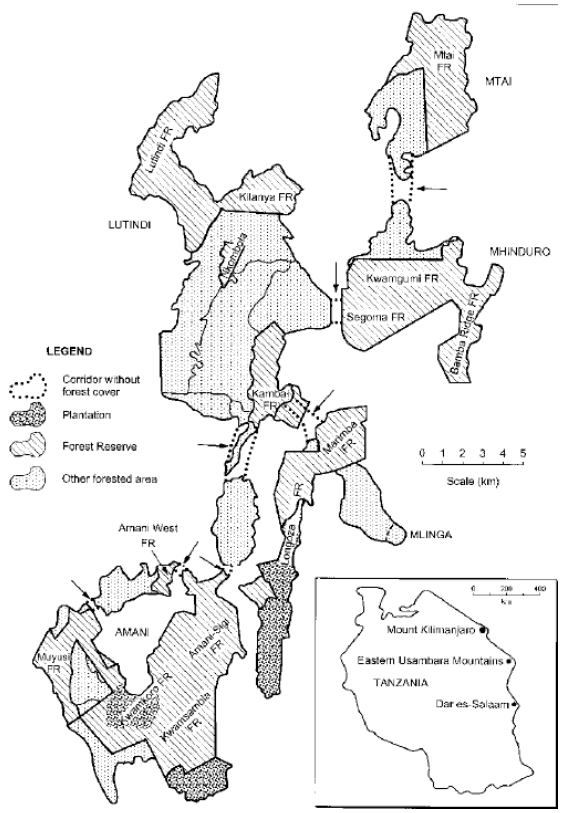

Figure 15. © Bennet (2003) / redrawn from Tye (1993)

4.3.2.2. Temperate rainforest corridors for forest birds, North Westland

Form	Programme, recommendations
Type	Planning
Location	North Westland, New Zealand
Scale	Regional
Involved sector	Spatial planning, forest management
Type of countryside	All types
Phase	Scoping, monitoring
Financing	Public
Responsible institution	Governmental institutions, local governments, landowners

In response to a scheme for the extensive harvesting of beech forests for timber in North Westland, New Zealand, a major 'wildlife corridor' was proposed to maintain the potential for temperate rainforest birds to move between reserves (O'Donnell 1991). This forested link was designed to follow topographic features that could be readily identified, and to have sufficient width to withstand strong winds and other natural disasters.

The link can function at two spatial levels. At the regional scale, it provides a broad forested link between the forests of the Paparoa Range and the Southern Alps. At a more localized scale, the forest link connects eight Ecological Areas that would otherwise be isolated by logged regenerating forests.

Following completion of a five-year research programme on the fauna of the North Westland forest corridor (Overmars et al. 1992), a formal recommendation that it be reserved for conservation was accepted by the New Zealand government.

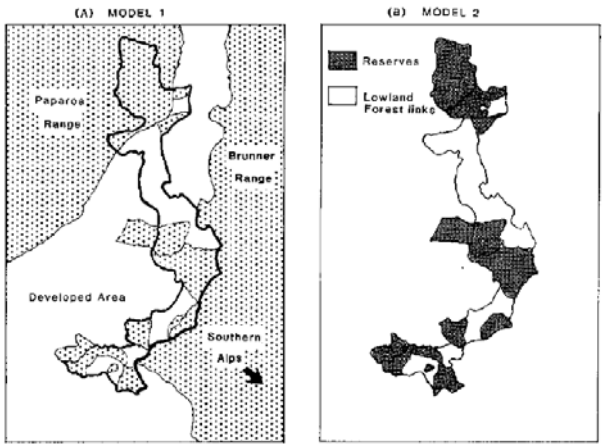

Figure 16. © Bennet (2003) / redrawn from O'Donnell (1991)

4.3.2.3. Forest management planning in East Gippsland, Victoria

Form	plan, programme
Type	Planning, regulation, managerial
Location	Victoria, Australia
Scale	Regional
Involved sector	Forest management
Type of countryside	Forests
Phase	Planning
Financing	Public
Responsible institution	Department of Conservation and Natural Resources

In East Gippsland, Victoria, publicly owned forests occur as a large contiguous tract of approximately one million hectares, forming part of the extensive forests along the Great Dividing Range in south-eastern Australia. The forest management plan for the East Gippsland Forest Management Area (Department of Conservation and Natural Resources 1995) incorporates a number of new measures in a strategy for forest management in this region.

The Special Protection Zone (SPZ) encompasses 16% of the East Gippsland FMA and is designed to complement conservation reserves in the region by retaining a linked network of important forest habitats throughout the managed forest. The main components of the SPZ are representative areas of vegetation types and old growth forests that are poorly reserved in the reserve system, and forest areas set aside for the conservation of threatened forest-dependent animals. These areas are linked to each other and to conservation reserves by linear reserves, natural features zones along streams and rivers, streamside and rainforest buffers, and other protected zones.

Guidelines for the network of linear reserves (Department of Conservation and Natural Resources, 1995) state that they will provide a number of alternative links between conservation reserves and large areas within the SPZ (Bennet 2003).

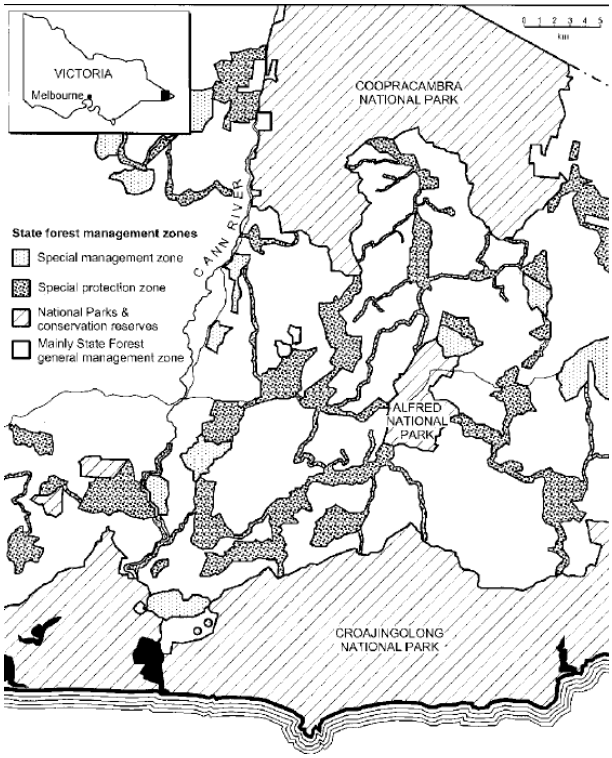

Figure 17. © Bennet (2003)

4.3.2.4. WildCountry – Australia

Form	Programme
Type	Planning
Location	Australia
Scale	Regional, national
Involved sector	Spatial planning, agriculture, nature protection management
Type of countryside	All types
Phase	Planning, constructing
Financing	Public

WildCountry is using landscape ecology to improve understanding of the large-scale ecological connections that still remain in place across huge areas of the continent, and which will form the basis of the conservation approach. Seven categories of ecological phenomena have been identified that require landscape connectivity and are crucial to biodiversity conservation (Soulé et al. 2004; Mackey et al. 2005). The considerations have led WildCountry to shape a conservation approach that aims to integrate the needs of nature with the demands of human use by strengthening ecological processes and environmental flows. The programme's focus is therefore on maintaining and restoring ecological connections in the landscape.

The programme is currently working in five regions: northern Australia, Cape York Peninsula, the Gondwana Link, the Western Wilderness, and western Victoria. The Gondwana Link is a good example of the approach. As a result of agricultural expansion two thirds of the vegetation has been cleared, leaving less than 10 percent of the original bushland. The removal of deep-rooted vegetation has left the resulting agricultural land very fragile. Five NGOs — the Australian Bush Heritage Fund, the Fitzgerald Biosphere Group, the Friends of the Fitzgerald River National Park, Greening Australia, and the Wilderness Society — are cooperating within the WildCountry framework to partially restore this vital pattern of movement into and across south-coast plant communities. One of the first actions is a cooperative project with the state government to secure the Walpole Wilderness Area — over 200,000 hectares of forest where the Gondwana Link corridor meets the wetter forest areas (Bennet and Mulongoy 2006).

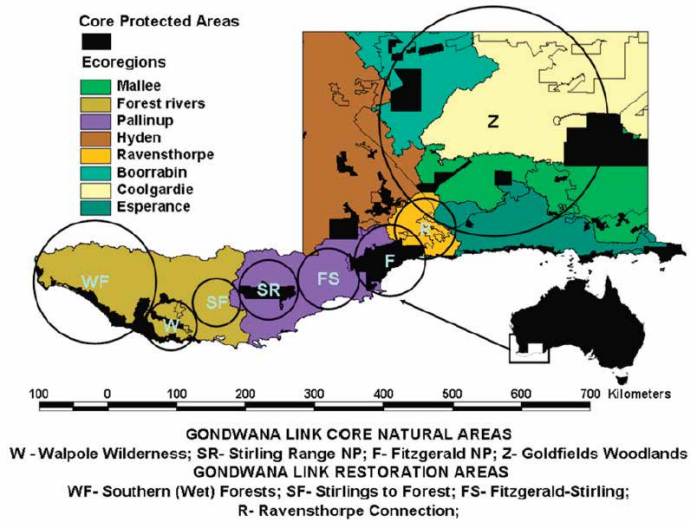

Figure 18. © WildCountry/Australian Bush Heritage Fund/Fitzgerald Biosphere Group/Friends of the Fitzgerald River National Park/ Greening Australia/Wilderness Society

4.3.3. AFRICA

4.3.3.1. Kibale Forest Game Corridor

Form	Programme
Type	Managerial, regulation
Location	Uganda
Scale	Regional
Involved sector	Spatial planning, nature protection management, agriculture
Type of countryside	Grassland, arable land
Phase	Planning, monitoring
Financing	Government
Responsible institution	Ugandan Government

The Corridor was gazetted in 1926 to allow for the movement of large game animals — particularly, the African Elephant. This linkage is a large tract of medium-altitude forest and elephant-grass habitat extending along the western side of Kibale Forest and providing a broad link between Queen Elizabeth National Park and Kibale Forest (Baranga 1991). Although legally gazetted, failure to manage and protect the Game Corridor led to almost total loss of its function by 1990. The protected habitat in the linkage diminished and it was estimated that by 1990 more than 90 % of the link and 10 % of the forest reserve had been claimed, with much of these areas under cultivation from a population that stands at about 40 000 people (Baranga 1991).

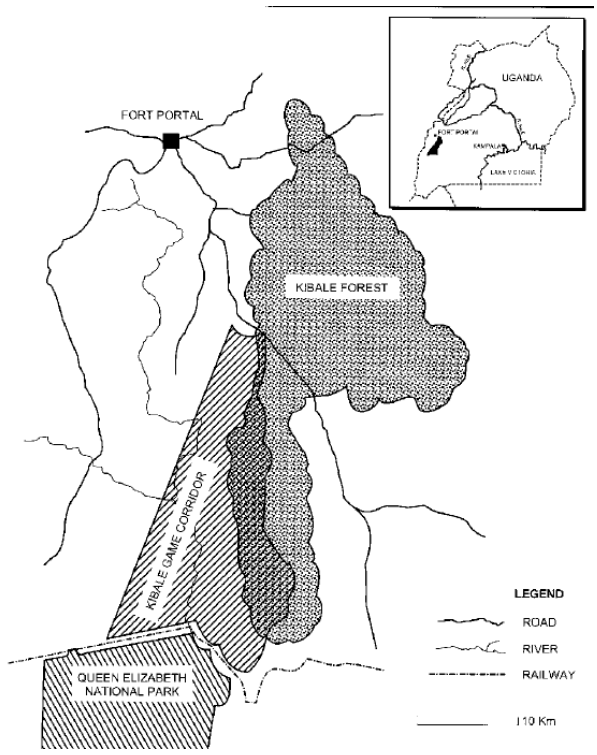

Figure 19. © Bennet (2003) / redrawn from Baranga (1991)

In 1992, following concern over the future of the Game Corridor, the Ugandan Government directed encroachers to leave and subsequently evicted 30 000 people from the reserve. There is now an extensive and continuous protected area from the Kibale Forest, which has one of the richest forest faunas in East Africa (Baranga 1991), to the savannas of Queen Elizabeth National Park. This offers greatly enhanced protection of habitat for a wide range of species and a protected migratory route for large mammals, especially the elephant and buffalo.

Nairobi Park is home to a wide range of mammals, including lions, zebra, wildebeest, impala, giraffe, various types of bucks, and antelope. With the onset of the wet season, the animals migrate southwards to the wildebeest calving zones in Amboseli National Park. These migrations are crucial to the survival of the populations of zebra and wildebeest in the park (Gichohi 2002).

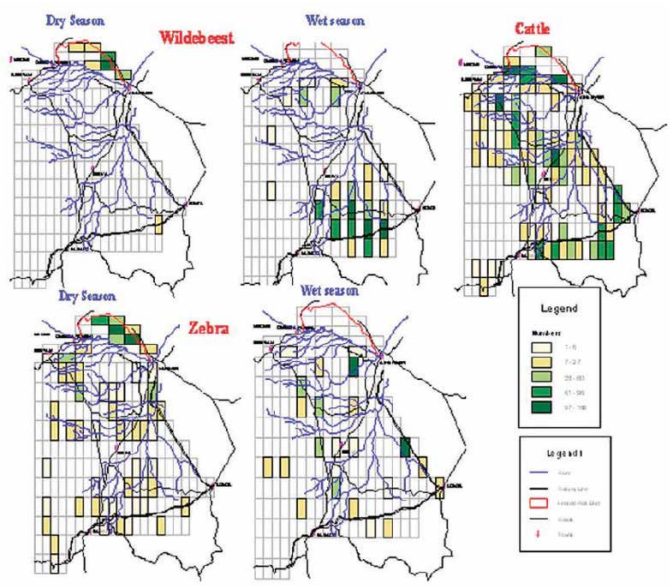

Figure 20. © Gichohi (2002)

The annual migrations are therefore viewed very negatively by the Maasai. The need to manage this conflict persuaded the Kenya Wild Service, the African Wildlife Foundation, and other partners to initiate the Wildlife Conservation Lease Programme. The programme covers an area of 2500 square kilometres that extends from Nairobi National Park through the migratory routes to the wildebeest calving zones in the south. Its goal is to change the attitudes of the Maasai livestock owners towards predators so that they accept for migrating herds to continue passing through their lands. Primarily, this is to be primarily through financial incentives. Landowners who join the programme receive compensation for any livestock lost to predators. Participants also receive a fixed annual payment whether or not they lose livestock. In return, landowners are expected to allow the movement of wildlife through their lands. The Wildlife Conservation Lease Programme started in 2000. These payments are financed through funds that are raised from donations by the project team (Bennet and Mulongoy 2006).

4.3.3.2. The Wildlife Conservation Lease Programme

Form	Programme
Type	Financial, planning, institutional
Location	Kenya
Scale	Regional
Involved sector	Nature protection management, agriculture, tourism
Type of countryside	All types
Phase	Planning, construction
Financing	Donation
Responsible institution	Kenya Wild Service, the African Wildlife Foundation, and other partners

4.3.3.3. Kwa Kuchinja Corridor

Form	Policy, project
Type	Planning, regulation
Location	Tanzania
Scale	Regional
Involved sector	Agriculture, nature protection management
Type of countryside	Grassland, arable land, forest
Phase	Planning, construction
Financing	Donation
Responsible institution	Tanzanian government, Tanzania Land Conservation Trust and Fauna and Flora International

As part of the community-based conservation movement, there is a new government policy in Tanzania promoting Wildlife Management Areas (WMA) where local people are supposed to manage wildlife. An important objective of this policy is "to transfer the management of WMA to local communities, thus taking care of corridors, migration routes, and buffer zones; and ensure that the local communities obtain substantial tangible benefits from wildlife conservation" (United Republic of Tanzania 1998). However, the implementation of WMAs has been stymied by regulations and apprehension among local people over land tenure. The concerns are especially strong for the Maasai, who rely on livestock grazing for their livelihood. Widespread intensive agriculture also excludes large mammals. International conservation nongovernmental organizations have begun to try to protect the Kwa Kuchinja wildlife corridor and the Maasai culture that depends on conserving undeveloped open space.

One local village in the corridor has expressed interest in setting aside part of its land to enhance wildlife movement in return for economic compensation. Rather than working through the government WMA program, some villagers are working with the new Tanzania Land Conservation Trust and Fauna and Flora International to identify a mechanism for generating revenue at the local level for the land set aside.

So far, implementing the Kwa Kuchinja wildlife corridor has involved land conservation tools such as purchasing land and trying to maintain grazing land that — it is hoped — can still provide a livelihood and important cultural resources for the Maasai, as well as necessary open space for wildlife migration. While incentive-based conservation is touted by some as the solution to local control over resources, there remains a need to absorb local knowledge about pastoral land management before a win-win solution is likely to develop. Community-based conservation needs to go beyond extending information to local people and should aim to involve them in land-use planning (Goldman, 2003).

Given the need to strengthen the conservation of Yunnan's biodiversity, a project was launched in 1998 to formulate protected area management plans and promote sustainable community development

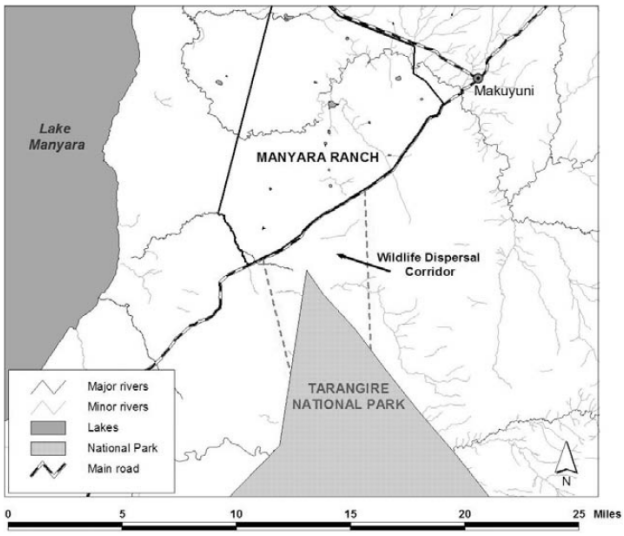

Figure 21. © Lara Foley / Wildlife Conservation Society and African Wildlife Foundation

4.3.4. ASIA

4.3.4.1. Corridors in Yunnan Province

Form	Project, programme
Type	Planning
Location	Yunnan Province, China
Scale	Regional
Involved sector	Spatial planning, nature protection management
Type of countryside	All types
Phase	Scoping, planning
Financing	Public
Responsible institution	Governmental institutions, local governments

in the province's tropical and subtropical forest zones. Funded jointly by the Chinese and Dutch governments, the Forest Conservation and Community Development Project focused on six nature reserves: Caiyanghe, Nuozhadu, Wuliangshan, Tongbiguan, Gaoligongshan and Xiaoheishan (Weimin and Busstra 2004). The latter two protected areas lie in close proximity to each other in western Yunnan.

Figure 22. © Forest Conservation and Community Development Project

The project is supporting the development of corridors between and within the two nature reserves. The corridor linking the central and southern parts of the Gaoligongshan nature reserve is intended to ensure continued movement of temperate and subtropical species between the two sites. The main purpose of the corridor is to maintain a continuum of the vertically diverse habitats that characterize Gaoligongshan and Xiaoheishan. For such a corridor to be functionally viable, an ecological restoration programme will first have to be carried out. An important obstacle to realizing these plans is that part of the forest in the Tongbiguan area is community owned, which limits the scope for introducing new forms of management. Further research is also necessary in order to ensure that the projected corridors will meet the needs of local species populations (Bennet and Mulongoy 2006).

Intensive agricultural development and human settlement which was proposed for the area of the Mahawelli Basin potentially threatened wildlife habitats, as well as the hydrological integrity of the catchments. Consequently, the reserve system was expanded

4.3.4.2. Jungle corridors and reserves in the Mahaweli area

Form	Project
Type	Recommendation, technical
Location	Mahaweli area, Sri Lanka
Scale	Regional
Involved sector	Water management, nature protection management
Type of countryside	Agricultural areas, wetlands, forests
Phase	Scoping, planning
Financing	Public (international support)
Responsible institution	US Agency for International Development

and upgraded to protect wildlife habitats and the catchments of new reservoirs. Plans for the system of protected areas included broad landscape linkages — approximately 5 km wide — as extensions of existing National Parks and reserves or as 'jungle corridors' between reserves.

The aim was to develop an integrated reserve system that allowed the continuity of ecological and evolutionary processes, including the migration routes of elephants. This project was designed as an example of how development could proceed in a manner compatible with the effective conservation of natural resources (Bennet 2003).

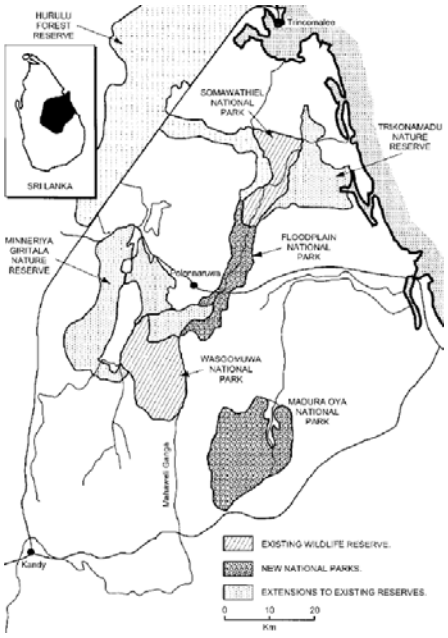

Figure 23. © Bennet (2003) / redrawn from Harris and Scheck (1991)

4.3.5. EUROPE

4.3.5.1. The Guadiamar Green Corridor

Form	Programme
Type	Planning, regulation
Location	Andalusia, Spain
Scale	Regional
Involved sector	Spatial planning, agriculture, nature protection management
Type of countryside	Arable land, orchards, grassland
Phase	Planning, construction, monitoring
Financing	Public
Responsible institution	Governmental institutions, local governments

In 1999, the Strategy for the Guadiamar Green Corridor was established at a specially organized international seminar. The goal of the strategy was not only to remedy the damage caused by the spill but also to restore the Guadiamar River as an ecological connection between the Sierra Morena Mountains and ecosystems along the Atlantic coast. The Guadiamar Green Corridor will also form part of the Andalusian ecological network (RENPA), which is currently under development (Vázquez 2003).

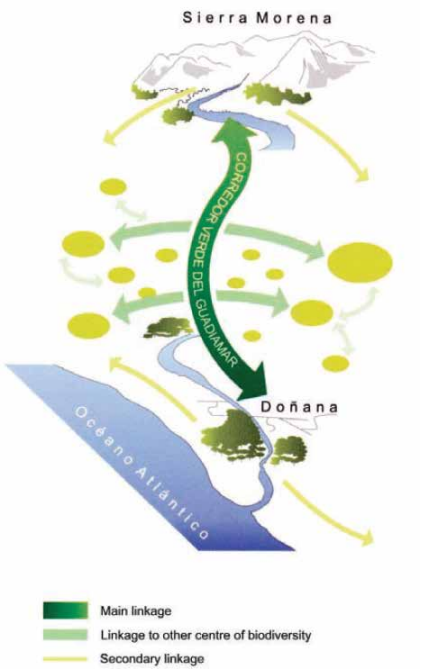

Figure 24. ©Andalusian Ministry of Environment.

Serious fragmentation of the Guadiamar basin dates back many decades. However, the process has accelerated in recent years primarily as a result of the increasing predominance of arable farming at the expense of old olive groves. An important consequence of this process was that the former intricate land-use matrix became transformed into a far simpler and homogeneous landscape. In addition, industrial and housing developments have caused serious fragmentation in the central and lower parts of the river basin.

A special research programme was established as part of the action plan. The Green Corridor Research Programme (PICOVER) is multidisciplinary in structure and aims to apply the principles of ecosystem approach through its four main themes: remedying and monitoring contamination, design of the Green Corridor, ecosystem restoration, and integrating natural and human systems (Arenas et al. 2003).

The integration of natural and human systems is an explicit element of the Green Corridor strategy. Priority here is being given to developing sustainable forms of agriculture and promoting recreational and tourist activities. Funding has been made available through the EU Agri-Environment Regulation and the Community Aid Scheme for Forestry Measures. Funding for developing the Guadiamar Green Corridor programme and implementing the various actions is being provided by four main sources: the national government, the Andalusian regional government, the regional water authority, and the administration of the Doñana National Park (Bennet and Mulongoy 2006).

4.3.5.2. Managing systems of open 'rides' in British forests

Form	Programme
Type	Managerial, technical, planning
Location	UK
Scale	National, regional
Involved sector	Forest management
Type of countryside	Grasslands, forests
Phase	Planning, construction
Financing	Public

The dense cover and scarcity of open areas amongst many plantations is an important issue: open areas and shrubby edges have been a feature of managed woodlands in Britain for many centuries and the survival of many plants and animals depends on open habitats and early successional stages of vegetation (Ferris-Kaan 1995; Warren and Fuller 1993).

Networks of 'rides', linear strips of grassy vegetation maintained mainly for timber extraction, are one source of open habitats within forests. There is much evidence that such habitats are of great value for plants and animals that require open sunny conditions or favour edge habitats between woodland and grassland (Warren and Fuller, 1993). Hence, management of rides as habitat for the conservation of plants and animals has assumed great importance, and considerable attention has been given to the design (orientation, width, shape) and management practices (such as timing and frequency of mowing and slashing) needed to maintain habitats of a suitable successional stage (Ferris-Kaan 1995).

Bernwood Forest in Oxfordshire, a Forest Nature Reserve of national importance for butterfly conservation, is managed for both timber and wildlife. A network of interconnecting rides and glades, forming together 1 % of the forest area, is managed to maintain habitat for butterflies and moths (Warren and Fuller 1993). A management strategy specifies particular vegetation conditions to be maintained along rides as habitat for wildlife.

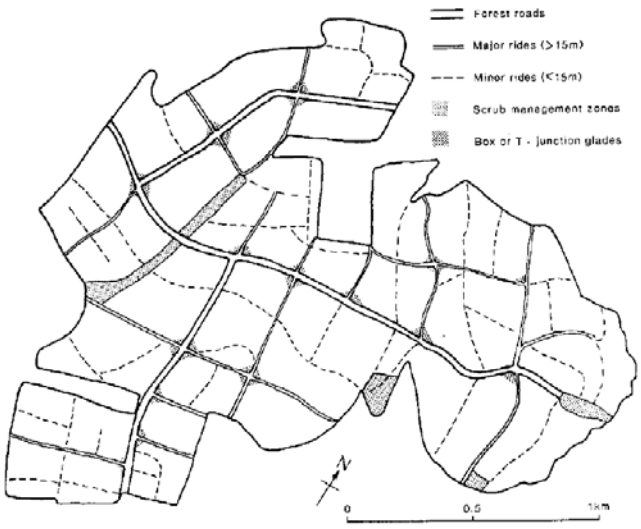

Figure 25. © Bennet (2003) / redrawn

4.3.5.3. Hedgerow networks and landscape consolidation in France

Form	Recommendation, tool
Type	Planning
Location	France
Scale	Regional
Involved sector	Agriculture, spatial planning
Type of countryside	Arable land, grassland
Phase	Planning

Throughout the generations, inheritance customs have resulted in many farms becoming a scatter of fields that may be up to five kilometres apart. Restructuring is done on a municipality basis and at the request of the majority of owners. In those landscapes with extensive hedge networks ('bocages' landscapes), initial attempts at re-distribution involved the destruction of hedges — both to increase field sizes and because hedges were no longer needed as property boundaries. This led to numerous environmental problems (Baudry and Burel 1984).

Recommendations suggested by ecologists, together with other constraints such as ownership patterns, are used to develop a final land-use plan. The ecological recommendations

4.3.5.4. The Alpine-Carpathian Corridor

Form	Project
Type	Managerial, planning
Location	Austria, Slovakia
Scale	International
Involved sector	Spatial planning, nature protection management, transport planning, forestry
Type of countryside	All types
Phase	Planning, construction
Financing	EU (Interreg)
Responsible institution	NGOs, Universities

are not necessarily adopted in their entirety, but they do have an important role in the process of landscape consolidation (Bennet 2003).

The mountain ranges of the Alps and the Carpathians provide habitat to many emblematic species, such as the deer, lynx, brown bear, and wolf, but are separated by a lowland area of intensive economic activity, including two capitals: Vienna and Bratislava. The objective of the Alpine-Carpathian Corridor project was to support the re-establishment of an ecological corridor between the eastern reaches of the Alps and the Western Carpathians in order to enable wildlife migration and genetic exchange between wildlife populations, whilst improving the area's recreational value for citizens. The project also aimed to strengthen conservation management in the protected areas along the Alpine-Carpathian Corridor and in neighbouring habitats.

The project developed GIS-based models in order to identify the optimal location of the corridor. To support implementation of the corridor, the project developed technical documentation for building wildlife overpasses across highways and facilitated knowledge-exchange. Specific outputs of the project included the construction of a green bridge over the A4 motorway in Austria, developing technical documentation for a green bridge across the D2 highway in Slovakia, and enhancing nature-based recreation opportunities through the establishment of a biking route. The project also provided assistance in integrating the Alpine-Carpathian Corridor into spatial planning instruments. (European Commission 2019)

4.4. Partners' examples

4.4.1. HUSKROUA/1001/038 – OPEN BORDERS FOR BEARS BETWEEN ROMANIAN AND UKRAINIAN CARPATHIANS

Form	Project
Type	Planning
Location	Romania
Scale	Regional
Involved sector	Nature conservation
Type of countryside	All types (mainly forests)
Phase	Planning, management, monitoring
Financing	EU
Responsible institution	WWF Danube Carpathian Programme Association, Romania-Maramures Branch Regional Children's Hospital, DistrictNGO "RakhivEcoTour," Public organization "Center for European Integration and Cross-border Cooperation"

The general Objective of the project was to preserve biodiversity in Maramures as a critical stepping stone for the connectivity of the Carpathian Mountains by reducing the risks of habitat fragmentation and, thus, restoring ecological corridors for bears as an umbrella species.

Specific objectives:

- Evaluation of project area to identify critical habitats, migration corridors and corridor restoration needs for bears between the Romanian and Ukrainian Carpathians.
- Propose and implement tools for the effective management of natural resources to contribute to the conservation of the critical habitats and corridors for bears.
- Develop management measures to contribute to the conservation of bears and their habitats and sustainable development of the communities.
- Increase public awareness and build capacity on the conservation of the natural values of the Maramures cross border area.

Methods:

- Trapping bears in specialized cages
- Tranquilization
- Collaring
- Monitoring/tracking using GPS-GSM

Financial aspects:

- Total budget/expenditure: 937 834,00
- Euro European Union funding: 844 050,60 Euro

Duration (timescale) of the project: 01.05.2012 - 30.04.2014

In order to define conservation activities and proper management of bear populations in the region, it was urgently needed to identify favourable habitats and critical corridors that provide connectivity. Then, human activity in those areas should be limited.

The project identified the first functional network of green corridors in Romania and in the transboundary region. Protecting this network is still required to have a healthy and viable population of bears in the Carpathians. There is no methodology in the current legislation for the designation and management of these areas.

4.4.2. BIOREGIO CARPATHIANS – INTEGRATED MANAGEMENT OF BIOLOGICAL AND LANDSCAPE DIVERSITY FOR SUSTAINABLE REGIONAL DEVELOPMENT AND ECOLOGICAL CONNECTIVITY IN THE CARPATHIANS

Form	Project
Type	Planning, digital analysis
Location	Romania
Scale	State, international
Involved sector	Nature conservation
Type of countryside	All types (mainly forests)
Phase	Monitoring
Financing	EU, state
Responsible institution	NFA Romsilva – Piatra Craiului National Park Administration - Romania, lead partner

The main objective of the project was enhancing the integrated management of the Carpathians protected areas and natural assets in a transnational context, thereby increasing the attractiveness of the region.

The analysis of ecological connectivity performed within the project was based on a GIS model completed by site visits in pilot areas. The visits aimed to validate the identified corridors and barriers blocking movements crucial for ecological and evolutionary processes.

The geographical data collected for the GIS analysis was used to produce thematic maps. They consist mainly of vector data (e.g. shapefiles of road, rivers, or settlement) and raster data (e.g., CORINE land cover, Digital Elevation Model), as well as of orthophotos and Land Use Satellite Images focusing on the project pilot areas.

Financial aspects:

- Total budget/expenditure: EUR 2,386,260.00
- EU funding: EUR 2,198,321.00

Duration (timescale): Jan. 2011– June 2014

Several institutions participated in the project:

- NFA Romsilva - Piatra Craiului National Park Administration - Romania, lead partner
- NFA Romsilva - Maramures Mountains Nature Park Administration - Romania
- NFA Romsilva - Iron Gates Nature Park Administration - Romania
- Regional Environmental Protection Agency Sibiu – Romania
- UNEP Regional Office for Europe Vienna, Austria
- WWF DCP Vienna - Austria
- Duna-Ipoly National Park Directorate - Hungary
- Szent Istvan University - Hungary
- EURAC Research - European Academy Bolzano/ Bozen - Italy
- ·State Nature Conservancy of the Slovak Republic
- National Forest Centre - Slovakia
- State Nature Conservancy of the Slovak Republic
- Agency for Nature Conservation and Landscape Protection - Czech Republic
- Environmental Information Centre UNEP/GRID Warsaw - Poland
- Public Enterprise Djerdap National Park - Serbia
- CBR - Carpathian Biosphere Reserve - Ukraine

Observers

- Ministry of the Environment of the Czech Republic
- Ministry of Environment and Forest - Romania
- Ministry of Rural Development - Hungary
- Ministry for the Environment, Department of Nature Protection - Poland
- Ministry of the Environment and Spatial Planning - Serbia
- Ministry of Agriculture, Environment and Regional Development of the Slovak Republic
- Ministry of Ecology and Natural Resources - Ukraine,
- Environment Agency Austria

The work of such projects can face important challenges that need to be considered and addressed in the future:

- Time limitations — especially regarding the data collection and analysis, which can create fragmentations in the database coverage.
- Financial limitations: some activities may cost more than previously planned. Furthermore, it is often difficult for partners to find the co-financing budget money.
- Communication: the language barrier, as well as the personal motivation, can have impacts on the communication between partners.
- Administrative issues: internal as well as external administrative procedures can create bottlenecks and hinder activities.
- Improve the efficiency of the ecosystem management for the Carpathian region; establish a management focus on key species and specific ecosystems as, for example, on virgin forests.
- Include the concept of ecological connectivity also in local spatial planning, in order to adequately address land — use change phenomena.
- Appropriate hunting activity is extremely important in the context of ecological connectivity, as it may help to preserve a near-natural forest and create the ideal conditions for the propagation of the widest possible spectrum of species.
- Policy and decision makers should ensure proper stakeholder involvement throughout policy development and decision-making processes to ensure that certain decisions will have an effect and have the opportunity to improve policies with a bottom-up approach.
- Resolving incompatibilities between the national regulations of the Carpathian countries that have negative impacts on nature protection and biodiversity protection.
- Improve the transparency and promotion of compensation mechanisms: a clear communication to private citizens should be promoted in order to clarify who can be the beneficiary of the compensation system, the amount, the conditions, and which are the steps in order to receive the compensation.
- Adapt legislation to enhance the promotion of sustainable practices in agriculture or forestry.
- Promote the enforcement of spatial planning regulation and the integration of different levels of planning; promote inter-municipal plans for municipalities belonging to the same geographical areas in order to functionally share big infrastructures, to effectively locate critical areas, and to be able to design ecological corridors at intermunicipal level.
- Install an advisory service centre to throw light on policy measures and legal restrictions to enable those remote located farmers at least the possibility to access public funds to reimburse the created damages. A clear system of complaint management should be set up and fostered in order to increase the trust of citizen in the responsible local institutions.
- Set up a system of database management and maintenance, interlinking among various existing resources enabling the synergy of initiatives and outputs. Develop basic common monitoring indicators and systems that are compatible for the entire region.
- Establish a network for long-term monitoring for ecosystems in the Carpathians which will help to improve the access to data.
- Enhance cooperation between the different stakeholders of the Carpathian countries.
- Engagement of NGOs in sustainable development and nature conservation.
- Improve the access to learning opportunities in the region for different stakeholders. Increase the curricula of universities, as well as the cooperation between them.

4.4.3. PIN-MATRA 2002/019 "SAFEGUARDING THE ROMANIAN CARPATHIAN ECOLOGICAL NETWORK"

Form	Project
Type	GIS analysis
Location	Romania
Scale	State
Involved sector	Nature conservation, spatial planning, transport infrastructure, tourism, agriculture, forestry, and mining
Type of countryside	Virgin forests
Phase	Analysis, planning, cooperation
Financing	State
Responsible institution	Altenburg & Wymenga Ecological Consultants -Netherlands, ICAS Wildlife Unit - Romania, Carpathians Wildlife Foundation - Romania, The Wildlands Project - USA

The main objective of the project was to provide a vision on safeguarding the Romanian Carpathians as a Regional Ecological Network conserving biodiversity, landscape, and traditional cultural values of European importance.

Specific objectives:

- Transfer knowledge and capacity to a key Romanian nature management organization (ICAS) in order for it to develop, as an expert national agency, the design, implementation, and management of ecological networks.
- Provide support to ecological network development in Romania by presenting an important case for the institutionalization of conservation planning, harmonised and integrated with other sectoral planning (transport infrastructure, tourism, agriculture, forestry, and mining), and which pays attention to reconciling the needs of people with the needs of nature.
- Reveal non-sustainable and environmentally detrimental developments that are currently undermining the existing connectivity of ecosystems within the Carpathian Range.
- Instil the importance of safeguarding ecological networks amongst different environmental stakeholders, scholars, and decision makers in Romania.

Objective computer modelling was used to determine the dimension of an ecological network able to durably withstand anthropogenic developments in the surroundings and to insure the effective conservation of biodiversity under the umbrella of large carnivores. The modelling was based on the current CORINE Land Cover database for Romania.

The tools used to obtain an objective delineation of the network, which is the most ecologically effective and economic, are a model called Marxan and Arc-GIS cost-distance analysis.

Duration (timescale): 2002-2005

The modelling results and biodiversity distributions indicate that the current protected areas system in the Carpathians, also proposed for the Natura 2000 constellation, is a serious shortcoming in protecting large carnivore populations in Romania and other biodiversity under their umbrella. It most probably protects less than 10% of the large carnivore population currently existing in the Romanian Carpathians.

Important ecological linkages are located by mapping intensive wildlife movement patterns. This can be achieved by using more or less laborious traditional and modern wildlife research techniques such as snow tracking, tapping of local knowledge, telemetry, and photo trapping.

At least 60% of the current large carnivore populations is recommended to be protected in a coherent system of large robust ecological core areas and linkages to ensure their perpetual survival and function as reservoir. Core areas with suitable habitat should be no less than 3500 km2 each and preferably up to three times greater. It is estimated that at least around ten core areas of the minimal size should be allocated within the protection zone, in the least disturbed areas, and containing the greatest amount of landscape and biological diversity. The ecological linkages should be robust and incorporate many of the habitat qualities of the core areas.

Further location of ecological linkages should be investigated as part of integrated land-use planning. Once located, an ecological linkage should be delineated and configured according to a design plan providing a detailed approach for internal and external nature management. The proper dimensions and habitat quality of the linkage are determined according to the dispersal needs of target or guiding species and resilience against external influences.

Where large populations of wildlife are at stake, as in Romania, it is crucial to incorporate as many well located and tailored wildlife passages as possible. This is also in the interest of traffic safety, to avoid potentially lethal and expensive collisions with large mammals. A generous instalment of wildlife passages will ensure high permeability of transport corridors.

4.4.4. COREHABS – ECOLOGICAL CORRIDOR FOR HABITATS AND SPECIES IN ROMANIA

Form	Project
Type	GIS analysis
Location	Romania
Scale	State
Involved sector	Nature conservation, spatial planning, transport infrastructure, tourism, agriculture, forestry, and mining
Type of countryside	All types
Phase	Analysis, planning, cooperation
Financing	State
Responsible institution	"Transilvania" University Brasov, project leader, Centre for Systemic Ecology and Sustainability Research - University of Bucharest, NIRD "Marin Cracea" - Brasov, Carpathian Foundation, Zarand Association, ACDB

The general objective of the project was to develop a system of methodologies necessary to establish ecological corridors at a national, regional, and local level by identifying critical areas in Romania in order to create the scientific, technical, and administrative conditions for the accurate definition of an effective ecological corridor system, as well as for its monitoring on the long term.

Specific objectives

- Developing methodologies to establish ecological corridors at national, regional, and local level by using modern spatial analysis.
- Identify national ecological corridors and develop principles and measures for their monitoring and management, so for them to be included in national policies for nature conservation, land planning, and any other relating fields (e.g., agriculture, water protection).
- Dissemination of the project results to the general public to inform main players on the role and functionality of ecological corridors.
- Training specialists to identify, monitor, and manage ecological corridors in Romania.

Methods

- Identifying corridors based on the complexity of ecosystems (landscape approach), species, integrated method, combining the structural approach to the functional one.
- Identification, selection, and compilation of the relevant existing data; develop the GIS database

Financial aspects

- European Economic Space (SEE) Grants 2009 – 2014, Ministry of Environment - Programul RO02 Biodiversitate si servicii ale ecosistemelor – 4,851,000 / 1,000,000 Euro

Duration (timescale): Sept. 2015 - Dec. 2016

4.4.5. LIFE12NAT/UK/001068- THE LIFE CONNECT CARPATHIANS, "ENHANCING LANDSCAPE CONNECTIVITY FOR BROWN BEAR AND WOLF THROUGH A REGIONAL NETWORK OF NATURA 2000 SITES IN ROMANIA"

Form	Project
Type	Planning
Location	Romania
Scale	State
Involved sector	Nature conservation, spatial planning
Type of countryside	All types
Phase	Analysis, planning, cooperation
Financing	EU, state
Responsible institution	Fauna & Flora International, project leader, Ministry of Environment, Waters and Forestry, General Inspectorate of the Romanian Gendarmerie, Zarand Association

The objectives of the project were to increase functional connectivity through securing and restoring critical habitat and landscape features as corridors. Moreover, to address the direct threats to carnivores — namely, human-wildlife conflict and poaching — and build local knowledge to allow co-existence of humans and large carnivores. Furthermore, to promote integrated conservation of the landscape through improving the information base; enhancing the capacities of responsible agencies; harmonising forestry and hunting strategies, and developing Regional Species Action Plans. Finally, to enhance the awareness and support of local stakeholders for the long-term conservation of bear and wolf.

Methods

- Kits for collecting samples have been provided to hunting area administrators within the project area.
- The 'howling survey' technique was used for wolf monitoring to determine the wolf's presence and start identifying the packs and their home ranges.

Financial aspects:

- Total budget – 3,264,811.00 Euro
- EU contribution – 2,448,608.00 Euro

Duration (timescale): Sep. 2013– Feb. 2019

Conclusions

- The wolf howling survey can provide additional and relevant data about the distribution and relative abundance of wolves in the area. The database should be at a centralised level and filled in with all required information and observations should be categorised according to the protocol. Preferably some form of recording that can be reanalysed and verified should be used in the future. Extend the study to other areas relevant from conservational point of view at the regional level. Each team member should follow the same method and field protocol for relevant, harmonised, and comparable results. Complete the information with other data sources — observations, tracks in snow or mud, DNA, collaring, camera traps, etc.

4.4.6. LIFE05NAT/RO/000170 - "ENHANCING THE PROTECTION SYSTEM FOR LARGE CARNIVORES IN VRANCEA COUNTY"

Form	Project
Type	Planning, monitoring
Location	Romania
Scale	State
Involved sector	Nature conservation, spatial planning
Type of countryside	All types
Phase	Planning, monitoring, awareness-raising
Financing	EU, state
Responsible institution	Environmental Protection Agency Vrancea, lead partner, University of Bucharest - CCMESI, Association for Sustainable Development "Focul Viu" Focsani, Focsani Forestry Department, Vrancea County Council

Objectives

- To include protected areas belonging to the local ecological network for large carnivores' protection into the Natura 2000 system.
- To implement the management plans for the protected areas included in the local network for large carnivores' protection in accordance with the Natura 2000 requirements and the forethoughts of the local plan for the large carnivores protection.
- To prevent the loss of the large carnivores population due to the direct or indirect poaching phenomenon.
- To prevent conflicts between large carnivores and local inhabitants.
- To raise awareness on the social-economic benefits that are generated by the inclusion of the protected areas in the Natura 2000 system.

Methods

- Assessment of large carnivores' populations was performed by radio monitoring activities.

- Assessment of large carnivores' relative abundance was performed by using remote cameras, hair snares, animals' tracks, signs, and scats.
- Assessment of prey species' relative abundance was performed by using the pellet count method.
- Data was included in the EPA Vrancea database and used in developing management plans of Natura 2000 sites. This action was followed up by an information campaign for the local population and authorities.
- The Animal Rescue Mobile Unit (ARMU) was implemented as an ambulance for large carnivores. It is composed of a veterinary and a field operator operating on a platform of a Dacia pick-up 4x4 car.

Financial aspects

Total budget – 577,989 Euro

EC contribution – 346,793 Euro

Duration: 01.11.2005-01.11.2009

Both the project implementation and the permanent monitoring of large carnivores has highlighted that there are still serious threats that may endanger the conservation status of species. If for the wolf and lynx the major threats are currently only habitat fragmentation in terms of major investments in road infrastructure or destruction of food resources (mostly poaching of prey species), for the conservation of the brown bear there remains several threats that may lead to the conservation status degradation — especially outside the territories of protected areas. Presently, large carnivores in Vrancea play also the role of "umbrella species" because its Natura 2000 status provides protection to other species and habitats of Community interest.

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Part 5

LAND STEWARDSHIP AND LOCAL STAKEHOLDER INVOLVEMENT

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5.1. General aspects

The changing trends in landscape protection funded the importance of landscape or land stewardship approach. Namely, a scope of conservation strategies emerged: to become bioregional; protected areas cannot be dealt with as protected and separated islands; and a highlighted importance on the link between nature and culture. In this context, landscapes shaped by human stewardship means taking care of the Earth while drawing attention to the people's (individuals, communities) essential role in the management of natural and cultural heritage (Brown and Mitchell 2000). The stewardship approach extends practices in nature conservation, stepping further and encompassing a range of private and public/private tools to create, nurture and enable responsibility in users and owners to manage and protect natural resources (Racinska et al. 2015).

According to existing definitions (Laven et al. 2012; Sayre et al. 2013, Milder et al. 2014), landscape stewardship has the following specificities (Plieninger and Bieling 2017):

- Seeks to simultaneously improve heritage, food production, biodiversity and/or ecosystem conservation and rural livelihoods, and particularly acknowledges the interconnections between social justice and environmental health;
- Works at a landscape scale and includes deliberate planning, policy, management, or support activities at this scale (while at the same time considering the complex and often non-linear interactions with processes and practices at other scales);
- Involves intersectoral co-ordination or alignment of activities, policies, or investments at the level of ministries, local government entities, farmer and community organisations, NGOs, donors and/or the private sector;
- Is self-organised and highly participatory (including people not only as variables affecting landscapes but also as participants in those landscapes), supporting adaptive, collaborative management within a social learning framework; and
- Values a diversity of perspectives and 'ways of knowing', including local and indigenous knowledge of landscapes and natural resources.

According to Racinska et al. (2015), the types of different tools identified in practice are:

- Management or property transfer: The landowner transmits his or her property (or part of it) or practical tasks of the property to a land stewardship organisation, which commits itself to developing responsible management of the property (sale, legacy, donation, exchange).
- Management support: The benefits for taking care of the land for the nature conservation purposes may include tax benefits, or market-oriented incentives (e.g., user fees for hunting, eco-tourism, eco-labelling, and certification, etc.), or fiscal incentives (compensations, grants, conservation contracts). The contribution of land stewardship organisations can be consultancy, practical expertise, also concentrate on a special task or action.
- Private protected areas and voluntary reserves: private protected areas include the management of a private land with the main aim to protect its natural values, independently of its legal status or level of protection.
- Voluntary reserves officially approved special protection areas: Contrary to the private protected areas that can be closed to the public, they would consist of land with open access which is managed by a group of voluntary stakeholders.
- Conservation easements and covenant/deed restrictions: A conservation easement transfers a portion of the rights associated with a piece of property, while allowing landowners to maintain ownership and to use the land in ways that do not conflict with the terms of the easement. Covenant is similar to covenants in that they can be used to restrict; it is a contract between a landowner and a second party that may stipulate certain land uses or practices.
- Land management organisations and Land Trusts: facilitators of nature friendly land management.
- Voluntary contractual agreements: Widely applied tool that does not require a special legislative framework.
- Tax incentives: Through income tax incentives, conservation easements are donated from revenue derived on lands. At property tax incentives, landowners are given tax credits if they restrict the potential development or use potential of their property.
- Safe harbour agreements: Landowners voluntarily implement restorative and habitat management measures aimed at the conservation of threatened

species. In return, they are provided with a so-called 'safe harbour guarantee', meaning no additional conservation measures will be imposed if the number of listed species increases as a result of the landowner's actions.

Analysing the relevant LIFE projects in the EU, the most common land stewardship mechanisms include management transfer and property transfer. Management support mechanisms are also popular, but tax incentives and tax benefits for engaging in voluntary land stewardship mechanisms are not widely applied.

5.2. Examples

5.2.1. AUSTRALIA: LANDCARE, FITZGERALD BIOSPHERE PROJECT

Form	Policy
Type	Agreement
Location	Australia
Scale	National
Involved sector	Agriculture, fishery, forestry, nature protection
Type of countryside	All types
Phase	Planning, management, monitoring
Financing	Self-sustained
Responsible institution	Private institution

In Australia, landowners join community-based sustainable land stewardship groups. A private non-profit, voluntary movement, Landcare Australia, works for the improvement of natural resource management and raises funds through corporate sponsorship to support land care community groups. The Department of Agriculture, Fisheries and Forestry also supports it. Approximately, four thousand groups operate — mostly, in rural Australia (Hilty et al. 2006).

The Fitzgerald Biosphere Project is different, for it "produced considerable benefits for corridors in the region" (Bradly 1991). This was done through innovative farm plans that included planting native species in agricultural belts to serve as wildlife corridors. It also demonstrated that sustainable land use can be promoted by community organizations such as land care groups and indigenous cultural groups (Hilty et al. 2006).

5.2.2. NATIONAL CORRIDORS OF GREEN PROJECT IN AUSTRALIA

Form	Project
Type	Organizational, planning, processional, managerial
Location	Australia
Scale	Country/state
Involved sector	Spatial planning
Type of countryside	All types
Phase	Scoping, planning, constructing

The National Corridors of Green project involve community groups, landholders, local government and other organisations in activities to manage and restore 'vegetation corridors' (Greening Australia 1994). The project is part of a national response to the loss and degradation of natural ecosystems and the consequent ecological problems and loss of productive capacity of agricultural land. The project is designed to bring groups together to carry out these works in a strategic manner in areas where environmental restoration is a high priority.

The objective is to promote linear habitats and habitat corridors that have multiple environmental, economic, and social benefits in the context of an integrated regional approach to land management. Revegetation of selected areas is a key part of the project (Bennet, 2003).

5.2.3. US, NEW YORK CITY - PARTNERSHIPS FOR PARKS

Form	Management
Type	Public-private management
Location	US, New York City
Scale	Local
Involved sector	Park management, recreation, education, nature protection
Type of countryside	All types
Phase	Planning, monitoring
Financing	Local-government and donation
Responsible institution	New York City Parks Department and the City Parks Foundation

Land stewardship activities are getting popular in urban areas as well. One example is a public-private organisation that is "a combination of the New York City Parks Department and the City Parks Foundation, dedicated to supporting community groups in their engagement with parks" (Svendsen and Campbell 2008). The ethos of the organisation is "thriving parks mean thriving communities," reaching 310 000 New Yorkers every year by offering a programme that encourages them to use and care for their local parks and green spaces. It organises programs in different fields of interests, like sports, arts, community building, and education programs for all New Yorkers in more than 400 parks, recreation centres, and public schools across New York City (https://cityparksfoundation.org/).

5.2.4. US THE STEWARDSHIP NETWORK

Form	Policy
Type	Capacity building, conservation, reservation
Location	US, Great Lakes Region
Scale	Regional
Involved sector	Agriculture, water management, nature protection
Type of countryside	All types
Phase	Planning, management, monitoring
Financing	Government, donation
Responsible institution	Governmental and non-governmental institutions

At the Great Lakes Region, people and organizations often lack capacities to be stewards of their natural resources in a meaningful way. To help them, The Stewardship Network (TSN) set its mission "to connect, equip, and mobilize people and organizations to care for land and water in their communities" (www.stewardshipnetwork.org). It uses a scalable model of linked local and regional capacity building, science communication, civic engagement, and on-the-ground stewardship activities to achieve conservation and restoration that improves social and ecological knowledge. As a boundary organisation, TSN, at the request of local community members and organizations, facilitates planning processes that bring different stakeholders together to develop shared understanding of ecological problems, build trust, and collaboratively pursue common goals. It works with different funding models to increase local capacity for stewardship; it also helps them collectively hire labour, rent equipment, and secure expertise, increasing the economy of scale of the on-the-ground work (Fischer 2015).

5.2.5. UNITED KINGDOM, SCOTLAND: RIVER TRUSTS AND RIVER BOARDS

Form	Policy
Type	Planning, regulation
Location	United Kingdom
Scale	National
Involved sector	Water management
Type of countryside	Water management
Phase	Management, monitoring
Financing	Government
Responsible institution	River Trusts and the River Boards

The River Trusts and the River Boards are to facilitate communities to work towards a common goal under the guidance of the competent authority. They use financing from several sources, including the private sector. There are two management models: one is for the in-stream works, the other is for riparian work. The first is a voluntary management transfer agreement where the river proprietors — those who undertake management actions by or on behalf of the River Trust — carry out all subsequent management. It is funded by the Trust. The second model is a voluntary management support approach where work is being carried out and financed by the project, but all subsequent management actions for maintenance are carried out by the landowner under an agreement with the competent authority and secured by an annual payment. The agreements last for 10 years but can be renewed provided they are still valid (Racisnka et al. 2015).

According to the Forest Act, a private forest owner can voluntarily conclude a notarised contract for the protection of a key habitat (in line with certain criteria, entered in the environmental register). The owner ensures the preservation of the habitat, and the state gains the right to prohibit or restrict activities.

5.2.6. ESTONIA: COVENANT/DEED RESTRICTIONS FOR KEY FOREST HABITATS

Form	Policy
Type	Planning, regulation
Location	Estonia
Scale	National
Involved sector	Spatial planning
Type of countryside	All types
Phase	Planning, monitoring
Financing	Government
Responsible institution	Governmental institutions

Legally, the owner undertakes that the property is encumbered with a personal right of use in favour of the state — i.e., the Ministry of the Environment — for a period of 20 years. Compensation is paid to the owner in equal yearly instalments (Racisnka et al. 2015).

5.2.7. BELGIUM: PORT OF ANTWERP

Form	Management
Type	Protection, management
Location	Belgium, Antwerpen
Scale	City
Involved sector	Spatial planning
Type of countryside	Port of Antwerpen
Phase	Planning, monitoring
Financing	Government
Responsible institution	Port, the competent authorities, and the NGO Natuurpunt

The aim of the safe harbour agreement is to support economic development and protect the existing species parallel. The parties are the port, the competent authorities, and the NGO Natuurpunt.

Thanks to the agreement, an ecological network has been identified. It incorporates the Natura 2000 sub-sites with permanent green infrastructure and the temporary zones for economic activity. A total 90 species are protected with a protection plan. When a new development site is established, the parties are obliged to mitigation and compensation activities that ensure the favourable conservation status of protected species (Racisnka et al. 2015).

5.2.8. FINLAND: SEVERAL TAX BENEFIT INCENTIVES

Form	Policy
Type	Tax benefits, incentive for nature protection
Location	Finland
Scale	National
Involved sector	Agriculture, nature protection
Type of countryside	All types
Phase	Planning, monitoring
Financing	Government
Responsible institution	Governmental institutions

In Finland, several type of tax benefits exist for engaging in voluntary nature protection mechanisms.

One type is the income tax relief: a private land purchased with natural conservation purposes from the government or from an institution is exempted from profit tax on any income gained from selling the property.

Another type is property tax reliefs: The real estate value is calculated as nil in taxation if an agricultural land is transferred into a nature protection area. Also, the same calculation is valid in inheritance taxes for an agricultural land transferred into a private nature protection area (Racisnka et al. 2015).

5.2.9. BELGIUM: REDUCED INHERITANCE TAX

Form	Policy
Type	Tax benefit, incentive for nature protection
Location	Belgium, Flemish region
Scale	Regional
Involved sector	Forestry, nature protection
Type of countryside	All types
Phase	Planning, monitoring
Financing	Government
Responsible institution	Governmental institutions

In the Flemish region of Belgium there is no inheritance tax (for 30 years) when, at a woodland, a management plan is in place and approved by the competent authority; it is carried out for 30 years; it remains the parcel a woodland for at least 30 years.

Where the parcel is located within the Flemish Ecological Network (large areas of it are included in Natura 2000), no inheritance tax is exposed. In case the successor does not meet the criteria, the tax is to be reclaimed for the remaining inheritance tax pro-rata. The parcel may not contain any housing or construction (e.g. stable, weekend cottage).

In addition, several tax reductions or even exemptions can be obtained in the Flemish region when the land is designated as a natural geological, geomorphological, or biological 'monument' (Demoulin 2017).

5.2.10. THE NETHERLANDS: PROLANDER

Form	Policy
Type	Tax benefit, incentive for nature protection
Location	The Netherlands, provinces of Drenthe and Groningen
Scale	National
Involved sector	Agriculture, nature protection
Type of countryside	All types
Phase	Planning, monitoring
Financing	A land trust of provinces
Responsible institution	Prolander

Furthermore, a total 30 % of half the restoration or maintenance costs can be deducted from the land-owners' income tax.

In the Walloon region, there is no inheritance tax if the parcel is within a Natura 2000 site — regardless of the land use (Racisnka et al. 2015).

Prolander is a semi-public organisation; a land trust that acquires and manages land in the provinces of Drenthe and Groningen. The policy is set out by the provinces and/or state; two main policy fields are agriculture and nature. By buying, selling, and providing land, the organisation is able to swap land between farmers and/or nature organisations — public and NGO.

Prolander also facilitates and sometimes manages the finances of the land development (including nature restoration projects). "Purchased land can be used in exchange for parcels of land with a farm owner within the framework of implementing nature conservation policy, water policy (e.g., flood plains), landscape objectives or infrastructure" (Racisnka et al. 2015).

5.2.11. SPAIN: FUNDACIÓN CALATUNYA-LA PEDRERA (FCLP)

Form	Management
Type	Nature protection
Location	Spain, Catalonia
Scale	Regional
Involved sector	Forestry, tourism, nature protection
Type of countryside	Natural sites
Phase	Management, monitoring
Financing	Private organisation
Responsible institution	FCLP founded by a bank

The FCLP is an independent foundation created by a bank in 2012. It supplies management and educational tasks on natural sites — 24 natural sites encompassing 7800 ha acquired in, mostly, Natura 2000 network sites — and for nature conservation purposes. Also, it manages land stewardship agreements (15 sites, 561 ha), they have 27 forest reserves with wood rights, and 64 agreements for 160 000 ha for conservation planning. Its income comes from the visitors to the tourist building La Pedrera, in Barcelona. The sum of their land accounts for 5 % of the land in Catalonia (Racisnka et al. 2015).

5.2.12. GREECE: BOURAZANI

Form	Management
Type	Nature protection
Location	Greece, Bourazani
Scale	Local
Involved sector	Wildlife management, tourism, nature protection
Type of countryside	Local
Phase	Planning, monitoring, monitoring
Financing	Private organisation, self-sustained
Responsible institution	Private organisation

Bourazani is a private wildlife resort and environmental park: a profit-making enterprise with an area of 2050 ha. It was established in 1916 and was originally used for grazing the owner's animals — sheep flocks, in particular — and later transformed to a wild-game hunting farm.

In recent years, the younger generation of the family which owns the land has transformed the estate, with the support of EU funds, into an environmental and education park open to visitors. The main purposes of their activities — as described in the park's website — "is the animal host, maintaining the animal balance of the population, the observation of animals in their natural environment, the information on the life cycles of these, information on flora and fauna themes of Bourazani region and efforts to preserve the environment and culture in our region."

The park is self- sustained through the visitors' fees. A traditional hotel, a natural history museum, and an environmental education and conference centre are situated in the park (Racisnka et al. 2015; http://mpourazani.eu/).

5.2.13. ITALY: RIVER CONTRACTS

Form	Management
Type	Tax benefits, incentive for nature protection
Location	Italy
Scale	National
Involved sector	River management, agriculture, nature protection
Type of countryside	Riverside
Phase	Planning, management, monitoring
Financing	Self-sustained
Responsible institution	Governmental institutions, Basin Authority ("Autorità di bacino")

Through the application of the Water Framework Directive and of the Flood Directive, a voluntary mechanism called River contracts was born. According to the adapted legislation, the reference body, the Basin Authority ("Autorità di bacino"), is responsible to work out a plan to flood risk management. The involvement of the stakeholders happens at two levels: firstly, the stakeholders provide their observations for the preparation of the plan — all the subjects (administrations, associations, economic operator) are taken into consideration and have effect (direct or indirect) — secondly, the stakeholders apply the interventions of the plan through river contracts.

The aim of the planning is to implement an integrated approach and participatory processes, and achieve "objectives of environmental restoration, reduction of the water pollution, improvement of conservation and management of the hydraulic risk, as well as sustainable use of the water at level of the river basin system". The river contracts are quite widespread in Italy, but the most advanced one is in the Piemonte region, where the first contracts were set and gained legal value through an administrative act which establishes the structure and principles of the contracts. The river contract's duration is established depending on the requirements of the needed interventions. During its fulfilment, the contract may be revised on the basis of unexpected events. "Usually, the contract is signed between public bodies (Basin authority or Region with Municipalities, Mountain Communities, Provinces, Park management bodies), but there are examples of contracts signed also with private bodies, such as environmental associations, trade associations for economic activities or for recreational/sport activities" (Racisnka et al. 2015).

5.2.14. FRANCE: PACTE PASTORAL

Form	Policy
Type	Agreement
Location	France, Causses Aigoual Cévennes Terres Solidaires
Scale	National
Involved sector	Agriculture, pastural farming, nature protection
Type of countryside	All types
Phase	Planning, management, monitoring
Financing	Self-sustained
Responsible institution	Intercommunal institutions

The Pacte Pastoral exists for the area of the Causses Aigoual Cévennes Terres Solidaires, where cultural landscapes depend on fashioned pastoral farming. The Pacte Pastoral is an intercommunal agreement for implementing the management plan of the Causses and Cevennes for the 2025-2021 period — thus, the results are still not known.

The pact exists to ensure a priority or support given to pastoralism with the help of the following rules: adopt a rule of priority to pastoralism in any property transfer; recognize pastoralism as a community service; define areas dedicated to pastoralism in the urban and rural planning document; oblige any opened tenement to allow free passage and grazing of the flocks. It is a form of "soft law," a party negotiated easement called "servitude pastorale" that allows farmers to use private lands for non-injurious pastoral activity (grazing and transhumance). The Pacte Pastoral also includes the commitment to encourage the adoption of pastoral easements whenever they are relevant (Racisnka et al. 2015).

5.3 Literature

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Part 6

TRANSPORTATION INFRASTRUCTURE, MITIGATING HARD MEASURES

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6.1. General aspects

In case it was not possible to avoid the crossing of migration routes, it is important to restore the connection by creating wildlife crossings or mitigate the negative effects.

In the following pages, we focus on smaller scale, local measures which mostly mitigate the negative effects of transportation infrastructure.

6.2. Worldwide examples

6.2.1. ECO-DUCT / FAUNA PASSAGE IN BANFF NATIONAL PARK, CANADA

Form	Eco-duct
Type	Planning
Location	Banff National Park, Canada
Scale	Local
Involved sector	Spatial planning, nature protection, infrastructure
Type of countryside	All types
Phase	Construction
Financing	n/a
Responsible institution	Ministry of Transportation

For the past two decades, the fences, tunnels and overpasses along the Trans-Canada Highway in Banff National Park have helped more than 152 000 animals cross the road safely. They have also reduced the vehicle collisions by about 80 %. There are currently a total 44 wildlife crossing structures — six overpasses and 38 underpasses.

One examples is a Fauna overpass in the Banff National Park which has been built above the heaviest-traffic highway in Canada. Thanks to its construction, the local Road Ecology Council has registered 10 000 safe animal crossings on this overpass alone.

The measure is targeting habitat preservation, establishment and strengthening of connectivity, transport security, and reduction of roadkills.

6.2.2. ESCAPE RAMPS, CROWSNEST LAKES, CANADA

Form	Eco-duct
Type	Planning
Location	Crowsnest Lakes, Canada
Scale	Regional
Involved sector	Private landowners, the “Highway 3 Partnership Group” (Miistakis Institute, Yellowstone to Yukon and Western Transportation Institute) working closely with Alberta Transportation
Type of countryside	The Crowsnest Lakes, the eastern and western parts of the Crowsnest Pass (Rock Creek, Iron Ridge, Leitch Collieries), deer, elk, moose, bighorn sheep, bears and cougars
Phase	Construction
Financing	Alberta transportation
Responsible institution	Alberta transportation

Installing fences along roads removes the problem of road mortality but increases the barrier effect. A wildlife fence “jump-out” allows animals that find themselves on the wrong side of the fence an escape back to safety and away from traffic. The project installed 1.5 kilometres of directional fencing parallel to Highway 3 on both sides near Emerald Lake. The goal of the fencing project was to funnel sheep and other wildlife to cross under the existing bridge rather than crossing or licking salt on the highway. Crowsnest Lake was chosen as a starting point for the fencing project because of poor driver visibility and the high numbers of big horn sheep killed there, and soon approved additional main wildlife corridors in the area. The number, type and location of escape structures depend on the target species, terrain, and habitat adjacent to the highway fence.

Road Watch in the Pass is a citizen science project developed by the Miistakis Institute in 2004 to collect data on the main wildlife corridors crossing Highway 3. Up to date, citizens have reported over 5000 wildlife observations. Over the years, the group has advocated for wildlife mitigation efforts to be made at those main corridors.

6.2.3. WILDLIFE DETECTION SYSTEMS ON HIGHWAY 3, CANADA

Form	Measure / wildlife detection system
Type	Planning
Location	Elko, Canada
Scale	Regional, national
Involved sector	Spatial Planning, Government/ industry collaboration, Transport
Type of countryside	All (especially deer, elk, moose)
Phase	Monitoring
Financing	The BC Ministry of Transportation and Infrastructure
Responsible institution	The BC Ministry of Transportation and Infrastructure

The measure is targeting establishment and strengthening of connectivity, mitigation of environmental damages, biodiversity improvement, transport security, decreasing economic damages and reduction of roadkills.

Animal detection systems or wildlife warning systems are designed to detect large animals that are on or near the road. Once a large animal has been detected, warning signs are activated that urge drivers to slow down or be more alert. There are different types of animal detection systems, including break-the-beam systems and area cover systems. Break-the-beam systems have a transmitter that transmits a signal to a receiver. When an animal's body blocks or reduces the signal, the warning signs are activated. The signal type may be microwave radio signals, infrared light, or laser. Another system type detects animals within a certain range of the sensor. The signals may include microwave radio signals or infrared light. Other systems use a buried cable that detects changes in an electromagnetic field as the animals walk over the cable, or they may use seismic sensors that record vibrations in the ground as large animals approach. This is in contrast to wildlife underpasses and overpasses which only allow wildlife to cross at particular locations, and these locations are fixed. The system is 100 % solar powered and each system is connected to a cell phone for remote monitoring, checking, and data collection. These systems may also be combined with wildlife fencing.

6.2.4. AVOIDING AND REDUCING ANIMAL MORTALITY MEASURES, BONVILLE, AUSTRALIA

Form	Project, measures
Type	Planning
Location	Bonville, Australia
Scale	Local
Involved sector	Spatial planning, nature protection, infrastructure
Type of countryside	Infrastructures, shrubs and wooded areas, wetlands
Phase	Planning, construction
Financing	n/a
Responsible institution	Ministry of Transportation, nature, National Park

The measure is targeting mitigation of environmental damages, decreasing of economic damages, transport security and reduction of roadkills.

Bongil National Park is widely acknowledged to have a diverse and valuable habitat that is home to a significant range of wildlife. Several strategies have been realised to reduce the animal mortality and increase biodiversity in the park:

- The median strip separating north and southbound lanes in the Pine Creek State Forest area would be larger than first planned. More native trees would be kept, and their central position would provide passage for Gliders to cross the highway (median trees act as the halfway point).
- The 60 m wide fauna overpass was designed to appeal to a great array of animals, hosting the biggest variety of vegetation types, and open to natural weather patterns and light. Additionally, eight underpasses were built.
- Temporary fencing created safe zones around construction sites; permanent fencing was erected beside forested areas and leading to fauna crossings. Noise barriers along the highway also acted as a barrier to wildlife, directing them toward crossing structures and away from the open road.

» Giving permeable bases to the culverts installed for wildlife movement would help maintain groundwater flow. This would also assist aquatic species, such as amphibians, to move through culvert tunnels.

The measure is targeting habitat preservation, establishment and strengthening of connectivity, biodiversity improvement, transport security, decreasing economic damages, and reduction of roadkills.

6.2.5. HIGHWAY 93, MONTANA

Form	Project
Type	Managerial, technical, planning
Location	Montana, USA
Scale	Local, site-scale
Involved sector	Transport, spatial planning
Type of countryside	All types
Phase	Planning, construction
Financing	Public
Responsible institution	The Confederated Salish and Kootenai Tribes, the Montana Department of Transportation

Mitigating the impacts of roads is primarily done by public transportation departments. However, some local interest groups have become involved in investigating alternative road design and impacts of roads on local wildlife. In Montana, the Confederated Salish and Kootenai Tribes, the Montana Department of Transportation, and other groups recognized an opportunity to protect wildlife when proposals arose for the reconstruction of U.S. Highway 93, which passes through the Flathead Indian Reservation.

Maintaining and restoring natural processes, including the movement of wildlife, became a major focus of this project, and landscape architects and wildlife biologists developed a workbook on the subject (Jones & Jones Architects and Landscape Architects, Ltd. 2000). Arguably, this highway project represents the most extensive effort to accommodate safe wildlife crossing in the United States. This corridor project is a good example of the advantages of collaborating with scientists in project planning and implementation (Hilty et al. 2006).

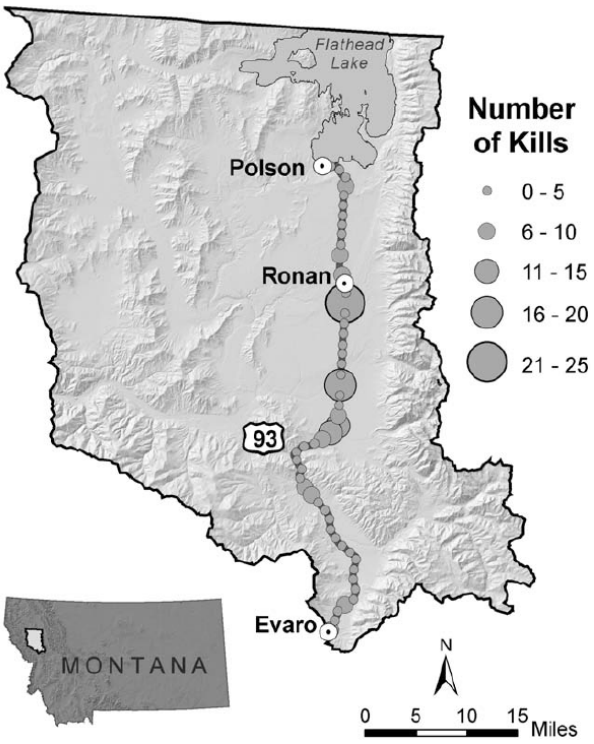


Figure 26. © Whisper Camel / Montana State University

6.2.6. NATURE BRIDGE / ECO-DUCT IN NATUURBRUG ZANDERIJ CRAILOO, NETHERLANDS

Form	Eco-duct
Type	Planning
Location	Get Gooi, Netherlands
Scale	Regional (state)
Involved sector	Spatial planning, Agriculture, Forestry, Water management, Hunting, Tourism and leisure, Nature protection, Transport, Local population/citizens
Type of countryside	All types
Phase	Construction
Financing	n/a
Responsible institution	n/a

The Zanderij Crailoo nature bridge is the largest eco-duct in the world with 800 m length and 50 m width. It is located in the Goois Nature Reserve in Het Gooi, province of Noord-Holland. The bridge was opened on May 3, 2006, by Queen

Beatrix. The project cost 14.7 million euros and was started in 2002.

The bridge connects the Spanderswoud and the Bussumerheide and crosses local road communication, a railway line, and the site of a Golfpark. The bridge is not only built for animals; there is also a bike path and a riding trail over it. The eco-duct is one of the links in the 'Heel de Heuvelrug' implementation programme.

The eco-duct consists of two viaducts. The first viaduct, with a length of 135 m, connects the railway, business park, and local road. The second viaduct, with a length of 35 m, ensures that the animals can safely cross through the area. Both viaducts are 50 m wide, made of concrete, and covered in soil. The measure is targeting connectivity establishment and improvement, reduction of biotope fragmentation, and reduction of roadkills — with accompanying impacts of transport and wildlife security.

6.2.7. ECO-DUCT A6 NEAR WATTENHEIM, GERMANY

Form	Eco-duct
Type	Planning
Location	Wattenheim, Germany
Scale	Regional (state)
Involved sector	Spatial planning, Agriculture, Forestry, Water management, Hunting, Tourism and leisure, Nature protection, Transport, Local population/citizens
Type of countryside	All types
Phase	Construction
Financing	Economic Stimulus Package II
Responsible institution	n/a

The green bridge over Highway A6 was built between Wattenheim and Enkenbach-Alsenborn. For decades, the motorway has been cutting up the biosphere reserve in this area. A total 3.5 million euros have been committed to the project, coming from the Economic Stimulus Package II. It was planned since March 2009 and finally completed by the end of 2011.

The site selection for the crossing aid was carried out after careful investigations by experienced wildlife biologists in a hiking area of many forest animals, with special consideration towards the endangered wildcat. The green bridge is designed not only for bigger forest animals like ungulates, but also for smaller mammals and other species.

In order for lizards to be able to move freely, they have raised loose rock suitable for their species, and even bats orient themselves in their flight over the highway to the green structures.

The measure is targeting connectivity establishment and improvement, reduction of biotope fragmentation, and reduction of roadkills with accompanying impacts of transport and wildlife security.

6.2.8. LIGHTNING – ENVIRONMENTAL ROAD STUDS IN NOORD, NETHERLANDS

Form	Project / measure / road lightning
Type	Planning
Location	Wattenheim, Germany
Scale	Local
Involved sector	Spatial planning, transport, nature protection, infrastructure
Type of countryside	All types
Phase	Construction
Financing	Province of Noord / Netherlands
Responsible institution	Province of Noord / Netherlands

Clearview Intelligence IRS1 studs proved financially and environmentally sound in this key nature area. The Province of Noord in Holland was looking for a solution to improve road safety on the N236, an area renowned for its natural beauty and outstanding wildlife that populates this region.

The installation of hardwired road studs was the perfect remedy between providing improved traffic safety in this area whilst maintaining an optimal living environment for the local wildlife.

The main key benefits of the project:

» Minimise local light pollution compared to street lighting, respecting the natural darkness of the local wildlife habitat;

- Highly visible traffic calming contribution to road safety in important environmental hotspots;
- Particularly effective at highlighting road layout changes in poor weather conditions;
- Significantly lower installation and lifetime operating costs than street lighting;
- Fit within existing road infrastructure, minimising physical encroachment into surrounding environment.

The measure is targeting strengthening the condition of the road, transport security, and reduction of roadkills.

6.2.9. AMPHIBIAN CLIMATE TUNNELS OF STAFFORDSHIRE, UK

Form	Amphibian tunnels
Type	Planning
Location	Staffordshire, UK
Scale	Local
Involved sector	Spatial planning, nature protection, infrastructure
Type of countryside	Urban area, areas for settlements and transport, wetlands
Phase	Planning, designing
Financing	n/a
Responsible institution	Staffordshire Country Council

When the Staffordshire County Council began the development of a new £10 M business park, they found a population of one of Europe's protected amphibious species. In order to carry on the project without impacting the area's biodiversity, the council turned to wildlife experts to deliver an eco-friendly solution: climate tunnels.

The Climate Tunnel system is an enclosed series of polymer concrete tunnels which can be installed to sit flush with the road surface and allow amphibians safe passage across potential 'risk' areas, such as roads and footpaths.

Furthermore, in order to create the right climate for the amphibians, slots are included at the top of the tunnels to equalize ambient conditions between the tunnel and open air. This allows for consistent ventilation and a humid environment favoured by amphibians, and also eliminates the problem of the tunnels drying out and dehydrating the amphibians, which can occur with other tunnel systems.

The measure is targeting habitat preservation, establishment and strengthening of connectivity, transport security, and reduction of roadkills.

6.2.10. THE USE OF HYDROSEEDING ON UNSTABLE DITCH SLOPES, FINLAND

Form	Measure – hydroseeding
Type	Planning
Location	Finland
Scale	Local. regional, national
Involved sector	Spatial Planning, Transport, Nature protection, Forestry
Type of countryside	All
Phase	Construction
Financing	n/a
Responsible institution	Staffordshire Country Council

This initiative is an example of the use of hydroseeding on unstable ditch slopes in Finland.

Hydroseeding has been proven to improve the stability of ditch slopes. The hydraulic seeding method can be very useful on steep slopes in road cuts. The slopes have to be correctly formed first; after that, the seed can be sprayed on to the slope. The material in the spray contains, among other things, organic glue and a range of grass seeds that stabilize the slope surface.

Another option is to support the slope to make it less unstable. This can be done, for example, with a gabion wall, rock support — an example of a well-constructed gabion basket support structure at the toe of a steep slope. The bottom of the ditch has also been protected from erosion with ballast structure — an example from Levi, Northern Finland.

The measure is targeting removing of ecological loads, transport security, improving maintenance, decreasing economic damages, and reduction of roadkills.

6.3 Partners' examples

6.3.1. TRANSGREEN – INTEGRATED TRANSPORT AND GREEN INFRASTRUCTURE PLANNING IN THE DANUBE-CARPATHIAN REGION FOR THE BENEFIT OF PEOPLE AND NATURE

Country	Czech Republic, Hungary, Romania, Slovakia, and Ukraine
Form	Project
Type	Wide ranges of mitigation measures, consultation, partnership building
Location	Tîrgu Mureș – Iași (Romania), Arad – Deva (Romania), Miskolc (Hungary) – Košice (Slovakia) – Uzhgorod (Ukraine), Beskydy (Czech Republic-Slovakia).
Field of harmonization	Transportation network, infrastructure, ecological connectivity
Scale	Local, interregional
Binding of the measure	Non-binding but recommendatory
Involved sector	Infrastructure, Nature protection
Phase	Project duration: 2017 – 2019;
Financing	EU funds, ERDF – Interreg Danube Transnational Programme (85% of project costs) Budget: EUR 2,481,321
Responsible institution	WWF Central and Eastern Europe, AUSTRIA; Friends of the Earth Czech Republic, branch Olomouc, CZECH REPUBLIC; Nature Conservation Agency of the Czech Republic, CZECH REPUBLIC, Transport Research Centre, CZECH REPUBLIC; CEEweb for Biodiversity, HUNGARY; Association "Milvus Group", ROMANIA; WWF Romania, ROMANIA; National Motorway Company, SLOVAKIA; The State Nature Conservancy of the Slovak Republic, SLOVAKIA; SPECTRA Centre of Excellence of EU – Slovak University of Technology in Bratislava

The project covered the following activities:

Developing adapted and specific technical solutions: Field studies focused on the Trans-European Network for Transport (TEN-T) infrastructure projects in different stages of development are conducted in four pilot areas: Tîrgu Mureș - Iași (Romania), Arad - Deva (Romania), Miskolc (Hungary) - Košice (Slovakia) - Uzhgorod (Ukraine), Beskydy (Czech Republic-Slovakia). In the pilot areas, critical areas for wildlife and safety, as well as ecological corridors, were identified. For each of the pilot areas, a 'Catalogue of measures' was elaborated together with decision makers, local stakeholders, nature conservation organisations, and road and rail administrations/authorities to avoid/overcome conflicts between transport planning objectives and green infrastructure objectives (Natura 2000 sites, wildlife corridors, road-less/low traffic areas, etc.).

Consultations and knowledge sharing was carried out across pilot areas that are in different stages of linear infrastructure development (planning, construction, operation, and monitoring), including a survey of costs and benefits of ecosystem services/ green infrastructure in relation to transport infrastructure.

Consultations for interdisciplinary approaches: A Partnerships Network was elaborated with ministries, planners, developers, administrations, relevant local authorities, protected areas, consultants, and NGOs for the development of the publication of the 'Guidelines for improving infrastructure development'.

On the political level, the project developed a 'Strategic Action Plan for Sustainable Transport Development in the Carpathians' and fostered cross-sectoral meetings at the national and Carpathian Convention level.

Project website:
www.interreg-danube.eu/approved-projects/transgreen

6.3.2. MOSTY U JABLUNKOVA – PLANTING OF GREEN VEGETATION

Country	Czech Republic
Form	Project
Type	Mitigation measure
Location	Czech Republic, cadastral area: Mosty u Jablunkova, 49.5560594N, 18.7423678E
Field of harmonization	Ecological network, connectivity, biodiversity improvement
Scale	Local
Binding of the measure	Non-binding but recommendatory
Involved sector	Agriculture
Phase	Monitoring
Financing	EU funds
Responsible institution	Friends of the Earth Czech Republic – Olomouc local group, local farmers, Municipality Mosty u Jablunkova

Figure 27 a and b. Map and image of the area Mosty u Jablunkova.
Source: http://olomouc.hnutiduha.cz/data/docs/OPZP_2014/zjednodusenaPD.pdf

Strengthening the TSES function in the route of the superregional biocorridor in cadastral area Jablunkov; tree planting, care of woody plants.

6.3.3. BIOCORRIDOR BY KLETNÉ ECO-DUCT

Country	Czech Republic
Form	Project
Type	Mitigation measure
Location	Czech Republic, cadastral area: Kletné, 49.6708731N, 17.9205389E
Field of harmonization	Ecological network, connectivity, biodiversity improvement
Scale	Local
Binding of the measure	Non-binding but recommendatory
Involved sector	Agriculture
Phase	Monitoring
Financing	EU funds
Responsible institution	DIVOUS (NGO), local farmers, land owners, Municipality Suchdol nad Odrou

The project consists of a green belt in the agricultural landscape, following up an eco-duct over the highway.

Figure 28. Map of the area Kletné; location of the eco-duct.

6.3.4. MITIGATION OF THE EFFECTS OF HABITAT FRAGMENTATION

Country	Czech Republic
Form	Project
Type	Processual measure; Planning measure; Organizational measure
Location	The Czech Republic
Field of harmonization	Ecological network and corridors in forests; Ecological network and corridors in agricultural (arable land, grass land)areas
Scale	Regional
Binding of the measure	Non-binding but recommendatory
Involved sector	Agriculture
Phase	Monitoring
Financing	EEA grants
Responsible institution	Czech University of Life Sciences Prague, Faculty of Environmental Sciences

This project was aimed to find systemic ways to remedy the negative impacts of fragmentation in the Czech Republic.

We consider land consolidation to be a universal socio-economic tool to alleviate the consequences of large-scale fragmentation of the agricultural landscape since it can significantly strengthen the farming prosperity on the basis of land ownership. The other option is the creation of rules for a farming policy that would directly reduce the extensive production blocks. The land consolidation and selected tools of agricultural policy are universal remediation steps for the reduction of negative impacts of fragmentation in the Czech Republic. Only the mutual interconnection of many favourable sites with locally stabilized populations may mitigate the effects of habitat fragmentation at the landscape level and ensure their effective long-term protection.

Involved stakeholders: farmers, Ministry of Agriculture

More information: https://www.fzp.czu.cz/en/r-6899-projekty-a-spoluprace-s-praxi/r-6923-projekty/r-13356-archiv-projektu/r-7668-fragmentace-biotopu-v-cr

6.3.5. WORKS FOR MAINTAINING/ RESTORING PERMEABILITY FOR MAMMALS

Country	Romania
Form	Programme
Type	Planning measure
Location	The entire route of the future Sibiu-Pitești highway, and is located nearby the Cozia National Park
Field of harmonization	Ecological network and corridors versus infrastructure corridors
Scale	Regional
Binding of the measure	Binding according to the national law
Involved sector	Transport infrastructure
Phase	Construction
Financing	It will cost over 1.3 billion euros and 85% of the funding would be provided from European funds.
Responsible institution	CNAIR - Compania Națională de Administrare a Infrastructurii rutiere din România (National Company for Road Infrastructure Management in Romania), Ministry of Transport

Provision of permeable structures for mammals — such as tunnels in areas where crossing passages for mammals were registered, bridges and viaducts along the route of the highway crossing the area, and the construction of three eco-ducts (one in the north of the Cozia National Park and two in the Olt Valley) — were identified — namely, ecological corridors. Both in the construction and operating phases, impacts monitoring will be annually carried out, including: species inventory; identification of lost and rehabilitated habitat areas or of habitat fragmentation situations; and assessment of the efficiency of mammalian passages.

The Sibiu-Pitesti highway intersects nine protected natural areas (SCIs and SPAs) on a length between one and seven kilometres on each one. Nearby the

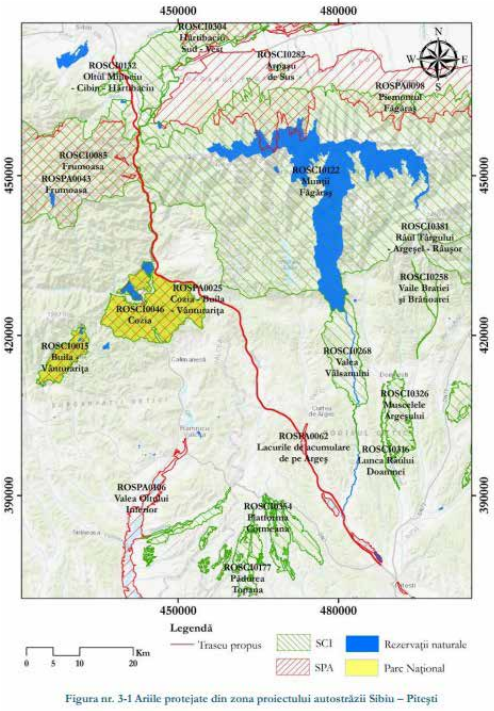
future highway, there are five more protected natural areas at distances between one and nine kilometres. Being located in marginal areas of protected natural areas, the future highway is intersecting the existent ecological corridors located between these protected areas, as well as ecological corridors located between the protected natural areas and other areas currently occupied by natural or semi-natural habitats. The most relevant form of impact is the fragmentation of habitats — especially of large mammals, for which the maintenance of populations depends on the existence of a good permeability of the landscape — namely, the fragmentation of ecological corridors (with impacts on biodiversity). This impact is estimated to occur at the level of the entire surface of three Natura 2000 sites adjacent to the project which are important sites for large carnivore populations: Cozia National Park, SCI Fagaras, and SCI Frumoasa.

The Sibiu-Pitesti highway (123 km), part of the Pan-European Corridor 4, is one of the most important infrastructure projects in Romania. The deadline for completion of the highway is 2025. Until January 2020, the Road Infrastructure Management Company had signed the contract for the construction of a single lot, "Sibiu-Boița," of 13 kilometres (under design). The area is important for the movement of mammal species, including large carnivores. The permeability of the study area for the large fauna was analysed both in the current situation — without the highway — and after the highway construction, and the connectivity was compared.

Involved stakeholders: Ministry of Transports, Ministry of Environment, Waters and Forests, National Agency for Environmental Protection, Environmental Protection Agencies from Valcea, Sibiu and Arges counties, Romsilva National Forest Authority, constructors, those responsible with biodiversity.

More information

- http://www.anpm.ro/documents/12220/2231306/Memoriu+de+prezentare+autostrada+Sibiu+-+Pitesti.pdf/d10d2c76-b0fb-4b34-99ae-8853851f1f22
- http://www.anpm.ro/documents/12220/2537467/20181228143020.pdf/fd92113f-fc26-4846-9cc7-0fbeb0431936
- http://www.anpm.ro/documents/12220/34391606/Studiu+EA_Autostrada+Sibiu+Pitesti.pdf
- Source of photos: National Company for Road Infrastructure Management in Romania: Presentation Memorandum of Bucharest-Pitesti Highway, http://www.anpm.ro/documents/12220/2231306/Memoriu+de+prezentare+autostrada+Sibiu+-+Pitesti.pdf/d10d2c76-b0fb-4b34-99ae-8853851f1f22
- http://www.anpm.ro/documents/12220/34391606/Studiu+EA_Autostrada+Sibiu+Pitesti.pdf http://www.130km.ro/a3.html



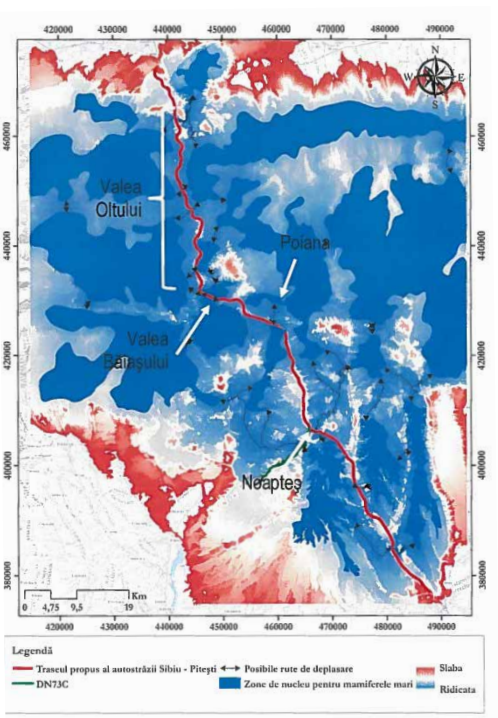


Figure 29a and b. © National Company for Road Infrastructure Management in Romania: Presentation Memorandum of Bucharest-Pitesti Highway

6.3.6. WORKS TO REDUCE THE RISK OF MORTALITY OF BIG CARNIVORES (COLLISION WITH TRAFFIC), WORKS FOR NOISE PROTECTION AND WORKS TO REDUCE HABITAT LOSS AND ALTERATION

Country	Romania
Form	Project
Type	Technical measure
Location	The entire route of the future Sibiu-Pitești highway, and is located nearby the Cozia National Park
Field of harmonization	Ecological network and corridors in urbanized areas, agglomeration zones; Ecological network and corridors versus infrastructure corridors
Scale	Local; Regional; Transregional
Binding of the measure	Non-binding but recommendatory
Involved sector	Spatial planning; Transport infrastructure; Forest management
Phase	Planning; Construction; Monitoring
Financing	It will cost over 1.3 billion euros and 85% of the funding would be provided from European funds.
Responsible institution	CNAIR - Compania Națională de Administrare a Infrastructurii rutiere din România (National Company for Road Infrastructure Management in Romania), Ministry of Transports

Avoiding/limiting access of wildlife in the road area in the case of large mammals by installing barriers, green alignments, and fences to prevent their access — high fence (3 m) and resistant (reinforced). There will be impact monitoring: the monitoring team will make a written report annually and any accidental killing of any species of conservative interest in both periods (construction and operation) will be reported. There will be facilities and equipment for noise protection. To reduce the loss and alteration of the habitats, afforestation works were provided to ensure a high degree of efficiency of the sub-passages and to guide the species towards them (e.g., the afforestation of a surface of 2.2 ha to the north of the ecological corridor, under a viaduct and others on both sides of the motorway, to increase the efficiency of under-crossing for large mammals).

The potential impact of the construction of the Sibiu-Pitesti highway on the biodiversity components consists of:

- **Increased mortality rates for species such as large mammals as a result of collision with traffic.**
- **Disruption of specific animal activities due to human presence, noise, and excessive lighting.**
- **Loss of natural habitat surfaces (including habitats of community interest or habitats used for food, rest or reproduction needs for species of community interest) as a result of occupancy with constructions (about 240 ha of forest will be cleared). These types of impact are estimated to occur over a distance of 1 km from the project boundaries.**

Nearby the protected Sibiu-Pitesti highway, all 3 types of carnivores were observed: approx. 200 specimens of *Canis lupus*, about 600 of *Ursus arctos* and approx. 150 of *Lynx lynx*, all of them having a good conservation status. In the construction and operation phase: reinforced fences (anchored in a solid, concrete foundation and securing/burying the lower part of the fence net) having at least 3 m high. These will be built on the route between Sibiu and Curtea de Argeș in order to avoid the penetration of wildlife in the motorway area of the highway and to guide the animals to the underpass areas of the highway.

Involved stakeholders: Ministry of Transports, Ministry of Environment, Waters and Forests, National Agency for Environmental Protection, Environmental Protection Agencies from Valcea, Sibiu and Arges counties, Romsilva National Forest Authority, constructors responsible with biodiversity.

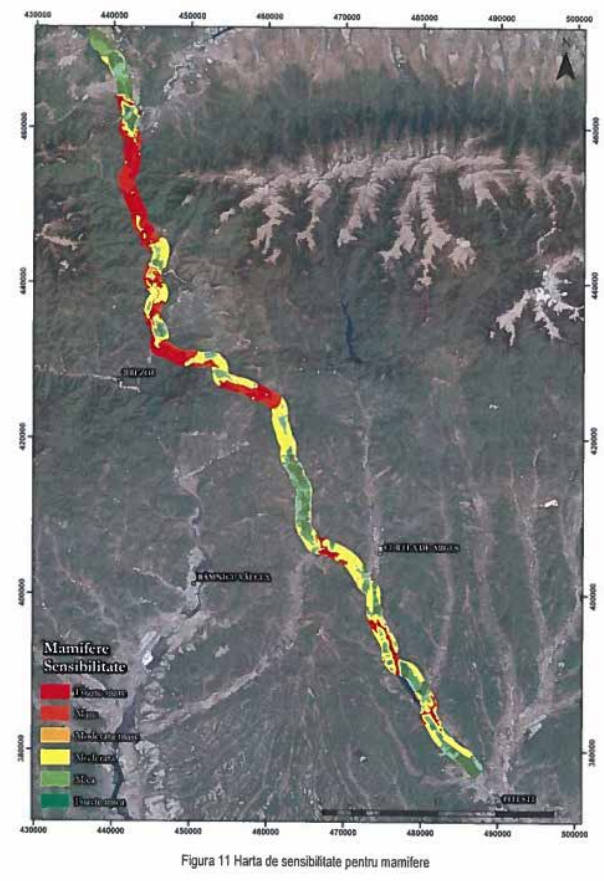


Figure 30. © National Company for Road Infrastructure Management in Romania.

Further information

- Presentation Memorandum of Bucharest-Pitesti Highway: http://www.anpm.ro/documents/12220/2537467/20181228143020.pdf/fd92113f-fc26-4846-9cc7-0fbeb0431936 (The Environmental Agreement, by the Ministry of Environment)
- National Company for Road Infrastructure Management in Romania: Presentation Memorandum of Bucharest-Pitesti Highway: http://www.anpm.ro/documents/12220/2231306/Memoriu+de+prezentare+autostrada+Sibiu+-+Pitesti.pdf/d10d2c76-b0fb-4b34-99ae-8853851f1f22
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6.3.7. ENSURING THE PERMEABILITY OF NATURAL PROTECTED AREAS BY ECO-DUCTS CONSTRUCTION

Country	Romania
Form	Project
Type	Construction, mitigation
Location	Lugoj-Deva Highway, Hunedoara county, Apuseni Mountains, Southern Carpathians
Field of harmonization	Ecological network and corridors versus infrastructure corridors
Scale	Local
Binding of the measure	Construction, mitigation
Involved sector	Spatial planning; Transport infrastructure
Phase	Planning; Construction, Monitoring
Financing	State budget, Large Infrastructure Operation Programme
Responsible institution	National Company for Road Infrastructure Administration (CNAIR) Minister for Transport, Infrastructure and Communications Entrepreneurs, Hunedoara county council, NGOs

There are three eco-ducts on the Lugoj-Deva Highway ensuring the permeability of the area of interest — mainly, for the preservation of the existing ecological corridor between the Apuseni Mountains and the Southern Carpathians.

Tunnels construction: each tunnel consists of two separate galleries (one per lane). Protective fences and sound-absorbing panels were placed to maximize the use of eco-ducts by animals through a corridor which continues 100 m on both sides of the highway, together with planting of shrub vegetation. The height of these panels varies between 2.5 m and 4 m.

Figure 31. The tunnel. Source: http://www.cnadnr.ro/en/proiecte/proiectare-si-executie-autostrada-lugoj-deva-lot-3. Report on the environmental impact for the Project: Lugoj-Deva Highway km 0+000-100+014 - http://www.anpm.ro/documents/12220/2231306/RIM+22.11.2016.pdf/c5ea415b-cd85-4dd1-8392-a1219323da2b and https://adevarul.ro/locale/hunedoara/autostrada-lugoj-deva-ecoduct-finalizat-7_5ca766444445219c57e240f86/2_5ca76699445219c57e241813.html#photo-head

6.3.8. ECO-DUCT VOLEČ (D11)

Country	Czech Republic
Form	Project
Type	Mitigation measure
Location	Czech Republic, cadastral area: Voleč, GPS: 50.1281814N, 15.5657417E
Field of harmonization	Ecological network and corridors versus infrastructure corridors
Scale	Local
Binding of the measure	Non-binding but recommendatory
Involved sector	Spatial planning; Transport infrastructure
Phase	Monitoring
Financing	State budget, Large Infrastructure Operation Programme
Responsible institution	Road and Motorway Directorate Ministry of Transport Road and Motorway Directorate, Královéhradecký kraj

The eco-duct over the motorway opened on 21 December 2006. It has a total width of 78 m, with a width for the passage of animals of 37 m. The whole bridge is covered with vegetation. It contains measures to reduce noise and traffic lighting. It is surrounded by forest from both sides.

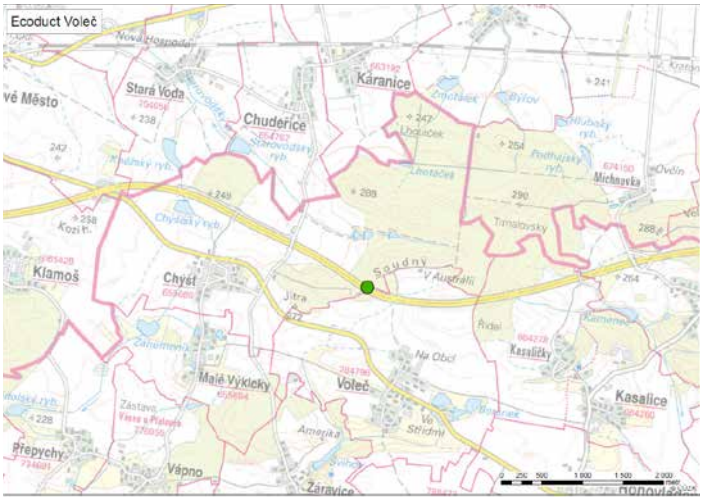

Figure 32. Eco-duct over motorway. Source: http://foto.ceskedalnice.cz/nase-foto/objekt/ekodukt/d11-volec/slides/02.html

6.3.9. RAILWAY BRIDGE UNDERPASS

Country	Czech Republic
Form	Project
Type	Mitigation measure
Location	Czech Republic, cadastral area: Mosty u Jablunkova, 49.5510622N, 18.7361236E
Field of harmonization	Ecological network and corridors versus infrastructure corridors
Scale	Local
Binding of the measure	Non-binding but recommendatory
Involved sector	Spatial planning; Transport infrastructure
Phase	Monitoring
Financing	State budget, EU funds
Responsible institution	Railway Infrastructure Administration Ministry of Transport Railway Infrastructure Administration, Moravian-Silesian Region

It comprised the elaboration of a sufficiently wide grass belt under the railway bridge allowing animal migration.

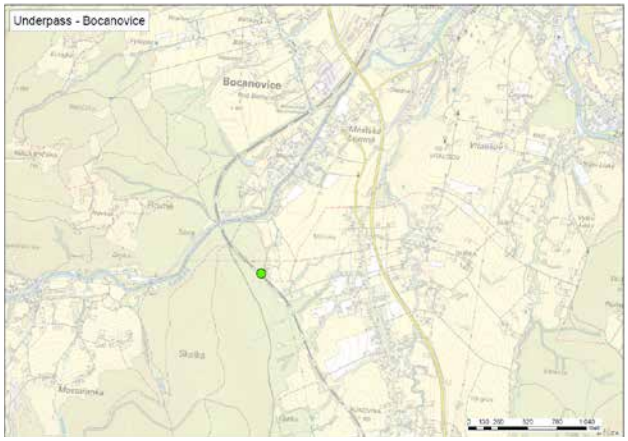

Figure 32a and b. Location and image of the railway bridge. Photo: Danial Mach, https://www.szdc.cz/stavby-zakazky/prehled-projektu/-/projekt/detail/54970973

6.3.10. UNDERPASS AT R1 ŽARNOVICA ŠÁŠOVSKÉ PODHRADIE, SLOVAKIA

Form	Mitigation measures on a highway
Type	Planning
Location	Žarnovica, Slovakia
Scale	Regional (state)
Involved sector	Spatial planning, agriculture, Forestry, Water management, Hunting, Tourism and leisure, Nature protection, Transport, Local population/citizens
Type of countryside	All types
Phase	Construction
Financing	State budget, EU structural fund
Responsible institution	National Highway Company (Slovakia)

The R1, near Žarnovica, is a new segment of a national highway with a length of 8372 m. It was completed in 2011. The new segment, opened in 2011, is located in a cadastral area of the cities Lehôtka pod Brehmi, Horné Opatovce, Lovča, Žiar nad Hronom, and Ladomerská Vieska a Šášovské Podhradie. This segment consists of 10 viaducts and bridges with a total length of 1209 metres.

The longest viaduct, with a length of 239 m, crosses river Hron and pond Lutilský potok, and enables the free movement of animals on ground or in river under the bridge. Fences around the highway are designed to guide the animals to the crossing points across the road to minimize possible road kills.

All bridges are constructed as monolithic concrete structures with four roadways on the top. The measures are targeting connectivity improvement, reduction of biotope fragmentation, and reduction of roadkills.

6.3.11. MAX SPEED LIMITS, CASE OF D1 HIGHWAY BRATISLAVA-TRNAVA, SLOVAKIA

Form	Measure
Type	Planning
Location	Bratislava-Trnava, Slovakia
Scale	Regional
Involved sector	Spatial planning, nature protection, transportation
Type of countryside	All
Phase	Monitoring
Financing	State budget
Responsible institution	National Highway Company

The aim of the initiative was to set a measure to reduce the risk of roadkills and to increase transport security of both persons and cargo. It involved a decrease of the maximal speed limit to 110 Km/h in all three driving lanes. Another part of the measure (for increasing of the security) was the building of 13 stacking areas.

Until the end of November 2010, the National Highway Company created six emergency lanes with a length 60 meters and a width of 3 meters each lane. The next phase of the measure involved

building up of seven emergency islands (until end of June 2011).

Furthermore, the maximal speed limit in the area with emergency islands was decreased in the right driving lane to 80 Km/h. There were mounted traffic signs regulating the minimal distance between vehicles to 70 meters. SOS mobile numbers were added to the milestones for in case of need they can be easily and quickly called upon.

The measure is targeting transport security, reduction of roadkills, and connectivity improvement.

6.3.12. TOAD MIGRATION AND ROAD CLOSURE, ŽELEZNÁ STUDIENKA, SLOVAKIA

Form	Measure – temporary road closure
Type	Planning
Location	Železná studienka, Slovakia
Scale	Local
Involved sector	Spatial Planning, Municipality, Transport, Nature protection, Local population / citizens / volunteers
Type of countryside	Urban forest
Phase	Monitoring
Financing	n/a
Responsible institution	State Nature Conservation, Management of the Small Carpathian PLA

The largest toad loss in the territory of Bratislava was in the area of Železná studienka, a well-known relaxation and recreation area. Annually, a large number of toads ended under the wheels of cars. This problem was solved by Bratislava conservationists through an action titled "Helping the toads during spring migration."

Železná studienka is located on the southern edge of the Protected Landscape Area of the Small Carpathians. The most effective measure to prevent the death of toads in the area was, at the time of migration, the complete closure of the road. One of the most effective measures was the construction of special subways with guiding devices that allow safe passage of the toads down the road. The barriers use red electric foil.

At the same time, transport of visitors is ensured by public transportation. For these reasons, it was not possible to prohibit entry for all motor vehicles. The traffic sign "Prohibition for all motor vehicles" was placed. Its validity goes generally from 20 March to 20 April every year. Vehicle control is provided by police on horseback.

The measure is targeting habitat preservation, mitigation of environmental damages, improvement of biodiversity, transport security, and reduction of roadkills.

6.3.13. FISH PASSAGE AT HYDROELECTRIC POWER PLANT LADCE BY THE RIVER VÁH, SLOVAKIA

Form	Measure – fish passage
Type	Planning
Location	Ladce, Slovakia
Scale	Local
Involved sector	Spatial Planning, Water management, Fishery, Nature protection, Energy
Type of countryside	Water habitat
Phase	Planning, construction
Financing	National
Responsible institution	Slovak water management company, Slovak Energy Company

The waterpower plant Ladce is the oldest operated hydroelectric power station in Váh river — it has been in operation since 1936. However, it was built at a time when electrification was just beginning and the demand for electricity supply was low. Therefore, it was designed for a low flow rate of 120 m3s-1. All hydroelectric plants below — but also over VE Ladce — have higher humidity; therefore, VE Ladce forms the so-called "Narrow throat" on Vah.

In 1999, Ladce was reconstructed to a flow rate of 2 x 90 m3s-1, thereby increasing the installed capacity from 13.8 to 18.9 MW.

The measure is targeting habitat preservation, connectivity strengthening, and improvement and mitigation of environmental damages.

6.3.14. REDUCE OF RISKS AND THREATS ON BIRD POPULATION IN HUNGARY IN RELATION TO TRAFFIC AND ROADS IN THE FRAMEWORK OF PLANNING AND MANAGEMENT PROCEDURES

Country	Hungary
Form	Policy
Type	Analysis, Processual measure; Planning measure
Location	Hungary
Field of harmonization	Ecological network and corridors Ecological network and corridors versus infrastructure corridors
Scale	National
Binding of the measure	Advisory
Involved sector	Spatial Planning, Water management, Fishery, Nature protection, Energy
Phase	Analysis, Planning; Monitoring
Financing	State company
Responsible institution	Land Stewardship Advisory Service of Birdlife Hungary and Hungarian Public Road Non-profit Pte Ltd. Co (Magyar Közút Non-profit Zrt.)

The project was carried out by the Land Stewardship Advisory Service of Birdlife Hungary on behalf of the Hungarian Public Road Non-profit Pte Ltd. Co. in 2005-2006. The project is based on an analysis of former field research and the summarized risk assessment of traffic and road constructions on bird populations of Hungary. The target group of the training included experts and engineers working in the field of road maintenance and environmental protection.

The project was based on the loss of habitats, habitat fragmentation, noise and other disturbances of the traffic negatively affecting the birds. There is currently a low level of information related to the threats on birds and about the possible protection methods and tools. The project intended to introduce a risk assessment approach. The risk of road traffic was evaluated based on the protection level of the bird species, possible effects of the traffic (a large part of the population is destroyed, or the habitat is reduced due to disturbance) and the former surveys. These analyses show which species need to be further assessed. In Hungary, the construction and use of a road poses a great risk on the following species: emperor bird, barn owl, haris, blue grouse, woodcock, owls, barn owl, bustards, and eels. Further development of the risk assessment approach is essential.

6.3.15. TRANSNATIONAL RESEARCH PROGRAMME "ROADS AND WILDLIFE"

Country	Austria, Belgium, Norway, Hungary, Ireland, the Netherlands, Sweden, and the United Kingdom
Form	Project
Type	Institutional and regulation measure
Location	Austria, Belgium, Norway, Hungary, Ireland, the Netherlands, Sweden, and the United Kingdom
Field of harmonization	Ecological network and corridors versus infrastructure corridors
Scale	Transnational
Binding of the measure	Non-binding but recommendatory
Involved sector	Spatial planning; Transport infrastructure
Phase	Planning; Monitoring
Financing	CEDR Conférance Européenne des Directeures des Routes
Responsible institution	Roughan & O'Donovan, Prof, Eugene O'Brien, Arena Road, sandyford ind estate, Dublin 18, Ireland info@harmony.com Tel: 00+353 1 294 0800 Programme Executive Board (PEB) of CEDR, national authorities

In Europe, over the past few decades, there has been a rapidly increasing interest and research into the multi-faceted interactions between roads and the landscape. The issue of habitat fragmentation by infrastructure and its impact on ecological functions in the landscape was greatly enhanced by the emergence of the organization Infra Eco Network Europe (IENE), which was founded at an international symposium in Maastricht in 1995.

CEDR is the Conference of European Directors of Roads. It is a non-profit organisation, created in 2003. The report "Mobility for humans and wildlife – cost-effective ways forward" is the outcome of the work of the CEDR Project Group "Wildlife and Traffic" in collaboration with IENE.

CEDR connected scientists and practitioners for a transnational research programme focusing on cost-efficient road management and mitigation strategies for roads and wildlife in 2013. The call was developed in dialogue with IENE and is funded by Austria, Denmark, Germany, Ireland, Norway, Sweden, the Netherlands, and the United Kingdom. The programme aimed at solving the conflict between wildlife and roads through developing cost-efficient methods for design and maintenance of mitigation structures such as fauna passages.

Three projects were elaborated under the program:

- SAFEROAD – Safe roads for wildlife and people – Cost-efficient mitigation strategies and maintenance practices
- HARMONY – Procedures for the design of roads in harmony with wildlife
- Safe Bat Paths – Fumbling in the dark: Effectiveness of bat mitigation measures on roads

Based on input from IENE experts, COST 341 produced the handbook "Habitat fragmentation due to transportation infrastructure." Widely appreciated by roads authorities, the Handbook was subsequently transformed into national versions in several countries. Although covering all major relevant aspects, the original COST 341 Handbook only superficially treated maintenance of mitigation measures and did not address the role of procurement of road structures, mitigation measures and their maintenance. The objective of the Harmony project is to address these three key issues missing from the original COST 341 Handbook.

The main goals of Harmony are:

- To provide guidance on a consistent approach to Environmental Impact Assessment (EIA) and Appropriate Assessment (AA).
- To provide guidance on methods of procurement of road projects and mitigation measures.
- To provide best practice recommendations for the maintenance of roads and mitigation measures.

Main deliverable: Guidelines (https://3e370274-79bf-479a-be0a-690637f02a27.filesusr.com/ugd/1cba1b_2d5724abcc834b2fbee1a69ea3f54c91.pdf)

The report is divided into three main parts, corresponding to Tasks 4.1, 1.4 and parts of Task 0.2 of the Harmony project. In the first part of the report (Section 2), existing and forthcoming legislation and guidance for road schemes across Europe are examined and guidance is provided based on the best practice that returns the greatest level of success and effectiveness. The Section is divided between Environmental Impact Assessments (EIA), made necessary under the EIA directive, and Appropriate Assessments required due to the Habitats and Birds Directives. The objectives of Section 2 are necessary in that no available European wide guidelines have been produced for the compilation of EIAs and Appropriate Assessments specifically for road schemes outside of COST 341. The countries whose national legislation and procedures were examined as a means to provide best practice guidelines are the eight reference countries of Austria, Belgium, Denmark, Hungary, the Republic of Ireland, the Netherlands, Sweden, and the United Kingdom. Section 3 of this report aims to give insight into the current approach to Project Appraisal for transport projects across Europe concentrating on national road projects. The nations considered in this section are the eight reference countries mentioned above, as well as Germany. The section concentrates on how each country's Project Appraisal gives due consideration to biodiversity among the factors included in the Appraisal. The section then discusses the manner in which each nation strives to strike the balance between the requirements to protect wildlife and other factors such as economy, safety, and society. The section concludes with a recommendation of the Appraisal Process which best encompasses biodiversity.

https://www.harmony-project.net/deliverables

6.3.16. MONITORING OF EFFECTIVENESS OF BIRD PROTECTION WALLS ALONG MOTORWAY M3 BETWEEN OSZLÁR – POLGÁR

Country	Hungary
Form	Project, hard measure
Type	Mitigation measure
Location	Hungary, motorway M3 Oszlár-Polgár
Field of harmonization	Ecological network and corridors versus infrastructure corridors
Scale	Local
Binding of the measure	Non-binding but recommendatory
Involved sector	Spatial planning; Transport infrastructure
Phase	Monitoring
Financing	State budget, EU funds
Responsible institution	Land Stewardship Advisory Service of Birdlife Hungary and Hungarian Public Road Nonprofit Pte Ltd. Co (Magyar Közút Nonprofit Zrt.)

The effectiveness of bird protection walls along motorway M3, between Oszlár and Polgár, were monitored and assessed on 2003-2004 by the Land Stewardship Advisory Service of Birdlife Hungary on behalf of Hungarian Public Road Nonprofit Pte Ltd. Co (Magyar Közút Nonprofit Zrt.).

The bird protection walls: 3 m high, loose wooden structure of monolayer (light filters through the gaps), approx. 1.5 m far from the roads. The walls were constructed along motorway sections on elevated level. The survey is focusing on four sections, from which three were settled in important migration routes and one in a resting area of migration routes.

The behaviour of birds was surveyed and assessed in the direct vicinity of the motorway and the influencing factors were explored (geography, vegetation, sources of food). Furthermore, bird species in the 400-400 m wide section of the motorway were assessed to define those species which stay far away from the road.

Figure 33a and b. Map of the survey area (right) and photo with the bird protection walls (below).

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Interreg
EUROPEAN UNION
Danube Transnational Programme
ConnectGREEN

ConnectGREEN DTP2-072-2.3

Restoring and managing ecological corridors in mountains as the green infrastructure in the Danube basin

Project partners

Romania: WWF Romania (Lead Partner) · National Institute for Research and Development in Constructions, Urban Planning and Sustainable Spatial Development · Piatra Craiului National Park Administration

Austria: WWF Central and Eastern Europe

Czech Republic: Nature Conservation Agency of the Czech Republic · Silva Tarouca Research Institute for Landscape and Ornamental Gardening

Hungary: CEEweb for Biodiversity · Hungarian University for Agriculture and Life Sciences (formerly Szent Istvan University)

Slovakia: Slovak Environment Agency · The State Nature Conservancy of the Slovak Republic · Slovak University of Technology in Bratislava – SPECTRA Centre of Excellence of EU

Serbia: Institute of Architecture and Urban & Spatial Planning of Serbia · National Park Djerdap

Associated Strategic Partners

Czech Republic: Ministry of the Environment · Ministry of Regional Development of the Czech Republic

Hungary: Bükk National Park Directorate

Romania: Ministry of Environment of Romania

Serbia: Ministry of Environmental Protection of the Republic of Serbia

Slovakia: Ministry of Transport and Construction of the Slovak Republic

Ukraine: Ministry of Ecology and Natural Resource of Ukraine

Austria: Danubeparks – Danube River Network of Protected Areas

France: Alpine Network of Protected Areas – ALPARC

Montenegro: Parks Dinarides – Network of Protected Areas of Dinarides

Pilot Areas

1. Piatra Craiului National Park – Bucegi Nature Park (Romania)
2. Apuseni-SW Carpathians (Romania) / National Park Djerdap (Serbia)
3. Western Carpathians (Czech Republic – Slovakia)
4. Bükk National Park (Hungary) / Cerová vrchovina Protected Landscape Area (Slovakia)

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Budget

Overall Budget: 2,603,415.83 EUR
ERDF Contribution: 2,040,010.84 EUR
IPA Contribution: 172,892.55 EUR

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