Green Infrastructure for the Alpine Space: from theory to practice

Deliverable D.T1.1.1- State of the art overview on existing ESS studies as connected to specific GIs in the Alpine space and pilot regions.

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Contents

What is LUIGI?

"Linking Urban and Inner-Alpine Green Infrastructure: Multifunctional Ecosystem Services for more liveable territories" (LUIGI) is a 33-months project funded by the European Union (EU) through the Interreg Alpine Space (AS) programme. The project involves 14 partner institutions and 26 observers from Austria, France, Germany, Italy, Slovenia, and Switzerland.

By recognizing the anthropogenic pressures on Alpine Space ecosystems and the benefits that those deliver to a wider area beyond mountain regions, **LUIGI aims to strengthen the link between mountain ecosystems and urban centers at the foot of the Alps, based on sound economic and social exchanges**. The LUIGI project seeks to i) recognize the benefits deriving from a green infrastructure (GI) network developed between mountain/rural and urban areas, ii) valorize their potential for a sustainable economic development, and iii) contribute to assuring higher quality of life harnessing the benefits deriving from the natural capital. The project targets actors involved along the urban/rural value chain, civil society, planners, and policy makers in order to foster investments, planning, and the maintenance of GI throughout the Alpine Space territory. LUIGI will provide guidance to support, among other things, i) the development of GI networks , ii) the assessment/evaluation of the environmental, social and economic benefits deriving from GI iii) effective and innovative governance and management of GI, and iv) the development of business models around the societal benefits of GI, and the mobilization of financial resources to support them.

LUIGI meets the priority of the Alpine Space programme of achieving a liveable Alpine Space, and especially its objective to enhance the protection, the conservation, and the ecological connectivity of Alpine Space ecosystems. The project is furthermore aligned with the objectives of the EU strategy for the Alpine Region (EUSALP), which aims to ensure sustainability in the Alps, and, more specifically, to develop ecological connectivity in the whole EUSALP territory.

The first Work Package

The first work package of the project "LUIGI" will spotlight the multiple benefits (ecological, economic, social, and cultural) of GI as a "common natural capital" and an ecosystem services provider. Its main output will be to illustrate the state of the art and delineate guidelines for the conservation and the enhancement of the provision of multiple ecosystem services deriving from GI. More specifically, it aims to provide a summary of existing knowledge and best practices on ecosystem services, GI design, and their interaction within the Alpine Space and the pilot regions. The results will feed into the other work packages and support all project activities.

Part A-The concept of Green Infrastructure

Introduction

This is the first deliverable of the first work package of the Interreg Alpine Space project "LUIGI- Linking Urban and Inner-Alpine Green Infrastructure: Multifunctional Ecosystem Services for more liveable territories". It aims to provide essential information about Green Infrastructure in the Alpine region to LUIGI stakeholders and project partners, or to whoever wishes to understand and apply this concept. It seeks to help public authorities, decision-makers, practitioners, and researchers to plan and manage Green Infrastructure (GI) networks in the Alpine Space. This deliverable is presented as a handbook, divided in two parts, focusing on key notions underlying the GI concept in the European Union and in the Alpine region, and on the benefits deriving from the establishment of a GI network.

Part A explains what ecosystem services and Green Infrastructure are, illustrates the role of Green Infrastructure in European policy, in the EUSALP macroregional Strategy, and in the Alpine Space programme, and presents past EU-funded project on GI.
Part B focuses on how to translate the GI framework into practice, i) highlighting important ecological and socio-economic principles that can guide a GI network development, and ii) describing the most common and important GI components found in the alpine region and spotlighting their associated ecosystem services.

Read **part A** of this deliverable to know:

What are ecosystem services and why are they important?
What is green infrastructure? Which criteria should it meet?
What does a GI network look like?
What is the European Union vision for GI?
How would a GI network help harness synergies between different EU policies?
What is the European Union doing to support GI in the Alpine Space?
Which European funded projects have dealt with GI before?

Read **part B** of this deliverable to know:

How can the structure of a GI network maximise the benefits I get?
Why is connectivity important for biodiversity?
Who should get involved in planning and managing a GI network?
Which are the economic benefits I could get out of a GI network?
Which are common and/or important GI components in the Alpine Space?
Which ecosystem services do those GI components provide to the community?

1. Harnessing the benefits of nature

From ecological structures to human benefits

Humans, just as any other species of the planet, rely on their surrounding environment to access food, shelter opportunities, and energy sources. Complex human structures have developed over time and, although the relation between nature and societal products might not always be as direct as it used to be, humans still rely on nature and its resources. We gain from the natural capital around us food, materials, energy, and an environment where we can relax, have fun, and get inspiration for science, art, and religion. Our societies exist as they are thanks to the fact that wetlands filter water and mitigate floods, that bees pollinate flowers and crops, or that forests regulate the climate, limit natural hazards, and provide wood. **Humans societies, and all other species, need nature and functioning, healthy ecosystems in order to live well**.

The cascade model (Young & Potschin, 2011) summarized in figure 1 can help better understand the benefits flowing or "cascading" from nature to humans. Ecological structures or processes such as forests, wetlands or meadows set the conditions for ecological functions to take place, such as the growth of wood, the slow passage of water or the flight of bees looking for nectar. Such **ecological functions give origin to ecosystem services**, **from which humans derive benefits**. Wetlands provide, for example, the service of regulating floods, and this benefits society by reducing flood danger to the point that humans are willing to pay for wetland protection or flood protection measures. Forests provide, among others, the service of fuelwood, and since humans benefit from the heat it produces, they are often willing to buy it. Meadows support bee populations, for example, which fly from flower to flower collecting nectar, and by doing this they benefit society by pollinating flowers and enabling fruits to grow and beautiful flowers to persist. Ecosystem functions would occur even if humans were to disappear, but ecosystem services have been conceptualized only because these ecosystem functions benefit humans and can create a demand in our society.

One of the many reasons why humans should take care of ecosystem functions, and the forests, wetlands and meadows that support them, is because otherwise we would not be able to receive all the benefit nature has provided us for millennia. **Ecosystems indeed need to be "functional" and in good condition in order to be able to support ecological functions and provide multiple ecosystem services to humans.** Different drivers of change, such as urbanization or conservation efforts, can over time directly or indirectly have positive or negative impacts on ecosystem conditions. A moderate use of ecosystem services is usually positively related to ecosystem condition, but an intensive use of provisioning ecosystem services has mostly negative impacts on ecosystem condition, and results in ecosystem degradation (MAES et al, 2018).

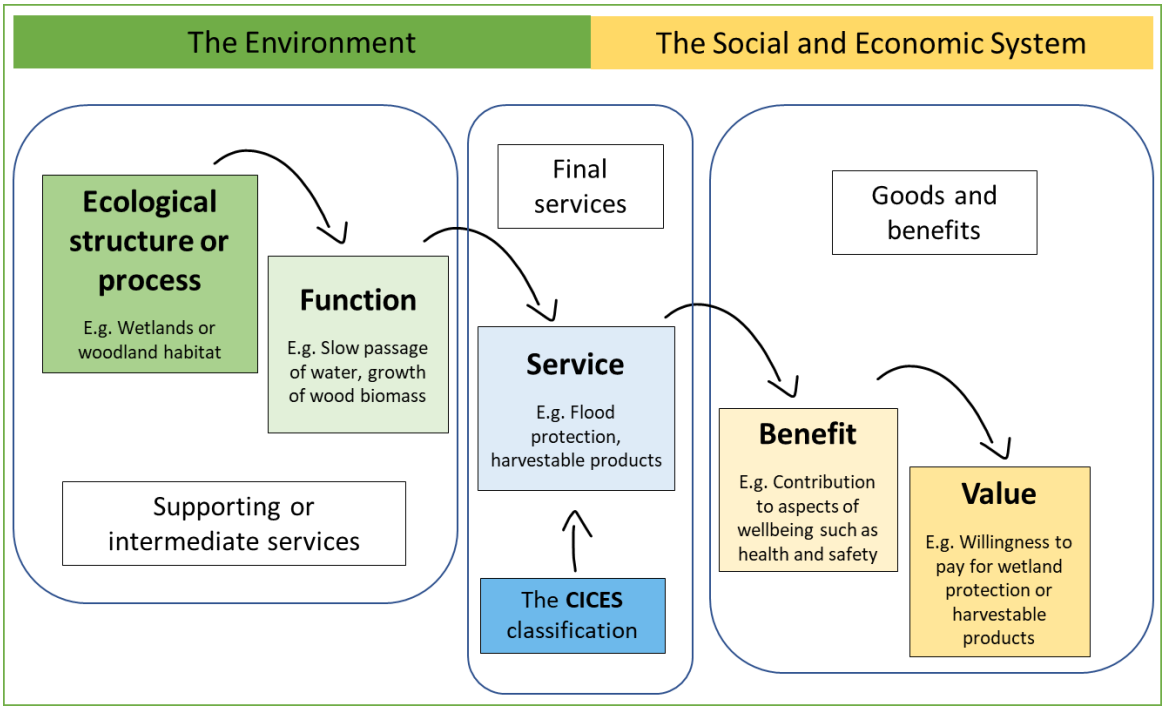

Figure 1. A graph illustrating the cascade model, adapted from Potschin, M. and R. Haines-Young (2016).

So, what are Ecosystem Services (ESS)?

Ecosystem services (ESS) are the benefits people obtain from ecosystems (MEA, 2005). These are the environmental, social, and economic benefits that humans receive for free from healthy and functioning ecosystems. Humans are dependent on the flow of these services, which represent the foundation of our society: valuing these life-supporting services in economic terms is not an easy task.

There are multiple ways to classify, measure and assess ecosystem services. According to the Common International Classification for Ecosystem Services (**CICES**), a classification system developed from the work on environmental accounting undertaken by the European Environmental Agency (EEA 2019), and based on the Millennium Ecosystem Assessment (MEA) and The Economics of Ecosystem and Biodiversity (TEEB), ESS are grouped into three main categories:

- **Provisioning services** such as food, water, timber, and fibres provision,
- **Regulatory and maintenance services** such as climate, flood, waste, and water quality regulation, or soil formation, photosynthesis, and nutrient cycling,
- **Cultural services** such as the provision of recreational, aesthetic, and spiritual benefits.

➔ The Interreg AS project AlpES focused on assessing and mapping the supply, the demand and the flow of certain ESS in the Alpine Space. Check this project to know more about ESS in the Alps!

What is Green Infrastructure (GI)?

Nature offers a whole range of benefits to humans for free, such as food, materials, water filtration, pollination, recreation opportunities, and many others. **These benefits could be further enhanced and harnessed by integrating the protection of natural processes in spatial planning and development**. This would be valuable because healthy and functional natural areas represent a winning tool for the simultaneous provision of ecological, economic, and social benefits to our communities. The European Union definition of Green Infrastructure (GI) is indeed based on the idea of consciously integrating the protection and the enhancement of natural processes in spatial planning and territorial development.

The 2013 European Commission communication *Green Infrastructure- Enhancing Europe's Natural Capital* defines GI as

> "a **strategically planned network** of natural and semi-natural areas with other environmental features designed and managed to **deliver a wide range of ecosystem services**.
>
> It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features and terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings."

There is not one widely recognized definition of GI among the scientific literature, therefore within the LUIGI project we chose to follow the **EU definition** and approach. This is because i) GI are understood according to this definition in a number of other EU policies and directives implemented in the Alpine Space territory, and ii) we share the idea that functional and healthy environmental features should be preserved and harnessed by multiple sectors of society.
To avoid misunderstandings, it should be pointed out that Green Infrastructure is also sometimes called ecological or green network, and that the GI concept sometimes overlaps with already existing notions in the fields of urban planning and architecture, such as green wedges or greenways (Turner, 1998).

Multifunctional natural solutions

Green Infrastructure often offers valid alternatives to widely used man-made, "grey" infrastructure that fulfils only one function at the time, such as drainage or transport. **Natural solutions are indeed multifunctional, meaning that they are** "**able to perform several functions and provide several benefits on the same spatial area**" (EEA, 2017). These functions could be environmental (e.g. conservation of biodiversity or adaptation to climate change), social (e.g. provision of green space or shade in summer), and economic (e.g. supply of jobs and development of business opportunities).

For example, while a draining pipe only transports rainwater, a **swale** also offers water quality treatment using natural processes, buffers peak flows, provides habitat, and makes the neighbourhood more appealing. Likewise, a **riverwalk** can provide habitat to many species, regulate the speed of the river flow, and create space and opportunities for businesses, social activities, low-emission transport like cycling, and others.

Multifunctionality allows to use space and resources in an efficient way, providing most of the time cost-efficient, win-win solutions to several policy requirements and societal needs. Moreover, the multi-functionality framework allows to reconsider and bring added benefits to existing green assets that were previously managed around a single purpose. **GI networks can be designed and managed to maximise the quality and quantity of the functions they support and the multiple ecosystem services they provide**.

This infographic developed by the MagicLandscapes Interreg Europe project illustrates some examples of the multiple functions and benefits supported by GI:

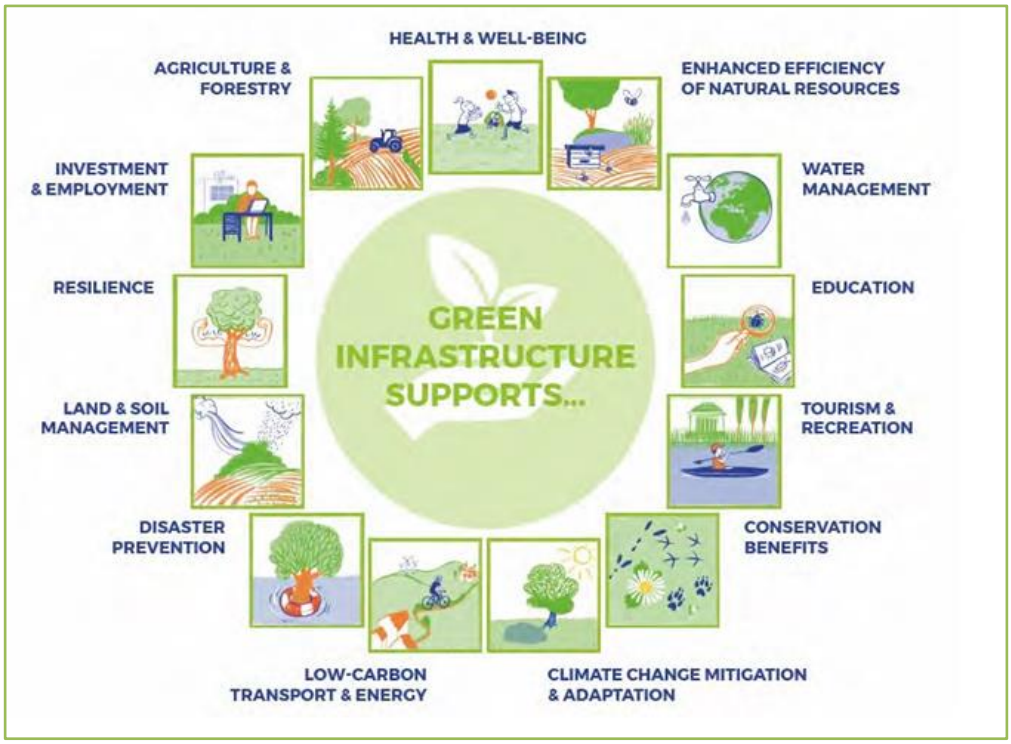

Figure 2. The multiple benefits of Green Infrastructure in John, Neubert and Marrs (2019)

A smart conservation approach

GI aims to enhance the ability of nature to deliver multiple ecosystem services by ensuring that its ecosystems are functional and in healthy state. Given that the scope of green infrastructure is to harness the benefits of nature, this entails also restoring and strengthening ecosystems and their services (EEA, 2011). The multifunctionality of GI links the concept of ecosystem services to the necessity of strategically planning green and open spaces (John, Marrs and Neubert, 2019). GI indeed represents a conceptual tool for designing and managing a large variety of ESS (Di Marino et al., 2019).

Green infrastructure supports socio-economic functions without undermining ecological processes. GI indeed plays a key role in conserving and enhancing ecosystems, their connectivity, and the ecosystem services they provide. By maintaining healthy environmental features, GI allows to exploit the services they provide to improve the environment quality of our air, water, and land, halt biodiversity loss, reduce the risk of natural disasters, mitigate and adapt to climate change, and create sustainable cities and communities, among others (EEA, 2011).

Establishing a functioning GI network represents a "smart" approach to conservation, which integrates nature conservation with land development, growth management and built infrastructure planning throughout the landscape (Benedict & McMahon, 2002). Smart conservation addresses the problem of urban sprawl and habitat fragmentation in a holistic way, planning and investing on GI networks strategically, with inputs from diverse professional practices and from the public, to include ecological, social, and economic benefits, functions, and values.

Within the LUIGI project, the **multifunctionality of natural areas allows to harness the economic value of several ESS and functions** to develop business models and financing opportunities that can enable the protection and the enhancement of the whole GI network. **GI provides a framework to assess the spatially explicit delivery of ESS**, to show the benefits and deficits of such services on a local level, and to identify exploitable synergies between ESS. This quantitative and practical approach to managing green assets and their socio-ecological impact makes GI a useful concept for public authorities and policy makers in the Alpine Space and beyond.

What does a GI look like?

There is not a specific description of what Green Infrastructure looks like: GI components can be very different from one other, they can be found in urban, peri-urban and rural areas, and the GI network they establish can range from the scale of a neighbour or city, to that of a large transboundary area such as that of the Alps mountain range. Many **different environmental features can be part of GI**, but they must be fulfilling the following criteria: **i) they should be part of an interconnected network** and not stand in isolation (e.g. a line of trees linked to other features vs a single tree) and **ii) they should be functional and in a healthy state** which allows them to deliver multiple ecosystem services.

This graphic from the EU Commission illustrates only some examples of what potential components of GI could be:

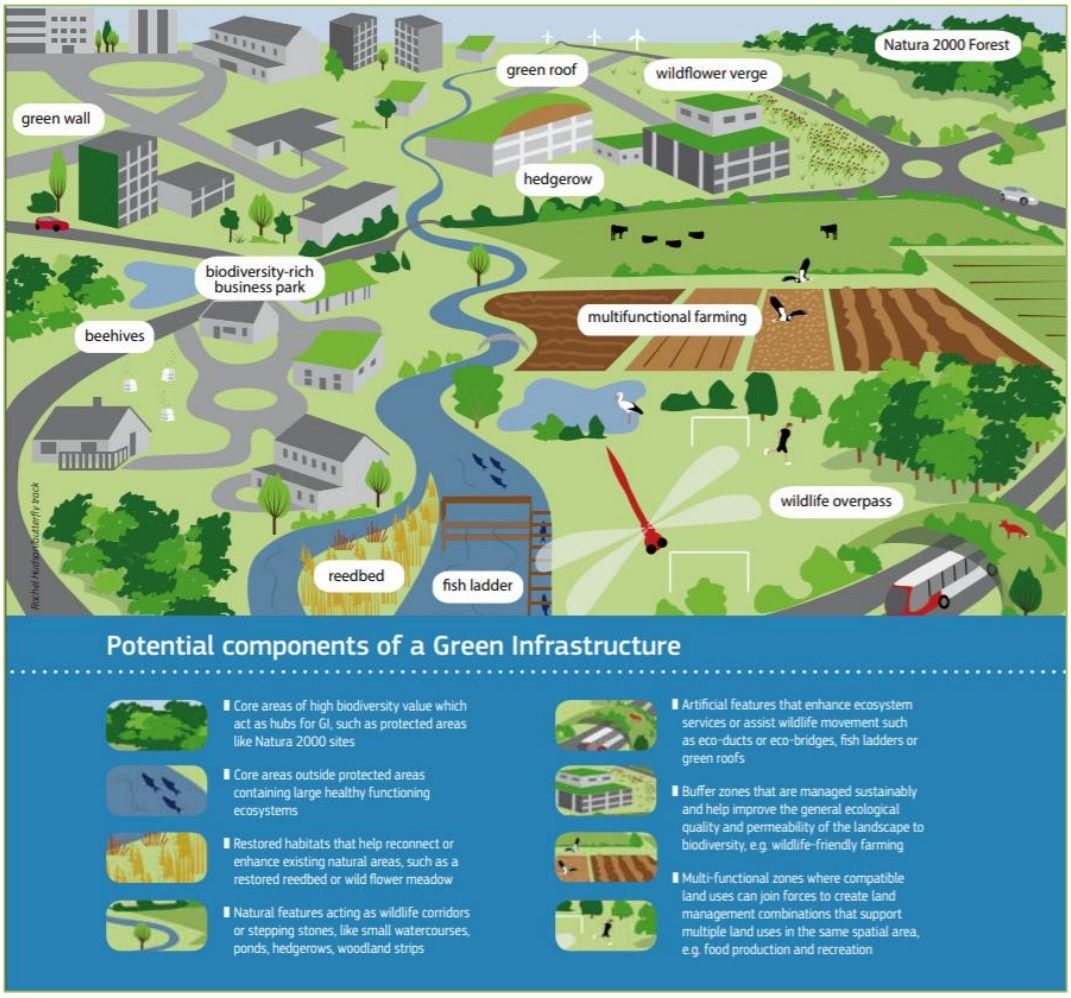

Figure 3. Components of Green Infrastructure. European Commission, 2013, in Building a green infrastructure for Europe. Publ. Office of the European Union, Luxembourg.

Natural areas of special relevance or protected by EU legislation, such as **Natura 2000 sites**, can represent the backbone of a GI network. Large, healthy, and functioning ecosystems both inside and outside protected areas, such as a Natura 2000 forest, can indeed act as core areas. Natural or artificial **connectivity features** such as hedgerows or wildlife overpasses can allow species to move through hostile landscape and reach mates, shelter, and food. Also **sustainably managed areas**, such as low-intensity and High Nature Value (HNV) farmland, can be considered a GI component as they improve the overall ecological quality of the area, provide favourable habitat to many species, and enable them the move freely throughout the landscape.

Further read:

- An approachable learning module on ecosystem services developed by ALPES, featuring an introductory video:
  http://www.alpeselearning.eu/b-1-what-are-ecosystem-services/

- The website where you can learn more about the CICES classification (and download the table):
  https://cices.eu/cices-structure/

- A short, readable overview brochure from the EU Commission:
  "Building a green infrastructure for Europe"
  https://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf

- A seminal scientific paper on the concept of multifunctionality:
  Hansen & Pauleit (2014). From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for Urban Areas. AMBIO, 43:516–529. An in-depth report of the EU commission (DG ENV) on Multifunctionality: "The Multifunctionality of Green Infrastructure" (2012)

- A practical example of how to use nature for a sustainable management of surface water:
  https://www.susdrain.com/

"The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services."

(Millennium Ecosystem Assessment, 2005)

2. GI in the EU

Green Infrastructure in European Policy

The European Union Strategy on Green Infrastructure

In 2013, the European Commission developed the **European Union Strategy on Green Infrastructure** in order to **protect and improve Europe's natural capital**, promote the **deployment of green spaces** across the European Union, and **mobilize investments** to encourage actions at all levels. More specifically, the strategy i) promotes GI in the main policy areas, ii) improves information, strengthening the knowledge base and promoting innovation, iii) improves access to finance and iv) fosters EU-level GI projects. The strategy was adopted in response to the commitments taken by the European Commission in the Resource Efficiency Roadmap and in the EU Biodiversity Strategy to 2020.

The **Resource Efficiency Roadmap** defines the objectives and the means needed to achieve the goals of the "Europe 2020" strategy, which **aims for a "smart, sustainable and inclusive growth**[1]" in the European Union. The Roadmap reports that the failure to protect the natural capital and to proper value ecosystem services must be tackled and indicates that investments in green infrastructure are an important step towards the achievement of this goal.

The **European Biodiversity Strategy to 2020** was adopted by the European Commission in 2011 in order to implement the commitments taken the previous year at the Convention on Biological Diversity. The headline target of the strategy is to "halt the loss of biodiversity and ecosystem services by 2020, to restore ecosystems in so far as is feasible, and to step up the EU contribution to averting global biodiversity loss". The strategy is developed around six targets, each linked to a set of supporting actions. **Target 2 of the strategy aims at maintaining and restoring ecosystems and their services through the inclusion of green infrastructures into spatial planning and the restoration of degraded ecosystems**. With such actions, the strategy aims to increase economic, territorial, and social cohesion, and ensure an increased connectivity between habitats and Natura 2000 areas, safeguarding ecosystems´ functions and the multiple services they provide to human society.

More specifically, **Target 2** is meant to be achieved through the following actions:

- Action 5: mapping and assessment of the state and the economic value of ecosystems and their services in the entire EU territory.
- Action 6: restoring ecosystems, maintaining their services, and promoting the use of green infrastructure.
- Action 7: Assessing the impact of EU funds on biodiversity and investigating the opportunity of a compensation to avoid the loss of biodiversity and ecosystem services.

The key role of green infrastructure for the protection of the EU's natural capital is clearly mentioned in target 2, but the deployment of GI is crucial also for the other five targets of the EU Biodiversity Strategy to 2020. The synergies are particularly relevant with Target 1, which implements the **Birds and Habitats Directives** and aims to prevent further loss of biodiversity and to fully restore European habitats. The

Natura 2000 network, established mainly to conserve key species and habitats across the EU in response to the Birds and Habitats Directives, **indeed constitutes the backbone of the EU Green Infrastructure network**. The objectives of the EU Biodiversity Strategy to 2020 have been confirmed and endorsed by the **EU Biodiversity strategy to 2030**, which emphasized the need of a trans-European GI network and the importance of GI for climate adaptation and green urban ecosystems. The European commission communication on the Strategy, also indicates that in order to meet the goals of the strategy, including investment priorities for Natura 2000 and green infrastructure, at least €20 billion a year should be unlocked for spending on nature.

GI contribution to other EU policies and international agreements

GI supports the achievement of several other key EU policy objectives by contributing significantly to the policy areas of regional development, climate change, disaster risk management, agriculture, forestry, and environment. On a regional level, GI is identified as a priority for investments both in the **Cohesion Fund and in the European Regional Development Fund** (ERDF). The reason behind this is the ability of GI to create a sense of community in urban areas, to strengthen the link with voluntary actions and to help fight social exclusion and isolation through the provision of appealing places to live and work in.

The EU Strategy on Adaptation to Climate Change prioritizes and encourages cross-sectoral, transregional and cross-border projects on GI and ecosystem-based approaches to climate change adaptation and disaster risk management. This strategy endorses the goal of the United Nations Framework Convention on Climate Change (UNFCCC) to bring together all nations in the common objective of reducing greenhouse gas emissions and increase the resilience and adaptation of ecological, economic, and social systems to the changing climate. The need of making cities and communities more safe, resilient, and sustainable, while preserving the environment and land resources, is indeed a major global challenge, which is spotlighted by the 11th United Nation Sustainable Development Goal. Green Infrastructure is one of the most widely applicable, economically viable and effective tools to reduce the impacts of climate change, such as the heat island effect in urban areas or the risk of natural disasters. The 2007 **EU Floods Directive** describes how **natural flood measures such as GI can cost-effectively reduce the damage of floods and droughts** by exploiting nature's own capacity to absorb and store water, restoring wetlands, floodplains, and reservoirs along river catchments.

The UNFCCC delegates all countries to promote the sustainable management, the conservation and enhancement of sink and reservoirs of all greenhouse gasses, including biomass, forests, and oceans, as well as other terrestrial, coastal, and marine ecosystems. **Land Use, Land Use Change and Forestry** (LULUCF) **activities play a significant role in controlling the global carbon storage**, therefore "GI initiatives in agriculture and forestry sectors that have a positive effect on carbon stocks and the greenhouse gas balances" are greatly encouraged. Moreover, nature-based solutions, such as **green roofs and walls, help reduce greenhouse gas emissions from the building sector and contribute to the Energy Performance of Buildings Directive**, which promotes the use of new and more resilient materials and design features in building construction.

The Environmental Action Programme to 2020 states that GI can play and important role in protecting, conserving, and enhancing the EU's Natural Capital such as land, soil, and water. The way agricultural

and forestry land is managed indeed impacts the degree to which Natural Capital will be available to future generations. The **Common Agricultural Policy** (CAP) "provides instruments and measures to encourage the enhancement of GI and high-nature value areas in the countryside", even if it does not explicitly include the GI concept. The **Forestry Strategy** addresses the achievement of the forest sub-target of the Biodiversity Strategy. It calls for measures that i) contribute to reduce forest fragmentation and degradation, and ii) aim at maintaining and enhancing forest ecosystems' resilience and multifunctionality. GI contributes to these objectives "by providing a coherent framework within which natural features are conserved and enhanced in forest areas". Moreover, GI supports the implementation of the **Water Framework Directive** by filtrating run-off and storm water, mitigating hydro-morphological pressures, and reducing water-related natural hazards such as floods and droughts.

In general, the contribution that GI can make to several policy areas is already acknowledged, but further effort is needed to ensure its application in spatial planning and territorial development decision making processes.

The EU GI Strategy so far

In 2019 the European Commission conducted a **review of the progress of the implementation** of **the EU Green Infrastructure strategy**, describing the challenges, lessons and recommendations encountered since the launch of the strategy. It was found that several national biodiversity strategies and plans include references to GI, but that this approach is generally not used to its full extent, as only a couple of member states have adopted national strategies specifically dedicated to GI**. More needs to be done to promote strategic and integrated programmes, and to highlight the multiple socio-economic benefits of using green instead of grey infrastructures**. Several funding mechanisms are in place to support GI investments, but access to finance needs to be improved, given that, for example, EU financing instruments are not fully used.

Although GI and nature-based solution are cost-efficient policy tools and have the potential to benefit the environment and climate, specific actions on the ground are still insufficient. For example, compulsory greening practices introduced under the CAP in 2015 are unlikely to provide significant benefits for biodiversity as they currently are implemented. **The deployment of GI needs to be further scaled up, and a more strategic approach to GI at EU-level would have the potential to provide greater benefits per euro invested than the current GI policy implementation**. Transnational projects such as the European Green Belt or the Lower Danube Green Corridor represent good examples that allow to achieve the full potential of GI.

Further read:

- The European commission webpage on the EU Green Infrastructure Strategy: https://ec.europa.eu/environment/nature/ecosystems/strategy/index_en.htm
- The official European commission communication on the EU Biodiversity Strategy to 2030: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0380

Implementing the EU green infrastructure strategy in the Alpine Area

The EU Macro-regional strategy for the Alpine Region

The implementation of EU legislation and policies is supported, among other tools, by EU macroregional strategies and EU funds such as the European Structural and Investment Funds.

The **EU Strategy for the Alpine Region** (EUSALP) is the Macroregional strategy for the Alpine area endorsed by the European Council. It **aims to address common alpine challenges** such as economic globalization, demographic trends, climate change, and the energy transition, **by strengthening the cooperation among member states and third countries located in the Alpine Area**. EUSALP comprises of Austria, Slovenia, Switzerland and Liechtenstein, and several German, French, and Italian alpine regions. EUSALP represents an opportunity to improve the cross-border cooperation of Alpine states, identify and implement more effectively common goals, thus achieving economic, social, and territorial cohesion.

In order to ensure that the Alpine region remains one of the most attractive areas in Europe, EUSALP focuses on the following policy areas: i) economic growth and innovation; ii) mobility and connectivity; iii) environment and energy; iv) governance, including institutional capacity. Nine action groups then work under such policy areas to achieve further specific objectives. **Action group 7, for example, aims to develop ecological connectivity in the whole EUSALP territory as part of the "Environment and Energy" thematic policy area**.

The **Alpine Space (AS) programme is the transnational cooperation programme for the Alpine region**, and it provides a framework to facilitate the cooperation among key players at various institutional levels in seven Alpine countries. The programme is financed through the European Regional Development Fund (ERDF) and national public and private co-funding. Calls for projects proposals launched by the programme are defined by key thematic fields of cooperation, identified by partner states and the European Commission, in line with the priorities of the European Union and of the EU Strategy for the Alpine Region.

One of the four thematic fields identified for the period between 2014 and 2020 is the priority "Liveable Alpine Space", which focuses on how to valorize and protect the unique natural and cultural heritage of the Alpine Region. The two objectives of this priority are to sustainably valorize Alpine Space cultural and natural heritage, and to **enhance the protection, the conservation, and the ecological connectivity of Alpine Space ecosystems.** The focus of the LUIGI project is aligned with the second objective of this priority.

Enhancing ecological connectivity and ameliorate, strengthen and restore biodiversity as well as the provision of ecosystem services in the alpine areas is therefore supported by the Alpine Space transnational cooperation programme, the EU Strategy for the Alpine Area, the EU Green Infrastructure Strategy, the EU Biodiversity Strategy to 2020, several other EU directives, and international frameworks such as the UN Sustainable Development Goals.

EU funded projects on Green Infrastructure and Ecosystem Services

Past projects in the Alpine Space and beyond

Project Acronym	Framework programme	Period	Description
GRETA	ESPON	2017-2019	**Title:** Green infrastructure: Enhancing biodiversity and ecosystem services for territorial development **Geographic scope:** European Union **Description :** the project reviewed benefits and challenges of ESS and GI; characterized in physical and functional terms the distribution of GI in the EU; spatially analysed the synergies and trade-offs for GI; analysed the policy context for GI implementation; and looked at case studies and best practices to finally develop policy guidelines and practice briefings.
ESMERALDA	Horizon 2020	2015-2018	**Title:** Enhancing ecoSysteM sERvices mApping for poLicy and Decision mAking **Geographic scope:** European Union **Description:** the project developed a stakeholder involvement process, developed, and tested a flexible ESS mapping, valuation, accounting- and an integrated assessment framework methodology at different spatial and temporal scales. Developed an online data sharing system for maps, defined a set of practical policy recommendations as well as recommendations for future development and implementation of policies.
ECOPOTENTIAL	Horizon 2020	2015-2019	**Title:** Improving future ecosystem benefits through earth observations **Geographic scope:** European Union **Description:** the project harnessed earth observations from remote sensing and field measurements to assess and model present and future ecosystem functions and services across ecosystems, landscapes and regions.
LifeSAM4CP	LIFE +	2014-2018	**Title:** Soil administration model for community benefit **Geographic scope:** natural, rural and “unsealed” land

			Description: The project developed a digital simulator to ensure a good land use planning and to promote land use decisions that help reduce the use of soil and the preservation of its ecosystem functions.
OpenNESS	Seventh Framework Programme (FP7)	2012-2017	**Title:** Operationalisation of Natural Capital and Ecosystem Services **Geographic scope:** European Union and beyond **Description:** the project translated the concept of Natural Capital and Ecosystem Services into operational frameworks that provide tested, practical, and tailored solutions for informing sustainable land, water and urban management and decision-making. It examined how the concepts link to, and support wider economic, environmental, and social European policy initiatives and investigated its potential and limitations.
OPERAs	Seventh Framework Programme (FP7)	2012-2017	**Title:** Operational Potential of Ecosystem Research Applications **Geographic scope:** European Union and beyond **Description:** this research project put ecosystem science to practice, provided stakeholders with user-friendly tools and instrument, worked across ecosystems in exemplar case-studies, engaged with stakeholders and, finally, worked with OpenNESS to develop an open platform for collaboration between communities of science, policy and practice. This online hub brings together innovations in nature-based solutions from across Europe
GREEN SURGE	Seventh Framework Programme (FP7)	2013-2017	**Title:** Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy **Geographic scope:** European Union **Description:** the project identified, developed, and tested ways of linking green spaces, biodiversity, people, and the green economy to meet the major challenges related to land use conflicts, climate and demographic changes, human health, and wellbeing. Provided evidence for urban green infrastructure planning and implementation and explored the potential for innovation in better linking environmental, social, and economic ecosystem services with local communities.
SWARE	Interreg Europe	2016-2021	**Title:** Sustainable heritage management of WAterway REgions

			Geographic scope: European inland waterways **Description:** the project aims to foster an integrated management of inland waterway systems which enhances the synergies between the protection and the sustainable use of natural resources and cultural heritage by transforming and improving regional policies.
MaGICLandscapes	Interreg Central Europe	2017-2020	**Title:** Managing Green Infrastructure in Central European Landscapes **Geographic scope**: The whole territory of Central Europe (AT, HR, CZ, DE, HU, IT, PL, SK, SI) **Description**: the project introduced the GI concept, described in-depth the benefits of GI, reviewed GI in EU regulations and national laws. Generated transnational and regional GI maps. Generated regional GI functionality maps, conducting a connectivity analysis, field mapping, and functionality analysis.
ECONNECT	Alpine Space	2008-2011	**Title:** Improving Ecological Connectivity in the Alps **Geographic scope:** rural settings in the Alpine Space **Description:** the project gathered spatial data, analysed existing physical and legal barriers for the establishment of green corridors, and defined migration corridors. Created, approved, and tested a methodological strategy to establish ecological corridors and to promote this procedure across the Alpine region. Strengthened cooperation between relevant institutions and applied and applied concepts and actions in the pilot regions. Raised awareness and spread results on the importance of ecological connectivity.
greenALPS	Alpine Space	2013-2014	**Title:** Reconciling Renewable Energy Production and Nature in the Alps **Geographic scope:** Alpine region **Description:** the project processed and made available to key stakeholders results of projects such as ECONNECT and recharge.green on biodiversity, ESS and connectivity. It reviewed and analysed existing policy on the environment and provided policy recommendations. It analysed the network of stakeholders contacts and recommends ways to channel funding on biodiversity conservation
AlpES	Interreg Alpine Space	2015-2018	**Title:** Alpine Ecosystem Services - mapping, maintenance, management

			Geographic scope: Alpine Space region **Description:** the project developed an Alpine ecosystem services concept, carried out mapping and assessment for ecosystem services for the Alpine Space area including the testing in selected pilot regions. It provided stakeholders with the results through an interactive web GIS and ensured a multi-level and cross-sectoral transfer of project results to stakeholders through several new, tailored and transferable learning tools and targeted activities.
SPARE	Interreg Alpine Space	2015-2018	**Title:** Strategic Planning for Alpine River Ecosystems **Geographic scope:** rivers' catchment areas of the Alpine Space **Description:** the project provided an overview of priority Alpine rivers with hight protection need. Collected examples of successful river management and helped river managers to plan, apply, test, and evaluate participatory river management approaches. It made the lessons learnt from the river management examples and in from the project case studies available to the public and provided an interactive action and policy support platform called "SPARE-LIVE", including a decision and participation workflow, an e-learning facility on integrative river management practices for stakeholders.
AlpBIONET2030	Interreg Alpine Space	2016-2019	**Title:** Integrative Alpine wildlife and habitat management for the next generation **Geographic scope:** the EUSALP territory **Description:** the project investigated where and to what extent the Alpine territory is suitable for ecological connectivity on a spatially explicit level through a GIS-based analysis. Defined Strategic Alpine Connectivity Areas (SACA), created an Alps-wide planning tool for a smooth transition to a more connected Alpine macro-region (Jecami 2.0), developed guidelines for a resolution of human-nature conflicts, integrated wildlife management and connectivity in sectoral policies and strengthened the Network for Ecological Connectivity at all levels within the EUSALP territory.
LOS_DAMA!	Interreg Alpine Space	2016-2019	**Title:** Landscape and Open Space Development in Alpine Metropolitan Areas **Geographic scope:** urban and peri-urban settings in the Al-

			pine Space **Description:** the project investigated approaches to better protect, enhance, and develop green and open spaces and thus improve the quality of life in peri-urban landscapes. Developed a multifunctional peri-urban GI and connected actors over the entire Alpine Region through practice -oriented activities in the pilot regions. Applied new multifunctional participatory-processes and strengthened cooperation at the various planning levels.
HyMoCARES	Interreg Alpine Space	2016-2019	**Title:** HydroMorphological assessment and management at basin scale for the Conservation of Alpine Rivers and related Ecosystem Services **Geographic scope:** rivers in the Alpine Space **Description:** this project developed an interactive framework which allows to understand how river management decisions affect the delivery of ecosystem functions and services. The tools support planning and design of hydro-morphological management and restoration measures.
OpenSpaceAlps	Interreg Alpine Space	2019-2022	**Title:** Sustainable development of alpine open spaces by enhancing spatial planning governance **Geographic scope:** inner Alpine Space region **Description:** Based on the overview of the legal planning backgrounds and spatial and sectoral planning systems, the project seeks to improve local and regional planning processes for open spaces, identifying the main criteria for safeguarding open spaces and contributing to the harmonization of local governance and planning systems, involving local and regional stakeholders, and ensuring coordination across the Alps.

The contribution of LUIGI to GI development in the Alpine Space

LUIGI aims to support the scaling-up of the GI network across the Alpine Space by increasing its inter-connectivity throughout the landscape. More specifically, **LUIGI seeks to link GI across scales and connect urban and mountain/rural GI, linking urban centres at the foot of the Alps and the high-value natural areas along the mountain range.** LUIGI fosters a smart and strategic conservation approach which does not preserve natural areas in isolation, but strengthens the connectivity between existing natural areas restoring strategic natural and semi-natural habitats, enhances the delivery of ESS, and supports multiple functions in the same spatial area.

The challenge

Urbanization and land use change often represent a big threat for the conservation of functional natural areas and of the multiple benefits they provide to society. Introducing a GI approach into alpine landscape planning would therefore be beneficial i) in rural areas, where habitat fragmentation and degradation is leading to the deterioration of Alpine ecosystems, and ii) in urban and peri urban areas, where there is high competition for land, and a strong interaction of biophysical, social and governance structures and processes. In densely built-up areas where green spaces quantity and quality is limited, there is an imbalance between a limited supply of ecosystem services and their high demand driven by high population density. In rural areas, opposite trends can be observed. The supply of ecosystem services is generally higher because of the diversity and abundance of ecosystems, whereas the demand for such services is low due to the presence of an increasingly small population resulting from the abandonment of remote areas. **The demand for, and the supply of ecosystem services stemming from environmental features is therefore unbalanced in both rural and urban areas** (Schirpke et al.,2019).

By connecting rural/mountain to urban areas, **LUIGI aims to rebalance the supply and the demand of ESS between the two areas, linking people and the benefits deriving from nature**. LUIGI aims to exploit the synergies between GI functions by **developing business models** that foster sustainable economic development and create investment opportunities for the protection of GI. LUIGI will **explore governance approaches** that aim to minimize the gap between urban and rural policy regimes, and different stakeholders' interests and management options. A communication and capacity building strategy aimed at favouring the deployment of GI across the Alpine Space will be supported through project activities.

The spatial scale addressed by LUIGI and the development of business models are two defining features that distance LUIGI from other Alpine Space projects. For example, the ECONNECT and ALPBIONET2030 AS projects looked at ecological connectivity across the Alpine range, while the LOS_DAMA! AS project addressed GI in metropolitan areas. **LUIGI, connecting the rural and the urban GI Networks of the Alpine Space region, is conceptually placed between LOS_DAMA! and projects like ALPBIONET2030.**

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