EUROPEAN UNION

Shaping a sustainable future with Green Infrastructure

Interreg Alpine Space

LUIGI

European Regional Development Fund

Fondazione Lombardia per l'Ambiente

Città metropolitana di Milano

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LUIGI Linking Urban and Inner-Alpine Green Infrastructure - Multifunctional Ecosystem Services for more liveable territories

Project Lead Partner: Città Metropolitana di Milano

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Introduction

Introduction

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Abstract
Orchards, forests, rivers, green paths…There is a great variety of blue and green infrastructure, connecting mountain ecosystems and urban centres. Each of these natural or semi-natural spaces brings environmental, economic and societal benefits. It is precisely this wide range of benefits, called ecosystem services, that LUIGI explores and intends to strengthen in Alpine, rural and urban areas.
LUIGI – Linking Urban and Inner-Alpine Green Infrastructures. Multifunctional Ecosystem Services for more liveable territories – is a project of the European Union, approved on the fourth INTERREG V B tender of the Alpine Space Programme. It gathers 14 partners across 6 alpine countries, working together on future-oriented solutions to enhance ecosystem services and green infrastructure networks.

Keywords: Green Infrastructure; Ecosystem Service; Alpine Space; Ecological transition.

From Alpine vision to LUIGI mission: project pillars

The degradation of ecosystems has become an increasingly debated issue from different perspectives within the ecological transition framework. The Interreg Alpine Space Programme, EUSALP, and the Alpine Convention along with all the main European and international documents (i.e., the EU Green Deal, the UN 2030 Agenda for Sustainable Development, the Recovery and Resilience Facility) address this challenge. In order to achieve a real change, we believed it was necessary to create a technical and political debate with key actors by taking a multidisciplinary and transnational approach.
Against this background, a great work has been tried for comparing and aligning different languages, cultures, habits and vocations. Links and interactions between economic, environmental and social sustainability shape the domain of ecosystems where training, defining social and economic models, interacting with strategic and spatial planning tools have proven necessary steps. The effort will hopefully lead to extensive rethinking of people's behavior and to a more conscious production system.
By setting up the LUIGI project, we wish to introduce an empirical study based on a cross-sectoral work, being aware of the fact that, in a framework where complexity is the distinctive element, top-down interventions risk to generate negative effects. Such a unilateral approach might lead to an unaware behavior from people directly involved in the management of green infrastructures (GIs), preventing the unlocking of the real value of GIs and their ecosystem services. Therefore, we paid a special

attention to the project intervention logic, by focusing on fostering reflections and a participative approach that provides knowledge and awareness to key target groups, from practitioners to policy makers. We aimed at providing results, which could be a solid base for shaping new insights and inducing further research and reflections on these topics.

We are aware that the change starts from the elaboration of new priorities and values to strive towards, to which different subjects can contribute with specific competences and strengths.

The challenges addressed by the LUIGI project can be referred to five topics: environment, training, economy, governance, capacity building. These categories can be ideally linked to a common further element: the rural-urban connection, that not only is a physical link, but the source of more complex ecological and social relationships and therefore of new economic opportunities.

The LUIGI project is supported by an experienced and diverse partnership coupled with a strong list of observers which both represent local and regional authorities, NGOs and the civil society, research institutions and universities.

Surely, a sprinkle of ambition is needed when approaching the mentioned topics

Figure 1 - *LUIGI Partners and list of Observers. (https://www.alpine-space.org/projects/luigi/en/about-luigi/partnership/partners)*

within the discussed framework. Nevertheless, the motivation was found in a highly skilled working group, as well as in a peculiar project mission: the protection of alpine landscape and unique ecosystems.
During the project development as a matter of fact, a global pandemic has largely affected our lives and represented a limit for the project. Nonetheless, we got empowerment in return: we sorted out our personal and socio-political priorities, putting nature protection on top. A powerful and regenerative energy springs from the human-nature relationship, the definition of a new, more intense and well-balanced relationship is an essential element for future reflections. It is therefore necessary to focus on initiatives capable of increasing the human experience in nature nearby, both in quantity and quality, for more liveable green infrastructures in our territories.

LUIGI's objectives

The Interreg Alpine Space LUIGI project studies and tests a selection of interventions aiming at preserving and promoting the consolidation of green infrastructures (GIs) and the identification and enhancement of the related ecosystem services (ESS). The overall project objective is to ensure environmental, economic and cultural connectivity in a sustainable way, by promoting valuable connections between rural and urban areas of the Alpine Space.
Within the LUIGI project it is considered pivotal to preserve, valorize and promote GIs and the related ESS as a way to ensure a durable ecological, economic and cultural connectivity between rural and urban territories of the Alpine Space.
Consequently, LUIGI aimed at achieving three specific objectives:

1. valorizing the delivery of the economic, environmental and cultural ESSprovided by regional GIs, through management and policy instruments for decision makers;
2. empowering local decision makers and other target groups by improving land-planning capabilities of regional and local policy-makers, in highlighting alpine GI-networks which link rural and urban areas;
3. unlocking private investments, payments for ecosystem services (PES) for the ESs provided by mountain and rural areas, in order to strengthen the partnerships between rural and urban actors through innovative management approaches and sustainable business models.

According to the EU Strategy on Green Infrastructure (2013), a GI is a "strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services."

Ensuring well managed GIs can eventually lead to better quality of life and human well-being, improve biodiversity, protect us against climate change and encourage a smarter and more integrated approach to local development. Addressing these topics, three main concepts of GIs should be stressed::

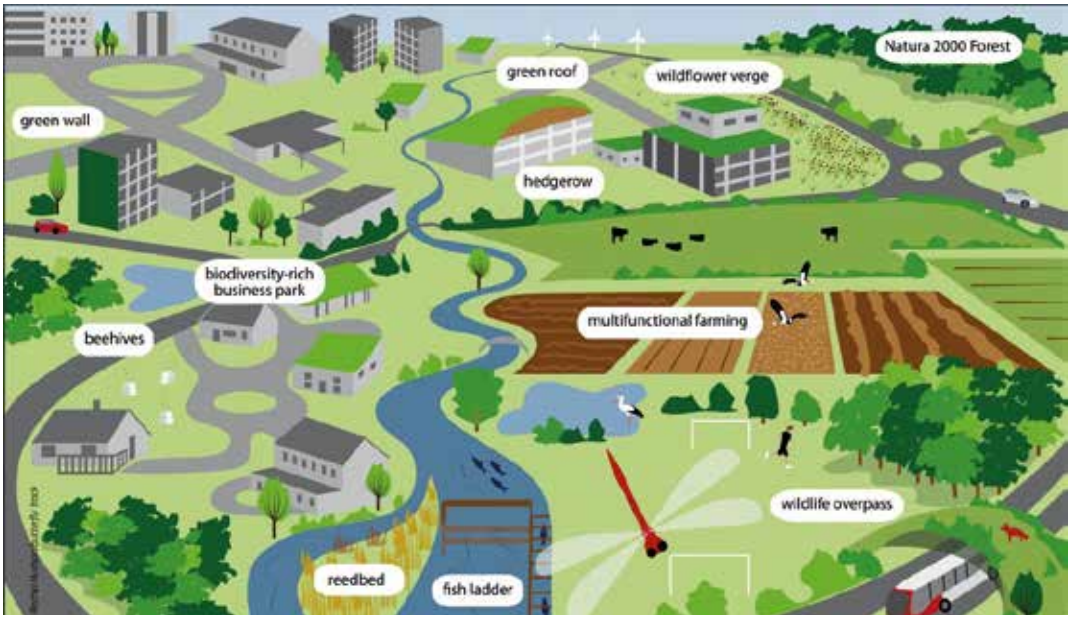

Figure 2 - *Example of Green Infrastructures. (https://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf)*

- *Multifunctionality*: usually GIs deliver multiple ESS and provide environmental, social and economic benefits;
- *Connectivity*: individual GI features need to be part of an interconnected network to be considered GIs (with Natura 2000 sites as backbone of GI);
- *Scale*: in general, GI assets are classified according to three different spatial scales[1]: City-region, regional and national scales (*e.g.* regional/national parks, rivers, forests, agricultural land, national/regional/local landscape designations, etc.); Town, city and district scale (*e.g.* city/district parks, urban canals, country parks, lakes, brownfield land, etc.); Local, neighborhood and village scale (*e.g.* street trees, green roofs/walls, local nature reserves, ponds and streams, etc.).

LUIGI recognizes and valorizes the joint benefits deriving from GI networks between rural and urban areas, as well as their potential for sustainable economic development based on natural capital and ESS.

ESS are the environmental, social and economic benefits that humans can obtain from healthy and functioning ecosystems. They can be classified into different categories: provision (supply of food, water, timber), regulation and maintenance (climate, of air and water quality), cultural (recreation, aesthetics and spirituality) and support to biodiversity conservation[2]. It is precisely this wide range of benefits, that LUIGI explores and promotes, strengthening the link between rural and urban areas for a

[1] Landscape Institute, 2009

[2] Common International Classification of Ecosystem Services (CICES)

better quality of life, by engaging stakeholders across sectors through participatory processes and building capacities of decision and policy makers for GI management, enhancement and valorisation.

Brief description of LUIGI WPTs

The project is structured in five work packages (WP), each of them focusing on a single aspect.

Firstly, WPT1 aimed at gathering existing knowledge and best practices on ESS and GIs in the Alpine pilot regions. This activity covered different typologies of GIs, for example food-tree-based, land use systems and cycle-pedestrian green paths.

This work package spotlighted the multiple benefits (ecological, economic, social and cultural) of GIs as common natural capital and ESs providers. In particular, Eurac Research as responsible partner for the activity, worked on the identification of GI networks and the ESS provided within the Alpine Space with a focus on LUIGI pilot regions. The main output is a collection of *Guidelines for the maintenance, conservation and enhancement of GIs and related ESS*.

After identifying and analyzing regional GIs in the case study areas, WPT1 developed maps and guidelines for the management of ESS in urban and rural areas.

WPT2 assesses the suitability of pilot regions' ecosystem goods and services to be traded on the market. Their market potential, social and environmental benefits are assessed by analyzing different parameters such as consumer demand, conditions for regional markets, public support policies, financial sources and infrastructures.

Lombardy Foundation for the Environment (FLA), as responsible partner for the activity, coordinates the collection of tools and analyzed mechanisms for enhancing value chains for a more effective cooperation between urban and rural areas. In particular, the activity focused on the identification of financial sources to fund initiatives on GIs, the development of local value-chains considering ESs as assets from regional GIs, and the development of *ad-hoc* business models in GIs areas, using inputs from ESS of GIs

A synthetic output of this work package is a Stock-exchange model to be tested on pilot-regions.

After identifying ESS with market potential on a regional and wider level, the WP developed business models for profitably trading in products and services from regional GIs. Business models have been tested by involving key-target groups such as entrepreneurs, local target groups and institutions.

The aim of **WPT3** is to synthesize and analyze the state of the art on the governance methods for GIs as well as GI management practices in the identified LUIGI pilot regions. Weihenstephan-Triesdorf University of Applied Sciences (HSWT) collected good practice examples and case studies on the local level and set up a framework for transferring approaches to a better GI governance in the Alpine Space. The main goal was to establish a participatory, co-creative and co-productive knowledge

transfer (through workshops, interviews, networks) within the project partnership as well as among other stakeholders.
The Agriculture Institute of Slovenia (AIS), as responsible partner for WP4, coordinated the work on education and training for sustainable GIs management and ESs provision, by creating teaching and training modules on landscape planning, management techniques, society engagement and innovative GI business models. **WP4** aimed at increasing knowledge on sustainable practices for managing GIs: on one side, project partners ensured dissemination and implementation of this knowledge in the pilot regions; on the other side, existing training and education offer on green infrastructure management has been assessed and AIS collected suggestions to improve them.
Finally, **WPT5** took care of capacity building, focusing in particular on knowledge transfer to policy makers at significant local, national and transnational levels. In order to achieve this result, Grenoble École de Management (GEM) designed ad hoc tools, such as a Massive Open Online Course (MOOC), webinars, workshops and factsheets. The definition of existing thematic networks of institutions directly involved in ecosystems, ecological connectivity and sustainable production helped mainstreaming LUIGI core topics to all relevant levels in the Alpine Space.

LUIGI pilot regions and implementation areas
As mentioned above, the partnership identified 10 pilot regions where initiatives and project activities as been implemented. In particular, within each pilot region, one to three implementation areas (case study) have been selected: some of them were chosen as best practices to be possibly replicated in other areas, others presented key challenges to be addressed, whose solutions could be also transferred to similar scenarios.
LUIGI pilot regions present very different features, showing the great range of landscapes that the Alpine Arc offers: from rural areas, where green infrastructure networks and ecological corridors are intact and functioning, to urban areas, such as Milan, Munich and Grenoble, where the delivery of ecosystem services is significantly jeopardized.
The common traits shared among all implementation area were:
- characteristic landscapes for the pre and inner Alpine region;
- economic relevance, as the ability to mobilize financial resources and market potential of products and services;
- presence of GI supporting biodiversity and (or) ecological connectivity.

Further "nice-to-have" criteria were selected, in order to better profile each implementation area:
- existing sustainable practices and land management options for food production;
- tree-based systems supporting cultural landscape (traditional or innovative/ adapted land-use practices);

- existence of traditional land use forms with cultural landscape elements;
- good example of GIs that serve as functional or spatial connections between urban and rural areas;
- applying innovative planning, management, governance solutions and communication strategies on GI;
- creating social benefits for the pilot region and its inhabitants (e.g. welfare, well-being, health, recreation etc.) and activating civic engagement;
- existing educational practices on GI, for creating and developing knowledge especially for practitioners in the value chain, citizens and regional experts, civic administrations and government representatives.

Given the complexity of this framework, LUIGI pilot coordinators (Partners who were in charge of implementing project activities carrying through the case studies), adopted a tailor-made approach in order to best engage that particular target groups in that given territory.

The book

This book mirrors the work that has been done by the WPT leaders. The volume is divided into four sections, which correspond to the topics covered by the researchers and the practitioners involved in the LUIGI project. Each section includes a theoretical part, where the general topic is presented, and a specific part on the project activities. Hence the book helps build a framework of analysis for the manifold issues that concern green infrastructure and highlights the contribution of the project to the scientific and technical debates on GIs.

Section 1 explains the ecological relevance of green infrastructures and illustrates a methodology to map regional ecological corridors and local ecosystem services multifunctionality. The thorough work made by the researchers from EURAC provides planners and policymakers with innovative and sound tools for understanding the ecological relevance of green infrastructure in the Alpine Space and for dealing with green and open space planning and management.

Section 2 presents the project activities coordinated by the researchers of Lombardy Foundation for the Environment (WPT2). It deals with the economic issues related to green infrastructures, and in particular with the valorization of the ecosystem benefits to enhance the development of green and natural spaces. The authors interestingly demonstrate that, by acknowledging the ecosystem benefits, new markets may be created making the economic activities more sustainable. The section delved into some analytical tools that can be applied for fostering market activities based on ecosystem benefits, such as value-chain analysis and innovative business models. Some of these tools are tested in the project pilot regions.

Section 3 illustrates the relevance of governance forms and models in green planning and management. The concept of governance depicts the ways in which public and non-state actors work together for the spatial development of green and natural

spaces. The researchers from Weihenstephan-Triesdorf University of Applied Sciences and Technische Universität München provide a typology of governance actors and analyze the different forms of governance in the pilot regions. The section puts forward an analytical framework on GI governance, which is applied in the Alpine Space with rather insightful results, especially for policymakers and practitioners who are willing to collaborate to enhance more resilient and sustainable GIs.
Finally, Section 4 includes the work of WPT4 and WPT5 on education and on the knowledge transfer to policy-makers. The researchers from the Grenoble École de Management summarize the main aspects of knowledge transfer for GI valorization: mapping and quantifying, enabling and governing. The authors from the Agriculture Institute of Slovenia describes the educational modules developed throughout the project.

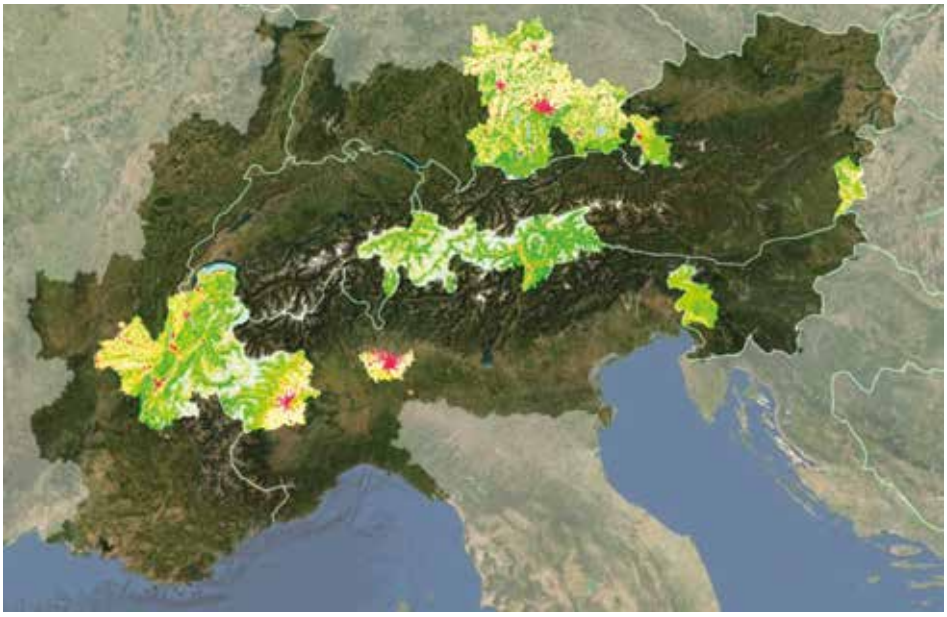

Figure 3 - *LUIGI pilot regions. Map elaborated by Eurac Research for the LUIGI project (2021).*

SECTION I

Chapter 1

HARNESSING NATURE TO MEET MULTIPLE SOCIETAL CHALLENGES: THE POTENTIAL OF GREEN INFRASTRUCTURE FOR THE ALPS

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Abstract
The concept of Nature-based Solutions is guiding the development of actions that can benefit both human societies and biodiversity. In this chapter, we illustrate how Green Infrastructures in particular have been used by the European Union to foster the integration of natural processes into spatial planning and development. We describe how functioning ecosystems support the delivery of ecosystem services and we explain the importance of considering ecosystem services-based multifunctionality and ecological connectivity when identifying and mapping components of Green Infrastructure.

Keywords: Nature-based solutions; ecosystem services-based multifunctionality; ecological connectivity; natural resources management

1.1 Introduction

As the current biodiversity and climate crises become more evident, large sectors of society are increasingly aware of the role that nature plays in sustaining societies, economies, and the achievement of the 17 Sustainable Development Goals (Soto-Navarro *et al.*, 2021). In this context, the concept of Nature-based Solutions (NbS) has emerged in the last decade as international and European institutions, local authorities, and stakeholders recognized the potential of harnessing nature to address major societal challenges, such as climate change mitigation and adaptation, disaster risk reduction, human health and

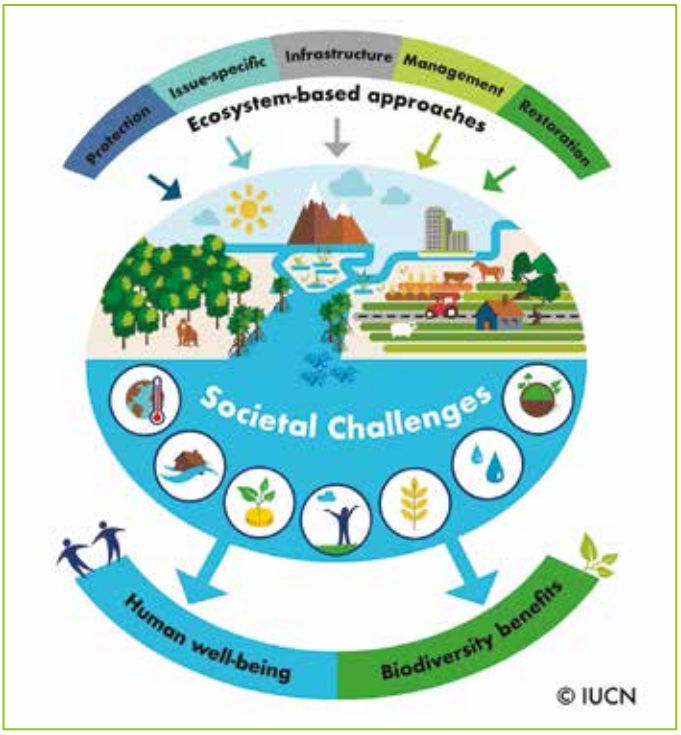

Figure 1.1 - *Nature-based solutions can help address multiple societal challenges, improving human well-being and supporting biodiversity (IUCN, 2020).*

wellbeing, food and water security, and socio-economic development, while also protecting biodiversity. Indeed, NbS are commonly defined as "Actions to protect, sustainably manage and restore natural or modified ecosystems, in ways that address societal challenges effectively and adaptively, to provide both human wellbeing and biodiversity benefits" (IUCN, 2020) (*Figure 1.1*).

NbS are acknowledged to be an umbrella concept for ecosystem-based approaches such as Ecosystem-based Adaptation, Climate Change Adaptation, Disaster Risk Reduction and Green Infrastructure, which are gaining increasing attention across the world. Even though the term NbS has been defined and used in a variety of different ways by different institutional bodies (e.g., IUCN, European Commission), all definitions share the overarching goal of enhancing the resilience of ecosystems and their capacity to provide multiple benefits, supporting biodiversity and human health and wellbeing (IUCN, 2020). NbS focus on bringing more, and more diverse natural elements and processes into cities and across landscapes through locally adapted and resource-efficient interventions, and include ecosystem restoration and conservation practices, as well as measures that foster the sustainable management and use of natural resources.

In this chapter, we will illustrate how NbS, and Green Infrastructure in particular, can promote sustainable livelihoods and address the impacts and drivers of the climate and biodiversity crises by working through nature rather than solely relying on man-made engineered solutions, mainstreaming nature conservation approaches into sectors such as agriculture, water management, urban planning, and rural development. In particular, we describe how functioning ecosystems and ecosystem-multifunctionality enhance the delivery of different sets of ecosystem services, and how ecological connectivity improves the ecological condition and the resilience of natural ecosystems and their ecological processes.

1.2.1 The importance of functioning ecosystems for delivering ecosystem services

Human societies need nature and functioning, healthy ecosystems in order to live well, sustain value chains, and respond to societal challenges. The cascade model (Young & Potschin, 2011) (*Figure 1.2*) illustrates how benefits flow or "cascade" 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 rise to ecosystem services, through which humans benefit from nature. Ecosystems need to be "functioning" and in good ecological condition in order to be able to support ecological functions and provide multiple ecosystem services to humans.

Wetlands, for example, provide the service of regulating the flow of water. By reducing flood danger, they benefit society to the point that people are willing to pay for wetland protection or flood protection measures. Among the services

delivered by forests, trees supply wood, and since humans benefit from burning or using it, value chains have developed around the provision of timber and firewood. Meadows support bee populations that fly from flower to flower collecting nectar, and by doing so meadows ecosystems sustain crop pollination, honey production and tourism activities.

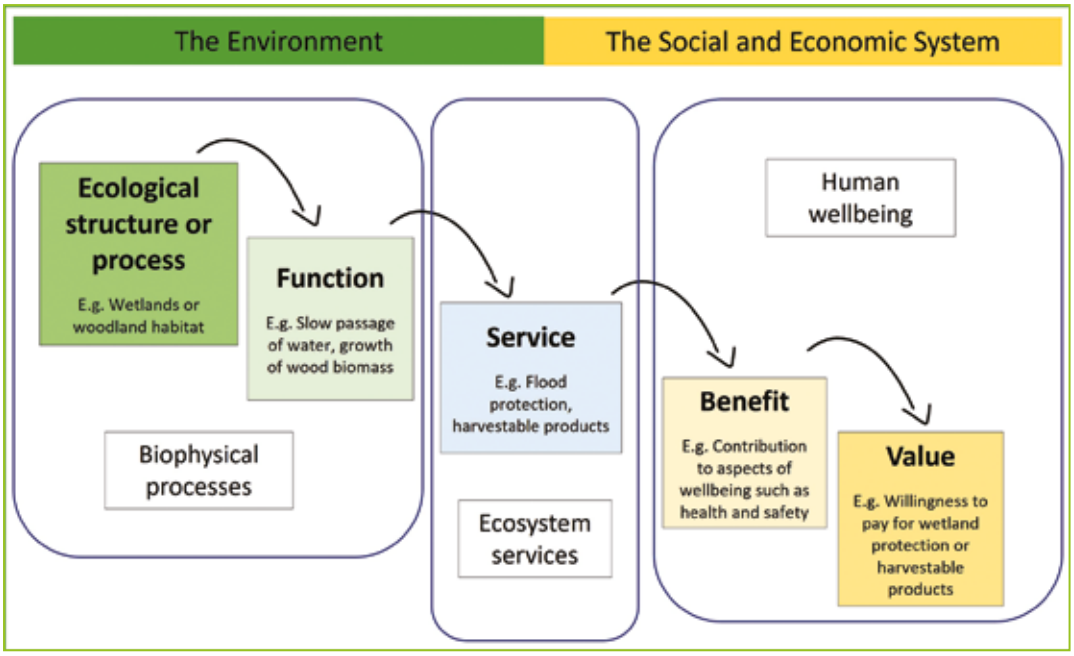

Figure 1.2 - *The cascade model illustrates how the benefits and values important for our socio-economic system originate from ecological structures and processes, and are delivered through ecosystem services. Illustration adapted from Potschin, M. and R. Haines-Young (2016).*

- Humans and nature: Ecosystem Services

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. People gain from the natural capital food, materials, energy, and an environment where to relax, have fun, and get inspiration for science, art, and religion.

Ecosystem services or nature's benefits to people, are the benefits that humanity obtains from nature and ecosystems (MEA, 2005; Diaz *et al.*, 2016). These include 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, and valuing these life-supporting services in economic terms is a challenging and widely discussed research activity.

There are multiple ways to classify, measure and assess ecosystem services. According to the Common International Classification for Ecosystem Services (CICES), adopted also by the European Environmental Agency (Estreguil, 2019), ecosystem services can be grouped into three main categories:
Provisioning services such as food, water, timber, and fibers provision;
Regulatory and maintenance services such as climate, flood, waste and water quality regulation, soil formation, photosynthesis, and nutrient cycling;
Cultural services such as the provision of recreational, aesthetic, and spiritual benefits.
While ecosystem functions would occur even in the absence of humans, ecosystem services have been conceptualized because many ecosystem functions benefit humans in multiple ways. Should ecosystem cease to function, people would not be able to receive all the benefits that nature has provided for millennia.
Different drivers of change, such as human activities, urbanization or conservation efforts, can over time directly or indirectly have positive or negative impacts on ecosystem conditions. While benefiting from ecosystem services usually does not affect ecosystem condition (*e.g.*, having clean, drinking water), an intensive demand of certain ecosystem services (*e.g.*, timber extraction from forests, or tourism activity in fragile mountain lakes) can have negative impacts on ecosystem condition, and results in ecosystem degradation (MAES *et al*, 2018). On the other hand, some services, like crop provision, are the result of a co-production between anthropogenic and natural assets (Diaz *et al.*, 2016)

1.2.2 Mainstreaming Green Infrastructure

The provision of ecosystem services can be enhanced by mainstreaming the integration of natural processes into spatial planning and development at multiple spatial scales. Functioning natural areas in good ecological condition indeed represent a winning tool for the simultaneous provision of ecological, economic, and social benefits that can help meet multiple challenges.
The European Union definition of Green Infrastructure is based on the idea that consciously integrating the protection and the enhancement of natural processes in spatial planning and territorial development will benefit both society and biodiversity.
In 2013, the European Commission in its communication "Green Infrastructure-Enhancing Europe's Natural Capital" defines Green Infrastructure 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, Green Infrastructure is present in rural and urban settings."
Based on the principles of multifunctionality and ecological connectivity, Green Infrastructures are used in the context of planning, management, and conservation

of green spaces in different contexts and at different scales (urban, ecosystem and landscape scales), to improve their structure, composition, functioning and their potential to supply multiple ecosystem services to society. Green Infrastructure represent a conceptual tool for managing the large variety of ecosystem services provided by the landscape (Di Marino *et al.*, 2019) by strategically planning green and open spaces (John, Marrs and Neubert, 2019). Green Infrastructure provide a framework for assessing the spatially explicit delivery of ecosystem services, for showing the benefits and deficits of such services on a local level, and for identifying exploitable synergies between ecosystem services. This quantitative and practical approach to managing green assets and their socio-ecological impact makes Green Infrastructure a useful concept for public authorities and policy makers in the Alpine Space and beyond.

- Elements of Green Infrastructure networks

Many different natural features can be part of Green Infrastructure, as long as they are part of a strategic and interconnected network, and they are functioning ecosystems in a good ecological condition able to deliver multiple ecosystem services. Green Infrastructure elements can vary in size and characteristics, can be found in urban, peri-urban, and rural areas, and the Green Infrastructure network they establish can range from the scale of a city to that of a large transboundary area such as that of the Alps. Potential components of Green Infrastructure can range from forests to green roofs, wetlands, or wildlife crossings.

Natural areas of special relevance or protected by EU legislation, such as Natura 2000 sites, represent the backbone of a Green Infrastructure network. Large, healthy, and functioning ecosystems both inside and outside protected areas, such as a Natura 2000 forest, can indeed act as core areas for many species and provide important ecosystem services. 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 multifunctional forests and High Nature Value farmland, can be considered Green Infrastructure components as they supply ecosystem services, provide favorable habitat to many species, and support economic activities compatible with the protection of biodiversity.

1.2.3 Multifunctional Green Infrastructure elements

Nature-based Solutions such as Green Infrastructure are multi-functional, meaning that they are able to perform several functions and provide several benefits on the same spatial area (EEA, 2011). 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.* support of tourism activities or organic agriculture). 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.
Green Infrastructure networks can be designed and managed to maximize the quality and quantity of the functions they support and the multiple ecosystem services they provide (*Figure 1.3*).

Figure 1.3 - *Green Infrastructure support multiple environmental, social and economic benefits illustration (by Anja-Maria Eisen, in John, Neubert and Marrs (2019).*

By fostering and enhancing ecosystem functioning across the landscape, Green Infrastructure allow to exploit the services provided by nature to improve, for example, the 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).
Green Infrastructure can also support economic activities that do not undermine core ecological processes. The multifunctionality of natural areas allows to harness the economic value deriving from several ecosystem services and to develop business models and financing opportunities that can enable the protection and the enhancement of Green Infrastructure elements.

1.2.4 Supporting biodiversity and ecological connectivity

The protection, restoration and sustainable management of natural and semi-natural ecosystems gives rise to resilient Green Infrastructure elements in good ecological condition that contribute to halting biodiversity loss. Enhancing ecological connectivity across the landscape through a green infrastructure network is crucial for maintaining such ecological condition and for the preservation of animal populations over time. A high degree of connectivity is indeed generally linked to low habitat fragmentation, and this means that organisms can move to find mates, food, and shelter. This increases the genetic variability of a population and its chances of survival over time (Hilty *et al.*, 2006). Moreover, corridors allow species to move their range in response to climate change. Ecological connectivity expresses the configuration of landscapes and the degree to which this allows the movement of species, and it can be either structural (*e.g.*, as in ecological corridors physically linking habitat patches) or functional (e.g., small woods acting as stepping-stones only for those species that are able to move across unfavorable habitat) (EEA, 2014).

One of the objectives of the European Union's macro-regional strategy for the alpine region (EUSALP) is to reduce habitat fragmentation in the Alpine Arc given that all of the largest valleys are considerably fragmented (Interreg Alpine Space project "AlpBIONET2030"). Conservation efforts must therefore aim at ensuring that landscapes across the entire Alpine region have functional ecological networks and are therefore permeable to animal species. Since connectivity depends on structural natural features, such ecological networks need to be implemented on the ground, preventing land conversion, and restoring habitats in strategic areas important for network-level connectivity (Jongman, 2008). A backbone of areas of high ecological importance, such as the Natura 2000 sites, reserves, or parks, can for example be connected through different natural or man-made environmental features to form a wider Green Infrastructure network across the landscape.

1.3 Conclusion

Nature-based Solutions provide a framework for guiding the development of actions that address multiple societal challenges whilst improving human well-being and benefiting biodiversity. To do so, functioning ecosystems in good ecological condition are needed to support the provision of multiple ecosystem services to people. In this context, Green Infrastructure integrate natural processes into spatial planning and development and aim to harness the benefits of nature while protecting and enhancing ecosystems.

Multifunctional Green Infrastructure elements allow to use space and resources efficiently and deliver multiple ecosystem services that can help address several societal challenges. Green infrastructure networks that improve the permeability to animal movement and habitat suitability of the landscape support biodiversity and enhance the resilience of ecosystems and their ecological processes.

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SECTION I

Chapter 2

A framework for identifying and mapping Green Infrastructure networks in the Alps

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Abstract
By proposing a practical approach for mapping Green Infrastructure networks in the Alpine Space region, in this chapter we highlight how Green Infrastructure can enable practitioners and researchers to foster multifunctionality and guide ecosystem restoration. To this end, we spatially explicitly map several ecosystem services at high-resolution, assess ecosystem multifunctionality, and combine these findings with an ecological connectivity analysis to identify potential Green Infrastructure networks. This mapping approach can support decision-makers to conserve, restore or sustainably manage our natural resources effectively and efficiently.

Keywords: Nature-based Solution, Green Infrastructure, Ecological connectivity, Ecosystem services based multifunctionality

2.1 Introduction

As the interest in Nature-based Solutions and Green Infrastructure increased worldwide, several methodologies have been developed to identify which areas in particular should be carefully managed, protected or restored in order to provide both human well-being and biodiversity benefits (IUCN, 2020). The diversity of such methodological approaches stems in part from the different scopes and scales of analyses (regional, national, transnational), and from the availability of data and technical expertise (Honeck *et al.*, 2020). A previous Interregional Central Europe project addressing Green Infrastructure, called "Magic Landscapes", for example, identified green infrastructure as a selection of Corine Land cover classes, but mapped those in very large areas of central Europe, using a transboundary common dataset. Other research projects addressing Green Infrastructure at the national or regional level areas instead used other datasets and more complex analyses in line with national policy and administrative practices (e.g., in Spain, Basnou *et al.*, 2020 and Garcia *et al.*, 2020). In this chapter, we present the methodological approach developed in the LUIGI project for the identification of alpine Green Infrastructure networks, which comprises of an ecological connectivity and of an ecosystem services-based multifunctionality assessment.

2.2 Methodology for the identification of Green Infrastructure components

The present approach for the identification of Green Infrastructure components is based on the most recent spatial data and methodological developments presented in a joint report of the European Commission's Joint Research Centre (JRC) and

European Environmental Agency (EEA) (Estreguil *et al*., 2019), and in technical reports developed by the EEA and its European Topic Centre on Urban, Land and Soil Systems (EEA, 2014; Carrao *et al*., 2020). Such reports provide indications on how to map Green Infrastructure networks that, building on designated protected areas, complement the network with other key natural and semi-natural features that support the movement of medium-large mammal species and the delivery of ecosystem services. In line with Estreguil *et al*. (2019), we adopt two complementary approaches: a physical mapping which identifies protected areas, ecological networks, and other valuable natural areas, and a functional, ecosystem services-based mapping which ensures the delivery of provisioning, regulating and cultural services. Following the European Commission's definition of Green Infrastructure as an interconnected network which provides multiple services, we map Green Infrastructure based on an ecological connectivity assessment and an ecosystem services-based multifunctionality assessment. One of the aims of this study has been to find a compromise between the spatial resolution used for the analysis, and the extent of the area analysed. In LUIGI, we decided to carry out our analyses at high resolution (25 m) over the administrative NUTS3 regions involved in the project (Nomenclature of Territorial Units for Statistics), as they represent a suitable scale for addressing urban-rural linkages, given that they often feature big cities and the surrounding rural and alpine areas, and that land management regulations often occur at this scale.

The components of Green Infrastructure networks considered and mapped (*Figure 2.1*) in the LUIGI project are therefore:

Ecological Conservation Areas (SACA1, see section below) which include protected areas and other valuable natural areas. These areas were identified by the Interreg Alpine Space project Alpbionet 2030. Such areas should be conserved and/or protected.

Ecological Corridors connecting Ecological Conservation Areas, which should be managed to ensure the effective movement of forest based, medium-large mammal species. Connecting features can be part of the existing landscape which needs to be conserved, or features that should be restored to a more natural state to close gaps in the network. In some cases, it might be necessary to establish wildlife crossings.

Top Multifunctional Areas including those areas displaying the highest ecosystem services-based multifunctionality values (top 10%) in urban, agricultural, forested, and open areas. These areas should be sustainably managed to ensure the delivery of ecosystem services.

Practitioners implementing Green Infrastructure networks in their regions should, however, also take into account the requirements of local animal and plant populations that are not directly addressed by the present approach.

In the following sections, we outline the methodology used for the ecological

connectivity and the multifunctionality assessments to identify ecological corridors and top multifunctional areas.

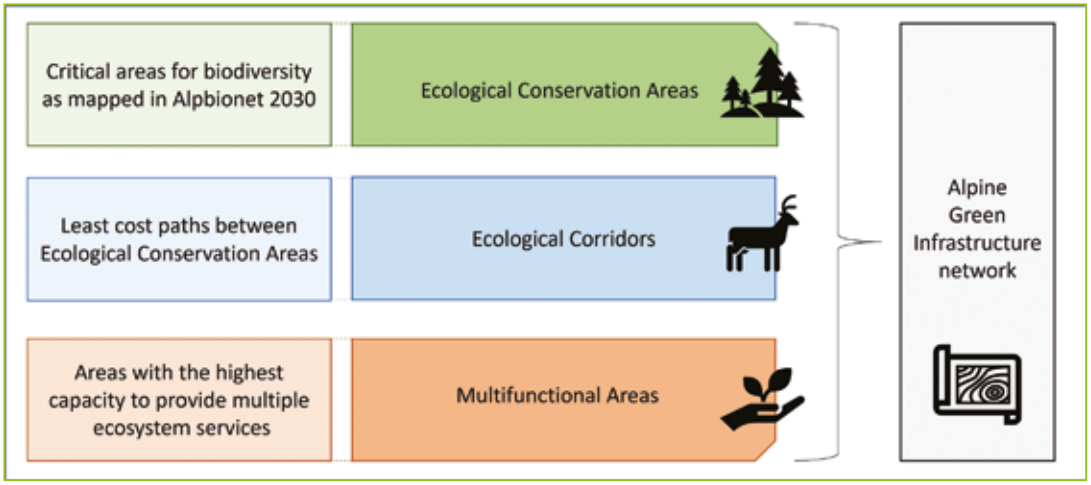

Figure 2.1 - *Methodological approach for identifying Green Infrastructure networks in regions of the Alpine space. Ecological corridors connecting conservation areas with high ecological value support biodiversity and the viability of animal populations. On the other hand, multifunctional areas provide multiple ecosystem services and contribute to address multiple societal challenges (own elaboration, 2021).*

2.2.1 Mapping ecological corridors between Ecological Conservation Areas

Green Infrastructures networks are considered effective conservation measures as they connect existing protected areas, increasing the habitat available to species and favouring the degree of ecological connectivity between bigger core habitat areas. Ecological connectivity, defined as the ability of animals to move through the landscape (Taylor *et al.*, 1993), is critical for maintaining animal populations genetic diversity and metapopulations viability, and allowing species to shift their geographic range in adaptation to climate change (Cushman *et al.* 2013).

Green Infrastructure networks have the potential to support biodiversity conservation by both providing favourable habitats and acting as ecological corridors (EEA, 2014). Areas with high ecological value and limited anthropic disturbance such as protected areas, forests or alpine meadows provide habitat to many flagship and common species of the alpine region. Linear landscape features, such as hedgerows and riparian vegetation, or small woods acting as stepping-stones can, moreover, help some animal species move across anthropized areas (such as intensively used agricultural areas), allowing them to reach new habitats, resources, and mates.

- LUIGI and AlpBionet 2030

One of the aims of the mapping effort carried out in the LUIGI project has been to identify, in each LUIGI pilot region, ecological corridors that can connect areas with high ecological value, such as protected areas. The identification of regional corridors in the LUIGI pilot regions builds on the work done by the Interreg Alpine Space

project Alpbionet 2030, which assessed the capacity of the EUSALP area to support ecological connectivity, and subsequently identified three classes of Strategic Alpine Connectivity Areas (SACA): Ecological Conservation Areas, Ecological Intervention Areas, and Connectivity Restoration Areas. Ecological intervention areas, in particular, are "areas with high potential for connectivity in which larger, more or less natural non-fragmented zones could easily be created, especially by connecting protected areas, Natura 2000 sites or other precious biotopes". In the LUIGI project, we aimed to provide detailed recommendations to spatial planners and policy makers of the project pilot regions on how to prioritize actions in the "Ecological Intervention Areas" so as to best ensure connectivity between "Ecological Conservation Areas".

- LUIGI approach to mapping ecological corridors

The scope of the LUIGI project has been to identify ecological corridors that could favour the movement of medium-large forest mammal species across the landscape and between Ecological Conservation (SACA 1) areas.

Ecological Conservation (SACA 1) areas have been used as "core" areas to be connected to allow consistency and comparability with the Interreg Alpine Space Project AlpBionet 2030. These areas have a minimum size of 100 ha and have been described as "areas that still have considerable space for connectivity with non-fragmented surfaces and where connectivity needs to be conserved. Such areas are characterized by a sparse infrastructure, dispersed settlements and large natural areas at mid-altitude". These areas were identified considering the following variables: Altitude and Topography; Population; Land use; Environmental protection; Fragmentation. (For more details on the methodology used by Alpbionet 2030 to map Ecological Conservation Areas, visit: https://www.alpine-space.org/projects/alpbionet2030/en/project-results/wpt3)

Medium-large forest mammals have been very often used as a focal species group for ecological connectivity assessments because the breadth of their movements makes them particularly susceptible to habitat loss and fragmentation, and because they can act as umbrella species for other animals with more limited habitat requirements (Carrao *et al*., 2020; de la Fuente *et al*., 2018; 2011, Beier 2008).

Ecological corridors were modelled and mapped taking in account the landscape resistance, which represents the degree to which the landscape facilitates or impedes animal movement across different land uses. In this context, the landscape resistance is intended as the opposite of habitat suitability, meaning that, for example, forests have a low resistance to animal movement, while urban areas have the highest. The range of landscape resistance values used for the connectivity analysis has been determined mainly in relation to the naturalness of different land use and land cover classes, following Garrutxaga *et al*. 2010 and the latest EEA- ETC/ULS report (Carrao *et al*., 2020). The use of a high-resolution map (5m) enabled the consideration of smaller landscape features (roads, single buildings, hedgerows) and a more accurate representation of the small-structured alpine landscape.

Given the core areas and the landscape resistance values for the target animal species described above, the mapping of the ecological corridors was carried out using the freely available "Linkage Mapper" and "Circuitscape" toolboxes in ArcGIS (McRae and Kavanagh, 2011; available at https://circuitscape.org/). These tools use electrical circuit theory to model the movement of animals between core areas throughout a continuous landscape characterized by a range of different resistance values, allowing to identify least-cost paths connecting Ecological Conservation Areas. Least-cost paths constitute the middle of ecological corridors, and corridor width was set to 2 km of cost-weighted distance units. Further information on the landscape resistance values used and on how the models were run in ArcGIS can be found in the documentation of the LUIGI project.
The outputs of the analysis conducted using the suite of tools in the Circuitscape and Linkage Mapper toolboxes comprised of a series of maps showcasing i) the current degree of ecological connectivity between Ecological Conservation Areas, ii) the location of optimal ecological corridors and of critical bottlenecks given the existing land use and iii) the major barriers affecting the location and quality of the ecological corridors.

2.2.2 Mapping ecosystem services-based multifunctionality

Terrestrial ecosystems support many ecosystem processes that give rise to multiple ecosystem functions and services. As described in chapter 1, such services can support us in addressing societal challenges, supporting food production, climate change mitigation and adaptation, mitigating natural hazards, and promoting human well-being. In the LUIGI project, 11 ecosystem services indicators were spatially-explicitly modelled and mapped at high resolution (25 m) to identify areas supporting high ecosystem services-based multifunctionality. The assessed ecosystem services build on the Common International Classification of Ecosystem Services (CICES v.5.1) and describe the potential supply of ecosystem services across the project pilot regions. Ecosystem services were selected and mapped according to their relevance for the Alpine Space and the availability of spatial data at the right resolution to model them. The following ecosystem services were included in the analysis:
Regulating ecosystem services: pollination potential, water flow regulation, water nitrogen filtration, carbon sequestration, natural hazard mitigation;
Provisioning ecosystem services: crop potential, water provision for drinking, fodder provision, timber provision;
Cultural ecosystem services: outdoor recreation potential, landscape aesthetics;

- Ecosystem services indicators

The ecosystem services indicator models have been developed mainly referring to and applying methodologies present in the literature that, in some cases, were adapted to the purpose and resolution of the assessment. The mapping procedure involved the use of a high-resolution land use map, topographic variables such us elevation,

slope and aspect, and climatic variables such as Growing Degree Days (GDD), mean annual temperature, precipitation, and solar radiation. Given the lack of a European-wide database on organic agriculture or forestry practices, croplands are assumed be managed intensively, while forests are assumed to be manged sustainably. All the ecosystem services indicator values were normalized from 0 to 100 to allow comparability and to be used in further analyses.
To allow consistency and alignment with previous European projects, the ecosystem services mapping procedure built on the results obtained in the Interreg Alpine Space project AlpES. We however acknowledge that other methodologies and approaches can be suitable to map individual ecosystem services, according to the data and technical expertise available. In *table 2.1* we briefly describe the assumptions and variables used in modelling and mapping the above-mentioned ecosystem services indicators, which were used to assess multifunctionality in the LUIGI project. For more information on the ecosystem services indicator models, please refer to the deliverables of the LUIGI project.

Table 2.1 - *Variables and assumptions used in the mapping of the indicators of Ecosystem Services supply in the LUIGI project.*

Pollination potential: the relative capacity of ecosystems to support wild bees is based on the availability of floral resources and nesting opportunities, the distance from water and natural areas, and the influence of temperature and solar irradiance on insect activity (Vallecillo *et al.*, 2018).
Water flow regulation: the amount of runoff retained per pixel is calculated based on land use type and soil characteristics with the curve number method, which estimates direct runoff or infiltration from rainfall excess (Sharp *et al.*, 2016).
Water nitrogen filtration: the amount of nitrogen contained in water run-off that is potentially filtered by ecosystems depends on the load of nutrients delivered by surrounding land uses and its nutrient delivery ratio, which is a function of land use and the upslope area and downslope flow path (Sharp *et al.*, 2016).
Carbon sequestration: the annual rate of CO_2 sequestration by the current landcover depends on above- and below-ground biomass increment in forests and grasslands which gives the amount of carbon being sequestered per year. Biomass increment in other land cover types was estimated with proxies or interpolations from land uses in the surrounding (Change 2006).
Natural hazard mitigation: the capacity of ecosystems to mitigate natural hazards depends on the capacity of vegetation to prevent soil erosion based on rainfall erosivity, soil erodibility, soil and topographic conditions (Fu *et al.*, 2011). Soil retention depends on proxy values of vegetation cover and soil management practice (Guerra *et al.*, 2016). Finally, the protective function of forest from hazardous natural processes (avalanches, landslides, rockfalls and water channel processes) is also considered (Bauerhansl *et al.*, 2009).

Crop potential: the potential to grow crops mainly depends on climatic conditions (GDD, which show daily temperature accumulations), water availability (Precipitation – Evapotranspiration), and topography (slope) (Bock *et al.*, 2018). Soil was not considered as a limiting factor since for agriculture some kind of soil treatment and preparation is always necessary and possible.
Water provision: the indicator describes the annual local water provision for general use. It is composed of a water budget (Precipitation – Evapotranspiration by plants) combined with the influence of the soil and landcover on the infiltration rate of precipitation. It estimates ground and soil water recharge at pixel level and excludes surface runoff (Karabulut *et al.*, 2016).
Fodder provision: the annual grassland biomass (fodder) production depends on the optimal yield according to the length of the growing season, the respective growth functions and the specific land use types (intensively used, moderately used and extensively used grassland). Biomass productivity is refined according to region-specific precipitation patterns and local small-scale topographic conditions (Jäger *et al.*, 2020).
Timber provision: sustainable forest management is largely limited to the regrowth rate in order to keep forest inventory stable. Hence, this indicator reflects the net annual increment of biomass in Alpine forests. Forest biomass increment is derived from satellite Gross Primary Productivity data, forest typology, altitude and climatic macro-area factors from the Swiss National Forest Inventory (Busetto *et al.*,2014).
Outdoor recreation potential: the capacity of ecosystems to support nature-based recreation opportunities depends on the recreational value of protected areas, the degree of human impact, distance to water, terrain roughness, presence of natural features, and size of urban parks. It also considers proximity based on the presence of access facilities such as roads or bus stops, and on the presence of user facilities such as mountain huts and benches (Cortinovis *et al.*, 2018; Schirpke *et al.*, 2018).
Landscape aesthetics: the capacity of landscapes to enable aesthetic experiences depends on the visibility of an area as observed from the rest of the region, from built-up areas, and from locations where Flickr photos are taken. Moreover, the objective aesthetic beauty of the area is taken into account by using proxy values for landcover types and applying focal averages since landscape is always perceived as a location with its surroundings (Garcìa *et al.*, 2020, Schirpke *et al.* (2021)).

- Assessing ecosystem services -based multifunctionality

Ecosystem service-based multifunctionality was assessed separately for different land use groups (agricultural landscapes, forests, urban areas, and "open" spaces at high elevations). Such land use groups reflect different levels of anthropization, and the different management, regulations and practices put in place by different sectors of public administrations. Given that the role of forests as multifunctional land use systems is already widely acknowledged (European Commission, 2013),

we decided to apply a more practice-oriented approach to give more precise indications to practitioners working in different land use groups.
Assessing ecosystem service-based multifunctionality separately indeed allows practitioners to identify the most multifunctional areas within urban, rural, forested and "open" landscapes. For each land use group, all ecosystem services were normalized on a 0-100 scale to identify the areas supplying higher multifunctionality. Multifunctionality was then calculated as the average ecosystem services value within each land use group. A final composite map was then created by merging the four groups to identify area-wide patterns of multifunctionality. Areas displaying values falling into the top 10% of the multifunctionality values were considered to be highly multifunctional (see chapter 3 for results of the multifunctionality assessment).

2.2.3 Identification of Green Infrastructure networks

Following the definition of Green Infrastructure, we combined the results of the ecological connectivity and multifunctionality analyses to identify areas that could potentially be part of a Green Infrastructure network.
The ecological connectivity assessment allowed to identify the ecological corridors that would become part of a green infrastructure network. The Ecological Conservation Areas representing core habitat areas with high ecological value constitute the backbone the Green Infrastructure network and should be protected and managed with particular attention. Bottlenecks along ecological corridors are also critical areas that should be managed to favour the passage of animals, conducting ecosystem restoration activities, or creating wildlife crossing opportunities.
The ecosystem services-based multifunctionality assessment led to the identification of multifunctional areas that support above-the-average multifunctionality. Areas that displayed the highest (top 10%) values were deemed to be hotspots of multifunctionality that should be preserved and managed with particular consideration.
These two components were then merged into a composite bivariate map showing the potential capacity of ecosystems across the LUIGI pilot regions to simultaneously support ecological connectivity and ecosystem services at different levels (*Figure 2.2*). These maps can support landscape planners and decision makers in identifying priority areas for intervention as well as critical areas that should be protected or sustainably managed. Moreover, these maps on ecological connectivity and multifunctionality can be overlayed with other information available at regional level (such as protected areas, properties receiving subsidies, areas under landscape and zoning regulations, transport infrastructure, road kills etc.) to support regional territorial planning and identify strategic and critical areas that could become part of a regional Green Infrastructure network.

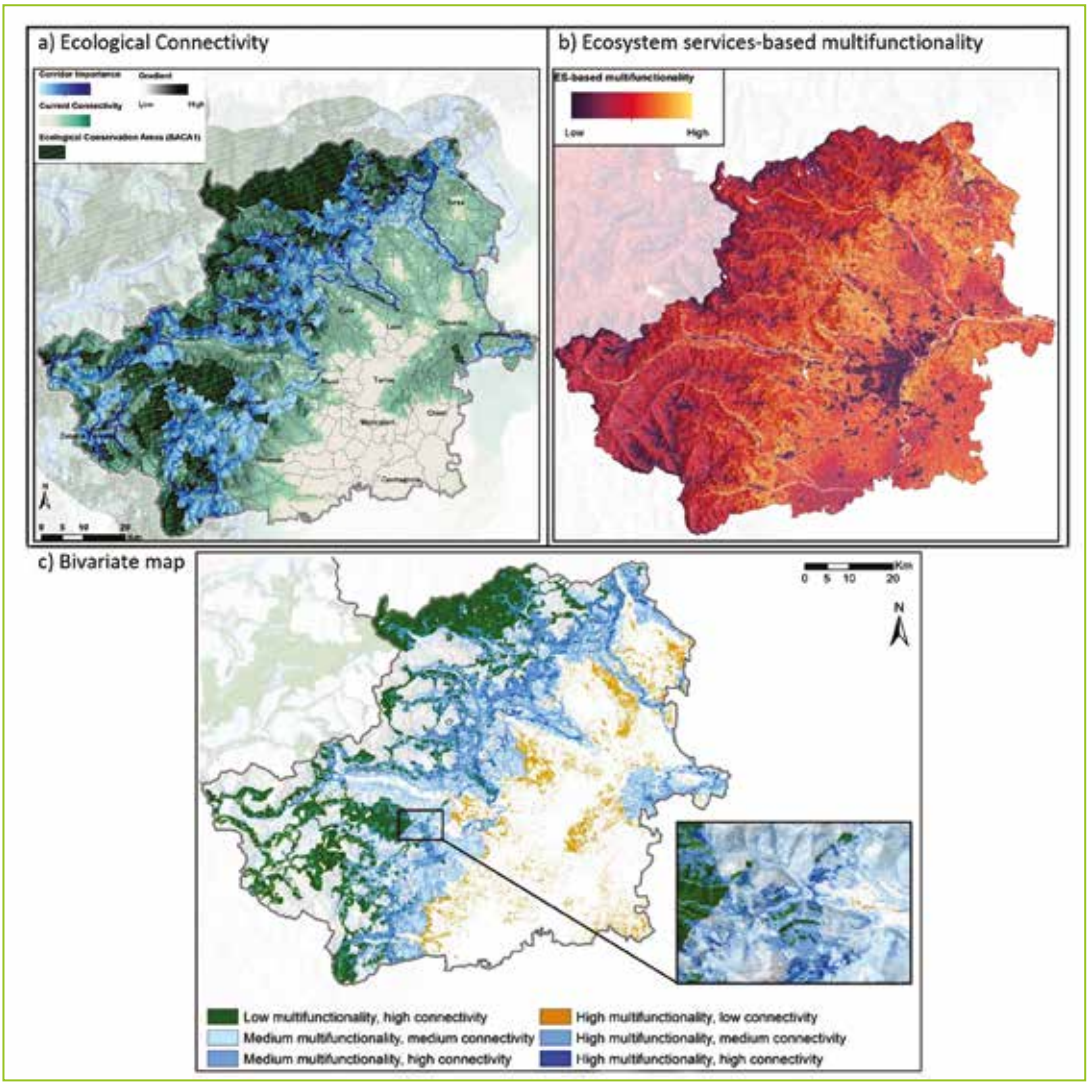

Figure 2.2 - *Illustrates how the ecological connectivity (a) and ecosystem services-based multifunctionality (b) assessments can be merged in a bivariate map (c) to identify synergies and those areas that provide ecosystem services and act as corridors at the regional level. The region of the metropolitan city of Turin (Italy) is brough as an example to illustrate the results.(own elaboration, 2021)*

- Suggestions for further applications

While in this chapter we have illustrated the methodological approach adopted in a transnational project such as LUIGI, similar assessments can also be conducted with different methodologies that might be more suitable for regional assessments (Estreguil *et al.*, 2019).

Core conservation areas, for example, could be identified according to regional priorities and legislations or to the habitat requirements of different target species. Values for landscape resistance could also be adapted to better reflect the

permeability of regional land uses to the animal species taken in consideration. While we appreciate ecological connectivity assessments based on cost-weighted distances, we acknowledge the existence of other methodologies based on patterns and morphological assessments (*e.g.*, Guidos toolbox).
Likewise, the ecosystem services-based multifunctionality assessments can be carried out using different indexes measuring multifunctionality (eg. Alpha-diversity, Beta-diversity as in Hölting *et al.*, 2019), over different areas (whole study region or clusters of land uses), with different sets of ecosystem services (all ecosystem services or specific bundles as in García *et al.* 2020). Moreover, as long as several and diverse ecosystem services indicators describing provisioning, regulating and cultural ecosystems services are considered, individual ecosystem services can be modelled in a variety of ways, with different levels of complexity (Grêt-Regamey *et al.*, 2015). Ecosystem services indicators could for example be retrieved from the Europe-wide assessments (JRC's ESTIMAP) or modelled fairly easily with the suite of InVEST tools (see for example the compilation of tools described in the **LUIGI deliverable D.T1.1.2**). Assessments conducted at a regional level should aim to use high-resolution datasets (*eg.* high-resolution land use maps used by the regional administration) and models that allow to get biophysical indicators describing as accurately as possible the actual provision of ecosystem services. In some cases, it might also be suitable to model not only the supply but also the demand, and therefore the flow, of ecosystem services in the region.

2.3 Conclusion

Mapping ecosystem services-based multifunctionality and ecological corridors between areas with high ecological value can support practitioners in identifying a green infrastructure network that benefits both society and biodiversity. This framework is in line with guidelines of the European Union and its Joint Research Centre, and with recommendations from the latest academic literature. The methodological approach presented here can be adapted to cater for different levels of technical expertise and data availability, and allows to capitalize from previous Alps-wide and regional projects. We believe that the present approach represents a sound transferable framework that can be applied in different regions of the Alpine Space to meet European policy goals, mitigate and adapt to climate change, and halt biodiversity loss.

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SECTION I

Chapter 3

Enhancing ecosystem services-based multifunctionality and ecological connectivity in the Alpine Space

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Abstract
In this chapter we draw on the lessons learnt from the mapping of ecosystem services-based multifunctionality in different case study regions of the Alpine Space to better characterize multifunctional alpine landscapes. Specifically, we discuss how ecosystem service-based multifunctionality can be assessed through different approaches, we describe the bundles of ecosystem services provided by different land use categories, and we illustrate the importance of landscape heterogeneity for enhancing multifunctionality and the permeability to animal movement.

Keywords: Ecosystem services-based multifunctionality, landscape heterogeneity, green linear elements; synergies and trade-offs.

3.1 Introduction

Nature-based Solutions and Green Infrastructure aim to enhance ecological processes and to harness the multifunctionality of ecosystem to support biodiversity and human well-being. Ecosystem multifunctionality indeed allows natural areas to provide multiple and diverse ecosystem services, helping to address simultaneously different societal challenges, such as water and food security, climate change mitigation and adaptation, disaster risk reduction and sustainable development. In order to support practitioners and policy makers in identifying multifunctional areas and the factors associated with high ecosystem services-based multifunctionality, in this chapter we describe some of the lessons learnt from mapping at high resolution (25 m) 11 provisioning, regulatory and maintenance, and cultural ecosystem services across multiple case study regions of the Alps. In particular, we will discuss i) how different approaches to interpreting multifunctionality affect the outcome of multifunctionality assessments, ii) how ecosystem services are provided in bundles across different landscapes iii) how high levels of multifunctionality are linked to landscape heterogeneity and, iv) how management practices affect multifunctionality at the local scale.

3.2 Approaches to the assessment of multifunctionality

Assessing ecosystem multifunctionality is by no means a trivial task and largely depends on which assumptions and methodological approaches are adopted (Manning *et al*., 2018). The spatial scale of the analysis, for example, affects the way ecosystems, natural features, and their related ecosystem services are included in the analysis (Laterra *et al*., 2012). At the local patch or plot level, multifunctionality is the

result of the structure, processes and functions of ecosystem, and can be enhanced by increasing species diversity and the structural complexity of land plots. At the landscape and regional levels, multifunctionality is instead the result of greater configurational complexity (Mastrangelo *et al.*,2014) and is also driven by geographic and climatic factors (Hölting *et al.*, 2019a).

The outcomes of multifunctionality assessments, moreover, greatly depend on the type of ecosystem services included in the analysis (Mouchet *et al.*, 2017) or on how the single ES are aggregated into a single multifunctional metric (Hölting *et al.*, 2019b). In this study, an integrative approach was used that considers provisioning, regulating and cultural services equally. Moreover, an averaging approach based on the 11 ES maps was adopted to derive the final multifunctionality indicator at the ecosystem level. In fact, our aim was to analyse the relationship between sometimes contrasting sets of ecosystem services and to identify landscape planning strategies that can best exploit the synergies occurring between different sets of ecosystem services. In particular, the following ecosystem services were mapped in the framework of the LUIGI Alpine Space project: crop potential, water provision

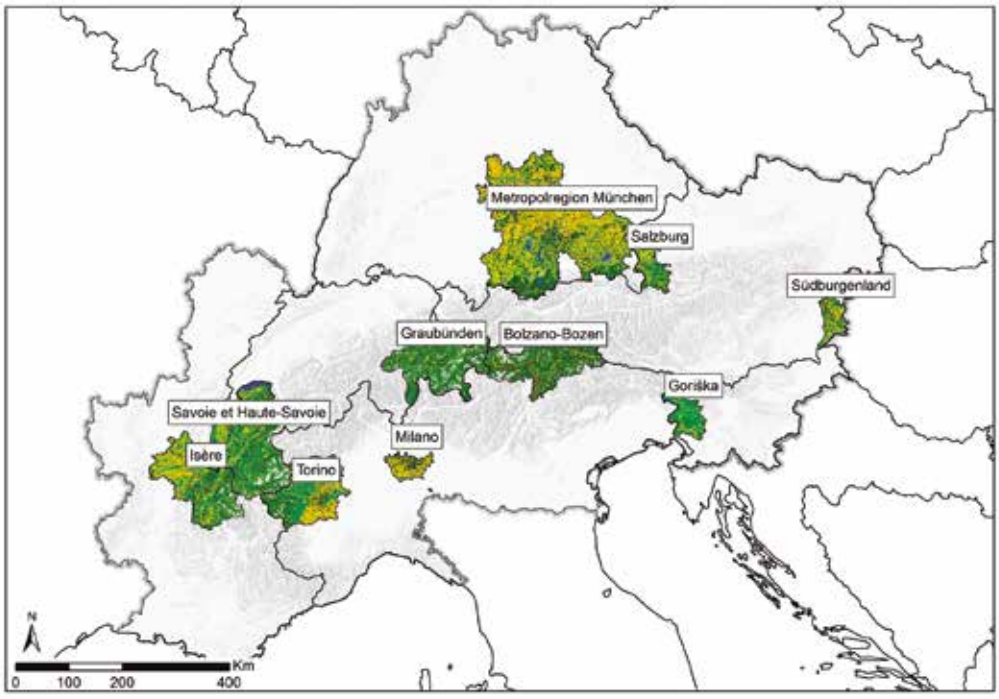

Figure 3.1 - *Regions of the EUSALP macro-region that have been analysed in the LUIGI project. Clockwise, starting from the west, we can find the regions of Isère (FR), Savoie and Haute-Savoie (FR), the metropolitan city of Munich (DE), the region of Salzburg (AT), Südburgenland (AT), Goriška (SI), the province of Bolzano-Bozen (IT), the Graubünden canton (CH), the metropolitan city of Milan (IT), and the metropolitan city of Turin (IT) (own elaboration, 2021).*

for drinking, fodder provision, timber provision, pollination potential, water flow regulation, water nitrogen filtration, carbon sequestration, natural hazard mitigation, outdoor recreation potential, landscape aesthetics (*see chapter 2*).
To identify the most multifunctional areas within different landscape types, we also mapped separately the multifunctionality of agricultural landscapes, forests, urban areas, and "open" areas above the tree line. On one hand, this eased the identification of the most multifunctional areas in a region and, on the other, it allowed to account for the different service provisioning capacities of distinct ecosystem types. Indeed, while forests are highly multifunctional and provide many regulating, maintenance, and cultural services in synergy (Felipe-Lucia *et al.*, 2018), high-altitude or farmed areas are often regarded to be less multifunctional (Mouchet *et al.*, 2017). This needs to be taken into account when performing a multifunctionality assessment across contrasting landscapes, such as the one presented here (*Figure 3.1*).

3.2.1 Provision of ecosystem services by different land use groups in the LUIGI pilot regions

The modeling and mapping of ecosystem services, and the subsequent analysis of ecosystem services-based multifunctionality at landscape scale has led to the identification of common patterns and trends across the LUIGI project pilot regions. In the following paragraphs, we describe the provision of ecosystem services in four main land use categories across the Alps, namely agricultural landscapes, forests, urban areas, and open areas above the timber line.
In our analyses, we considered **agricultural landscapes** to be composed of a mix of croplands, pastures, vineyards, orchards, green linear elements such as hedgerows, and small woody features. In such complex agricultural landscapes there is, as expected, a high provision of ecosystem services related to farming (*Figure 3.2a*). Crop potential and fodder production is very high (mean=69 and 45, respectively) given that most of the current agricultural areas are optimally located in areas with favorable conditions and a high number of growing degree days available. The service of nitrogen retention is also quite important (mean=46) due to the fact that in farmed landscapes the load of nutrients deriving from fertilization is typically high. Moreover, since other regulating and cultural ecosystem services, such as run-off retention, carbon sequestration, pollination potential, landscape aesthetics and outdoor recreation, display values close to the LUIGI pilot regions average, agricultural landscapes have resulted being some of the most multifunctional landscapes, with an overall ecosystem services provision average of 35.
In **forests**, most of the ecosystem services provided display values above the average, making forests highly multifunctional landscapes, with an overall ecosystem services provision average of 33 (*Figure 3.2b*). The highest values for timber potential, carbon sequestration, run-off retention, natural hazard mitigation and outdoor recreation

are found in forested areas. Forest functions and ecological processes, especially in broadleaf forests, foster water infiltration and slow water movement, reducing soil erosion and the risk of mudslies (Oven *et al.* 2020). Being a natural and generally

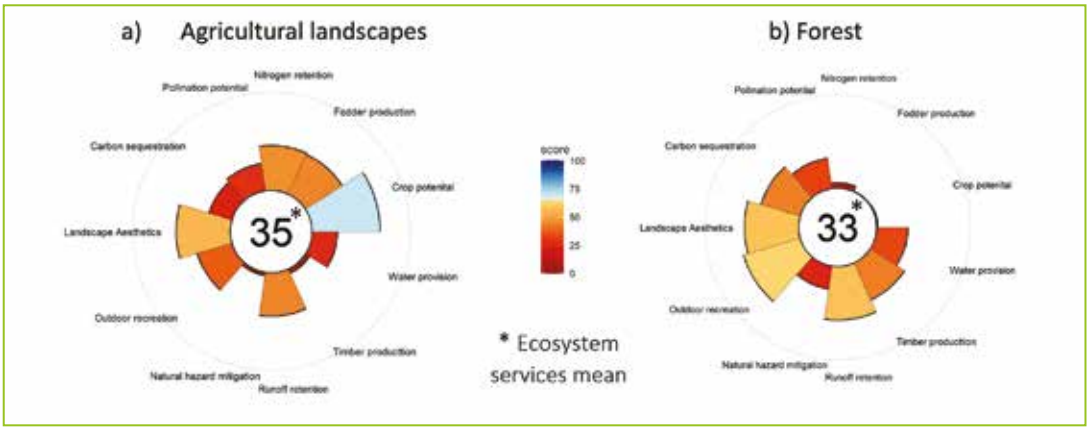

Figure 3.2 - *Ecosystem service provided by a) agricultural landscapes and b) forest. Agricultural landscapes include cropland, pastures, vineyards, orchards, and green linear elements such as hedgerows and small woody features (own elaboration, 2021).*

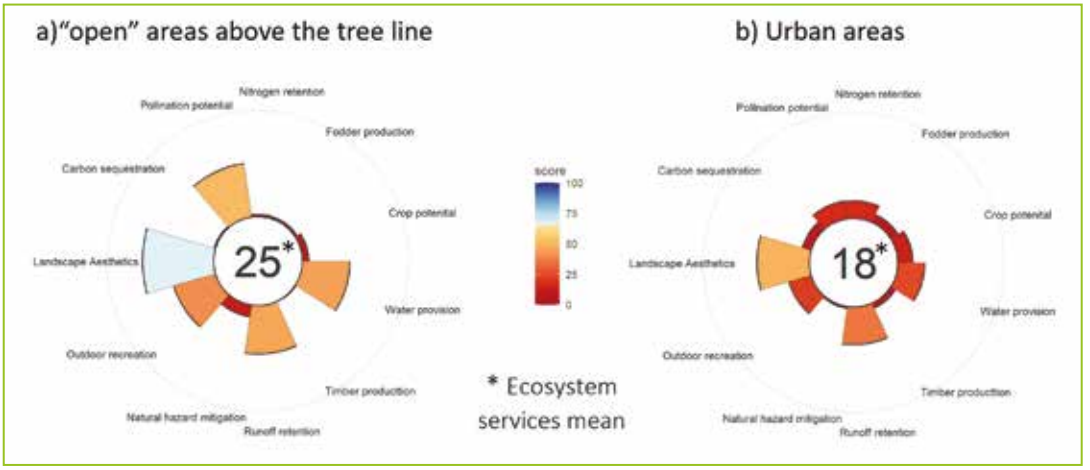

Figure 3.3 - *Ecosystem service provided by a) "open" natural areas above the tree line and b) urban areas (own elaboration, 2021).*

accessible land use type, forests also support outdoor recreation.

Extensive, natural areas above the tree line, which we refer to as "open" areas, include alpine natural grasslands and shrubland, sparsely vegetated areas, moors and sclerophyllous vegetation, bare rocks and areas permanently covered by snow. While these areas are crucial for biodiversity and for species living only in alpine conditions, such high-elevations areas exhibit low ecosystem-services multifunctionality (overall ecosystem services provision average of 25, *Figure 3.3a*). Nonetheless, alpine grasslands are particularly important for supporting pollinator

insect species and for absorbing rainwater, recharging groundwater levels. Such "open" alpine areas, moreover, greatly improve landscape aesthetics, fostering tourism activities.

Urban areas have, generally speaking, the lowest values of ecosystem-based multifunctionality (*Figure 3.3b*) due to the limited amount of natural and semi-natural spaces in urban areas. Urban parks, however, play an important role absorbing rainwater and stormwater run-off and are also relatively important for providing greenspaces for outdoor activities (i.e. urban parks).

- Synergies and trade-offs among ecosystem services

Some sets of ecosystem services are consistently associated across space or time and give rise to ecosystem services bundles (Raudsepp-Hearne *et al*., 2010). For example, carbon sequestration, the potential supply of timber and soil erosion mitigation are positively correlated because all these ecosystem services originate from the same or similar ecological process, i.e., the transformation of carbon dioxide into biomass through photosynthesis by the tree, which also grows roots through the soil. Forests indeed often display high multifunctionality values due to their capacity to simultaneously supply ecosystem services that share synergistic relationship, i.e., the provision of one service does not hamper the simultaneous provision of another one (Felipe-Lucia *et al*. 2018; Orsi *et al*., 2020).

On the other hand, some ecosystem services are negatively correlated because they usually originate from different geographical or ecological characteristics (Turkelboom *et al*., 2018). For example, outdoor recreation is negatively correlated with agricultural ecosystem services such as crop potential and fodder production.

Table 3.1 - *Correlation matrix between ecosystem services. Moderate correlations in Italics (0.3 ≤ ρ < 0.50), strong correlations in Bold (ρ ≥ 0.50). Crop potential (CP), Carbon sequestration (CS), Fodder production (FP), Landscape aesthetics (LA), Nitrogen retention (NR), Outdoor recreation (OR), Pollination Potential (PP), Runoff retention (RR), Timber production (TP), Water provision (WP), Natural hazard mitigation (NHM) (own elaboration, 2021).*

	CP	CS	FP	LA	NR	OR	PP	RR	TP	WP	NHM
Crop potential	1										
Carbon sequestration	0.08	1.00									
Fodder production	**0.91**	0.13	1.00								
Landscape aesthetics	*-0.40*	-0.25	*-0.37*	1.00							
Nitrogen retention	**0.88**	0.10	**0.87**	*-0.37*	1.00						
Outdoor recreation	**-0.52**	*0.46*	**-0.50**	0.22	**-0.53**	1.00					
Pollination potential	-0.20	-0.18	-0.26	0.18	-0.26	0.15	1.00				
Runoff retention	*-0.31*	*0.44*	-0.30	0.01	*-0.30*	0.50	0.30	1.00			
Timber production	*-0.41*	**0.85**	*-0.42*	-0.03	*-0.38*	**0.69**	-0.02	**0.57**	1.00		
Water provision	*-0.38*	0.00	*-0.38*	0.27	*-0.41*	*0.35*	0.21	*0.35*	0.21	1.00	
Natural hazard mitigation	**-0.51**	0.13	*-0.46*	0.16	*-0.48*	*0.48*	0.13	*0.42*	*0.37*	0.28	1.00

This occurs due to the fact that agricultural landscapes offer a limited possibility to perform outdoor activities, and the access to fields, pastures and hay meadows may even have a negative impact on yield.
As expected, also in our analyses some of the ecosystem services mapped displayed strong positive or negative correlations (*Table 3.1*), indicating that some sets of ecosystem services are delivered in bundles.
In order to enhance the overall provision of ecosystem services from the landscape, being aware of the strength and the type of associations between ecosystem services is critical, given that certain management practices might have a positive effect on a set of ecosystem services, and a negative effect on others.

3.2.2 Multifunctionality in heterogeneous landscapes

Complex agricultural landscapes featuring high shares of natural vegetation provide multiple ecosystem services because different bundles of services are delivered by each of the different ecosystem types. In a heterogeneous landscape featuring a mix of agricultural and forested areas, for example, a set of ecosystem services stemming from agro-ecosystems (crop production, fodder production, nitrogen retention)

Figure 3.4 - Land use associated with the highest ecosystem service-based multifunctionality in comparison to the overall land use composition of the Luigi pilot regions (own elaboration, 2021).

would be combined with a set of ecosystem services related to the presence of natural vegetation (carbon sequestration, timber provision, run-off retention, protection from natural hazards).

Our analysis has shown that some of the highest ecosystem services-based multifunctionality values are generally found in those areas at the feet of mountains displaying complex agricultural landscape patterns, featuring a mix of pastures, wood plots, and green linear elements such as hedgerows.

Vineyards, pastures, broadleaves forests, trees in agricultural settings, and green linear elements are indeed the landscape elements mostly associated with the highest levels of ecosystem services-based multifunctionality (*Figure 3.4*).

Areas with ecosystem service-based multifunctionality values in the top 10 percentile were considered to be "top" multifunctional areas. These areas were identified to better explore the distribution patterns and the characteristics of the most multifunctional areas that could become part of a regional Green Infrastructure network (*see chapter 2*).

The top multifunctional areas identified in the case study regions of the LUIGI project are particularly important for delivering crops, being reachable and attractive to tourists, supporting pollination, sequestering carbon, and mitigating the risk of

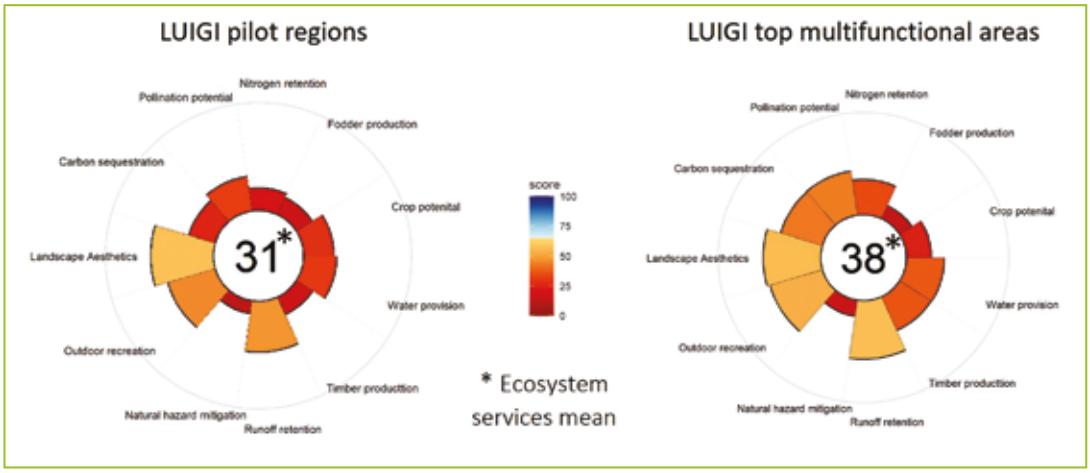

Figure 3.5 - *Ecosystem services provided by the most multifunctional areas, compared to the average provision of the whole pilot regions (own elaboration, 2021).*

floods by absorbing rainwater (*Figure 3.5*).

In complex and heterogeneous agricultural landscapes, natural vegetation benefits the provision of crops supporting pollination and the control of crop pests. Linear elements such as hedgerows also act as wind breaks and can limit the leaching of soil and nutrients into the water (Dainese *et al.*, 2017). Besides supporting agricultural production, green linear elements and woody feature provide habitat to a variety of species and act as ecological corridors and steppingstones, increasing the

permeability of agricultural landscapes (Collier, 2021). The presence of natural or forested areas on slopes moreover limits soil erosion and the risk of natural hazards. Complex landscapes with natural vegetation, finally, are usually more attractive to people and provide more opportunities for recreation in comparison to monotonous landscapes. Landscape heterogeneity is also generally positively correlated to biodiversity (García-Llamas *et al*., 2018).

3.2.3 The importance of local land management practices

While the analysis of ecosystem-based multifunctionality in LUIGI was carried out at landscape scale and did not take into consideration the effects of local management practices (*i.e.* land use intensity), there is mounting evidence that such practices greatly affect the ecological quality and the biodiversity of natural and semi-natural ecosystems (Balzan *et al.,* 2018), influencing their resilience and their capacity to deliver ecosystem services (Turkelboom *et al*., 2018).

Intensively managed forest, for example, often feature a single tree species planted at very high densities. This may be beneficial to maximize timber production but also reduces the resilience of forest plots to windstorms and other extreme events (Pretzsch *et al*., 2013). Moreover, the absence of diverse and native tree species reduces the habitat availability for many local animal species. Eventually, intensively managed plots and clear-cutting practices can also affect the nature recreation and aesthetic capacities of forested landscapes (Bliss J.C, 2000).

In the agricultural context, sustainable practices such as organic and conservation farming limit soil disturbance and the use of synthetic fertilizers and pesticides, while fostering crop diversification and soil organic cover. Such management practices improve soil health, limit the leaching of chemicals in water streams and increase the resilience of crops (Chabert & Sarthou, 2020). The presence of natural and semi-natural landscape elements in agricultural areas, such as hedgerows or woody features, supports the provision of ecosystem services and improves the permeability of agricultural landscapes, increasing ecological connectivity (Dainese *et al*., 2017).

In the Alpine context, orchard meadows are a good example of a traditional and extensive land use that typically provides high quality edible fruits while supporting multiple ecosystem functions and services (Forejt & Syrbe, 2019). The complex, multi-layered habitat structure featuring perennial fruit trees and semi-natural grasslands indeed supports high levels of biodiversity (Horak *et al*., 2013). This contributes to biodiversity conservation, pest and disease control, crop pollination, and the production of hey, honey and other beekeeping goods. Ground vegetation, roots, and healthy soil microbial community contribute to the regulation of water flow and quality, nitrogen fixation, organic matter accumulation, and soil formation (Maes *et al*., 2016).

3.3 Conclusions

Our integrative analysis of 11 regulating, provisioning, and cultural ecosystem

services allowed to map ecosystem service-based multifunctionality in agricultural landscapes, forests, urban areas, and "open" areas above the tree line. Strong positive and negative correlations between the 11 ecosystem services led to the identification of ecosystem services bundles that are consistently associated and that originate from similar geographical or ecological characteristics. The analysis of ecosystem service-based multifunctionality across multiple case study areas of the alpine region found that complex and heterogenous agricultural landscapes with a high share of natural vegetation are associated with high multifunctionality values. Heterogenous landscapes with compositional and configurational complexity indeed provide several sets of ecosystem services bundles simultaneously. Vineyards, pastures, broadleaves forests, hedgerows, and small woody features were found to be the landscape elements mostly associated with high levels of ecosystem services- based multifunctionality. While multifunctionality at the plot or patch level is the result of the structures, processes and functions occurring in each ecosystem, analyses performed at landscape or regional level can inform us on how multifunctionality is affected by the interaction of heterogeneous ecosystems and land uses, and by the different geographic and climatic conditions found in a region.

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SECTION II

Chapter 4

An economics for green infrastructures: concepts and tools

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Abstract

We propose a unified approach to recognising the economic value of green infrastructures (GIs) in urban and peri-urban areas of the Alpine region. This goal is addressed by combining three main activities: assessing the viability of markets for ecosystem benefits from regional GIs based on theoretical and practical tools; stimulating the identification of the role of regional GIs and their ecosystem benefits in the process of economic value creation, regional communities and ecological processes; and enhancing the visibility of the economic benefits from regional GIs for entrepreneurs by developing a tool (the GI Business Model Canvas) and some business model archetypes supporting the creation of new business based on the sustainable use of GIs, their services and benefits. The results of regional applications are also presented.

4.1 Introduction

Green infrastructures (GIs) are certainly sources of significant ecological services that support healthy and well-functioning ecosystems within urban and rural contexts, however their significance in delivering economic benefits to human societies has been limitedly investigated.

A variety of GIs are typically found in the urban and bordering rural and semi-rural areas of the countries around the Alpine arc, ranging from mountain forests to orchard meadows, hedgerows, farmsteads, urban and peri-urban parks, riparian areas. Each GI performs specific functions and delivers services valuable to the natural environment and the communities depending on and actively using the land where they localise.

Similarly, the territories hosting GIs show a remarkable diversity not only from an environmental point of view but also when looking at their social and economic variables. Such a diversity is visible through the plurality of rural and urban landscapes in the Alpine and peri-alpine regions that shape different communities and local economies, expressing their own needs, preferences, wants and visions of the future.

Frequently the GIs found in rural and peri-urban regions are public goods that have been providing their services from time immemorial with no significant burden for local communities. Traditional uses of some GIs allowed for the conservation of them and their services over time. Though, often those uses are no longer attractive or economically sustainable which dramatically reduces the human, material, and financial resources available for managing the GIs.

Against this background, the search for an economically grounded approach for

managing GIs has turned into a concrete challenge. The topics of beneficial societal and economic effects of, and financing methods for nature-based solutions (NBS) and GIs especially in urban areas received a growing attention from researchers and practitioners over the last few years. However, there is still limited awareness on how to turn those benefits into values that may feed new markets where a demand for the services and benefits from GIs is recognised by consumers, enterprises, actors across smaller or wider value chains, and public administrations.

The paragraphs that follow aim at proposing a unified approach to recognising the economic value of GIs in urban and peri-urban areas of the Alpine region. This goal is addressed by combining three main activities:

- assessing the viability of markets for ecosystem benefits from regional GIs based on theoretical and practical tools and checklists (*4.1 Understanding the territorial potentials*);
- stimulating the identification of the role played by regional GIs and their ecosystem benefits in the process of value creation for economic actors (e.g. firms in specific industries), regional communities (*e.g.* social groups, citizens, policy makers), and ecological processes (*e.g.* biodiversity conservation) (*4.2 Green Infrastructures value chains)*;
- and enhancing the visibility of the economic benefits from regional GIs for entrepreneurs by developing a tool (the Green Infrastructure Business Model Canvas) and some business model archetypes supporting the creation of new business based on the sustainable use of GIs, their services and benefits for value creation (*4.3 LUIGI value chains and business models*).

The combination of the above-mentioned activities frames the basis for a "regional ecosystem stock exchange" (RESE) that is expected to provide elements in support to the proper functioning of markets for regional GIs and their benefits. The ecosystem stock exchange may collect information on the ecological, economic and governance aspects of GIs in the Alpine region and disclose it to stakeholders potentially interested to invest in the construction, management, and maintenance of GIs for economic, social, or institutional reasons.

As a whole, the Chapter can be read as a tentative contribution to consolidate the economic and business case for regional GIs, based on a collection and focused elaboration of existing market and business experiences and methodologies.

4.2 Green Infrastructure and markets. Understanding the territorial Potential

Green Infrastructures, as peculiar ecosystem structures and functions, provide a range of services from which benefits of different types descend. These services are typically supplied simultaneously (though conflicts are possible) and can produce several benefits participating in determining more dimensions of the wellbeing of a society. Particularly, and for reasons of simplicity, it is possible to assume that the benefits from GIs are grouped according to the three typical dimensions of

sustainability they more directly address, *i.e.*, environmental, economic, and social. The ecosystem services (ESS) derived from biophysical structures and functions become benefits when they are perceived as such in the social and economic system, as shown in *fig. 4.1.*

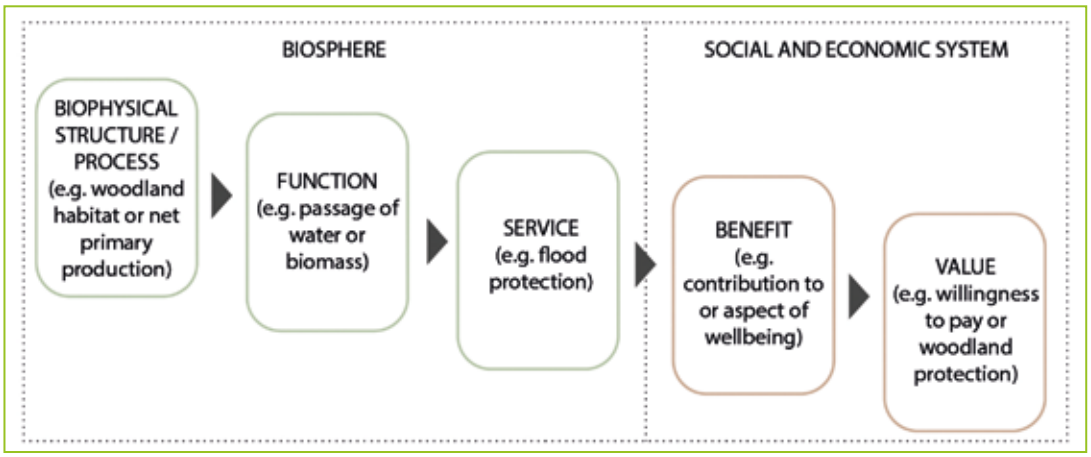

Figure 4.1 - *Ecosystem Service cascade model (Croci and Lucchitta, 2021).*

It is essential to identify potential beneficiaries for assessing any type of benefit, and identifying the services being responsible for its delivery. Additionally, a single service can participate in delivering multiple benefits, for example water regulation provides flood prevention, drinking water, and recreation potential.

When the demand for ecosystem services is explicitly expressed and the benefits are assessed, values can be traded in some forms of markets. The benefits derived from ESS touch upon a wide range of issues. Some of them have a direct impact on economic activities and are easily translatable into values. Few economic sectors (e.g., agriculture) evidently depend on the products from the land. Moreover, the quality of GIs contributes to improve place attractiveness and to create open public spaces for recreation and leisure, fostering tourist activities and raising local property values.

Other benefits are less directly visible, but even more essential for human wellbeing. GIs can be carbon sinks which play a pivotal role in climate change mitigation strategies. The value of carbon storage and sequestration may be assessed and converted into monetary measures. International carbon trade schemes, but also local planning tools of payment for ESS have been proliferating lately. GIs also improve local environmental conditions and supply services that are needed in climate adaptation strategies. GIs contribute to water management and flood mitigation, heat mitigation, noise and pollution reduction. These benefits assume a particular significance in urban contexts, where nature-based solutions (NBS) limit the negative effects of the combination of uncontrolled urbanisation processes and climate change. For instance, the economic value of these benefits may be assessed

by calculating the avoided costs related to healthcare, grey infrastructures and disaster-related damages.

In the LUIGI framework, the suitability of the pilot regions has been assessed to host markets that foster the recognition of ecosystem benefits and the generation of social and economic values out of GIs. By starting from a tentative set of ESS and the possible associated benefits, the existence of some distinctive features (market conditions) is checked in the pilot regions in order to assess market feasibility and potential for the ESS deriving from regional GIs.

When economists refer to potential markets for ESS, they are focusing on transforming the benefits of services produced by the ecosystems into visible values. All economic sectors and individuals are dependent on ESS, however ecosystems and the services that they provide can be damaged by human activities or other shocks (e.g., climate change). Those damages intuitively correspond to economic and welfare losses.

Economics has traditionally taken all the ecosystem services (e.g., clean air) and goods (e.g., water) for granted, by focusing only on the commercial value of land and depletive uses of resources (e.g. oil and minerals extraction). This led to an undervaluation of ESS since the market prices capture just a small share of their values by ignoring either the other benefits that ecosystems provide to the economy or the society or the impacts that human activities show on natural resources. The "invisibility" of ESS has implied *overexploitation* (e.g., the cost of damages to ecosystems is external, so not totally perceived by the responsible subject for the exploitation of ESS) and under the provision of those services and benefits that ecosystems provide – since the benefits are not captured by market prices. The benefits of ESS are likely to become more visible only through regular use of inclusive measures of sustainable development to assess the progress of societies that help estimate their social, environmental and economic ecosystem values. It has been demonstrated, for instance, that ESS make important contributions to 41 SDGs targets (Wood *et al.*, 2018).

Many potential markets for ESS have not emerged because of the invisibility of the services and benefits and the high transaction costs associated with them, particularly where many of the desirable institutional characteristics for creating markets are not met. Following the market design theory, three main conditions have to be met for creating functioning markets (Roth, 2008):

- a large number of participants;
- the availability of adequate information on the objects of the transactions (i.e., ecosystem benefits and values);
- the reduction of the transaction costs, associated with the large number of participants.

In a market which takes into consideration the values derived from GIs and aims to support ecosystem benefits, the assessment of ESS and their societal benefits is of vital importance. That means identifying the ESS that are likely to generate the highest

benefits to the community[1]; measuring the qualities being traded, by determining what is being traded/purchased and, therefore, protected; identifying the actors who benefit from ESS and those who contribute to supply them by planning and managing GIs; and using clear measures of exchange (currency) as the basis of the transaction to capture the significant values exchanged.
For this purpose, the LUIGI project investigated some features of the pilot regions and of the case study areas. More specifically, a questionnaire has been designed to cover the following dimensions (*see Table 4.1*).

Table 4.1 - *Questionnaire circulated in the Pilot Regions ((own elaboration, 2021).*

First part (Pilot region)	Second part (Case study area)	Third part (Green infrastructures)
Regional economics, competitivity (e.g., net business population growth, employment by economic sector)	SDGs covered by the ecosystem services in the area	Ecosystem services and benefits
Demographic and social indicators (e.g., educational attainment level, unemployment, creude rare)	Institution and governance (e.g., - List of institutions involved in the governance of the case study area; list of territorial plans and green legislation (for each institution); Green subsidies (for each institution): existing public subsidies that condition the supply of ESS (e.g., subsidies for agriculture)	Trade off (e.g. tourism vs regulating services, profit from agriculture vs biodiversity)
		Stakeholders: co-providers and beneficiaries (e.g., list of companies involved and role; motivation to sell: ngos involved and role (management, fundraising...); list of institutions involved and type of management (direct, contracted-out))
		Mediators
		Possible conflicts

The first part of the questionnaire investigates the regional economic context whereby the markets for ESS may emerge. Information on regional competitiveness, economic sectors, employment, social capital and public investments help comprehend the large picture in which the GIs are situated and how the values derived from GIs may be integrated into the existing markets.
The second part looks at the governance of specific areas: the institutions, the NGOs

[1] This method would involve a bio-economic modelling procedure that would estimate the scale of benefits from increasing the provision of the relevant ecosystem service and comparing these to the costs of production.

involved in green management, instruments like local territorial plans and subsidies for private actors. Moreover, it looks at how the GIs in the area help address sustainable development targets, by reporting which SDGs are affected by the benefits of the local GIs.

Finally, the third part looks more closely at the GIs. It asks for information about the perceived ESS and benefits, the possible trade-offs, and the actors who benefit and contribute to provide ESS. Here the stakeholders are defined according to their positioning towards the benefits provided by GIs, and hence to their potential role in a market for ESS. The co-providers - being those who collaborate on green planning, management and stewardship - are potential sellers in a market for ESS. The beneficiaries are those who have access to the benefits and therefore constitute the potential demand for ESS, i.e., those who are willing to pay for ESS. This analytical division is in fact quite problematic, since co-providers and beneficiaries are blurred categories, and the beneficiaries are often involved in some sorts of GI management activities. However, such a typology helps highlight the demand side, delving into different stakeholders' perspectives.

The perceived trade-offs between ESS and the possible conflicts between stakeholders help face the complexity of the ecosystem dynamics and the peculiarities of markets for ESS. The mediators, or facilitators, are those actors who can facilitate the exchange between the stakeholders, providing information and reducing conflicts and transaction costs.

Overall, the above-mentioned questions constitute a first informational basis to understand the viability of territorial markets for ESS and to detect the main elements of ESS markets: the participants, the values to be traded, the governance and institutional rules, and the macro-economic regional context.

The analytical approach suggested above focuses on assessing the general feasibility of ESS markets based on an analysis of general features concerning GIs, benefits and stakeholders. However, the connected benefits can require special market and business structures to be conveyed to different groups of beneficiaries aiming to generate economically sound exchanges.

4.3 Green infrastructures value-chain: incorporating natural benefits in territorial value chains

The Value Chains (VC) are a sum of activities that can be analysed to study a productive economic system. The VC analysis allows displaying the mechanism that transforms the benefits generated by GIs into multiple values perceivable by the stakeholders. A VC can be defined also in a specific area or territorial context. The assumption of a regional scope for VC does not only design a perimeter where the VC operates but precisely identifies the locality where the value is generated. In general terms, the origin of value along a VC seems to depend on its inter- and intra-linkages with other organisations and stakeholders and their dynamics, where a company

or an association is embedded and integrated. Especially for companies relying on significant territorial assets and resources e.g., GIs, that are not limited to financial and typical developmental variables, the access to localised assets, services and groups is essential for value creation. According to the theory of ESS, it is possible to identify services and a set of attached benefits for each specific GI using standard benefits from literature review and some results from locally administered questionnaires in the project pilot regions. When services specifically originate in areas with not (easily) replicable features, as it is typically the case with ecosystems and natural GIs, their benefits can directly participate in shaping a regional category of value added (VA) that can become a strategic competitive advantage for some VCs and the firms that shape them. Recognising and disclosing the opportunity to create economic value from a combination of regional GIs and stakeholders can attract investors and entrepreneurs and spur the growth of ESS-based markets in the region. Such an advantage would be difficult to obtain elsewhere and depend on a special linkage of a firm or VC with the territory from which the benefits derive, based on an ecological - even though human mediated - connection. Several economic sectors depend on ESS from GIs (TEEB, 2010). Often ecosystem goods and services originating from GIs enter in regional VCs and contribute to value creation. Not all the links between GIs and values within VCs are direct. Sometimes transformations or intermediate steps are required to extract values and bring them into the production process of a firm. For instance, in the case of Forestry, GIs directly provide raw material, while in Cosmetics, the active ingredients provided by a specific plant need to go through a specific process before entering as a value in the VC.

- Creating values from ecosystem benefits: an idea for GI value chains

The LUIGI project investigates a unique type of VC based on its link to ecosystems, ESS and benefits. Particularly, the project has focused on those values that originated from GIs through a process included in the resulting VC. The GI-VC for the purpose of the LUIGI project is a special type of VC receiving inputs from GIs and delivering outputs (as value propositions, or proposed values) that incorporate those inputs. Aiming at illustrating the transformation process that takes place along the GI-VC, its essential components (inputs and intermediate products), its activities (primary and support activities) and phases, the participating actors or stakeholders, and its feedback on the GIs need to be considered in any attempt to perform a VC analysis. To better clarify our line of reasoning, we deem fundamental to describe the following general aspects of the GI-VC can be identified as follows:

1. the GI-VC as a comprehensive process interacting with physical, ecological and social context and elements outside the VC itself,
2. the stakeholders intervening along the GI-VC and their roles with special reference to their relationship with the GI-VC activities, the inputs and especially the GI-benefits entering the VC, the outputs and proposed values (PVs) positioned at the end of VC,

3. the beneficiaries and potential users of the benefits from the GI and the resulting proposed values at the end of the VC.

Fig. 4.2 shows the main processes under investigation, their components, and interlinkages as well as a selection of stakeholder types intervening in different phases of the VCs.

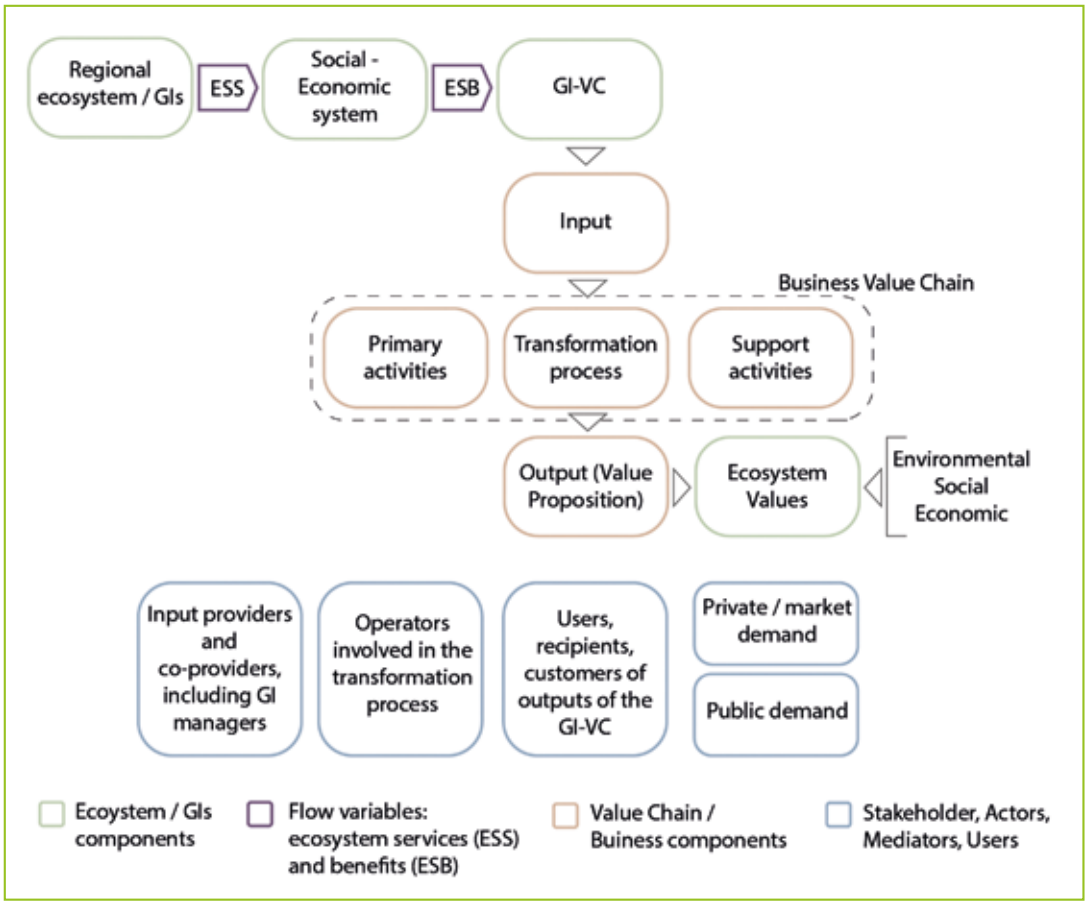

Figure 4.2 - *The GI-value chain ((own elaboration, 2021).*

The steps of the procedure to obtain a GI-VC are shown in *fig. 4.2*. The first step has regarded the description of the relationship connecting regional GIs to VCs for the creation of recognisable values. In the LUIGI framework, ecosystems are seen as stock resources present in different pilot regions that deliver a set of services benefiting the society and the economy at large. Ecosystems deliver services, seen as flows, that in turn generate benefits (other flows) to the society, including the environment and the economy. Those benefits hold societal significance which means that they affect part of the society and can enter VCs as inputs susceptible to be transformed through processes included in the VC into outputs valued by some stakeholder groups. The VC

where benefits enter as inputs can refer to a region, a single organisation or firm, or a network of organisations interacting with each other. In all cases, benefits undergo a transformative process inside the VC that can be further investigated, for instance by identifying primary and support activities and developing a typical business VC analysis. The result of the transformative process inside the VC can be referred to as "ecosystem value" (or GI value) meaning that the origin of the value is recognised by some groups of beneficiaries expressing a demand for the benefit and a relative willingness to pay for it rests into the ecosystem or GIs. It is worth recalling that the transition from benefits to values rests on the ability of the VC to identify significant benefits and posit them as values through an activity of "value proposition" by which the demand from the market (private) or institutions (public) is met or stimulated[2]. Secondly, it is essential to identify the types of values resulting from a VC. We assume that demands exist for different types of values but concentrate on the three Triple Bottom Line's (TBL) categories of environmental, social and economic ones. Under this point of view, there is a rich variety of categories of services, benefits and values identified in literature on ESS. At any rate, benefits suitable to undergo the transformation through VC can generate different values suitable to be integrated, e.g., by means of paradigms such as the one of Shared Value (CSV) enhancing "the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" (Porter & Kramer, 2011).

We posited as a necessary condition for any values to exist that there is a demand for them, as required by any market or quasi-market paradigm. The demand supporting any values can be expressed by different groups of beneficiaries and may assume monetary or other forms. We also notice that values are relative to the social and economic context where they materialise. As a consequence, when presenting VCs, we also discuss the conditions being necessarily associated to value creation, identification and analysis that refer to some of the conditions posited for the operation of efficient markets, and typically reproduced through market design exercises.

A firm's competitive advantage may depend on a plurality of values of different types. Since competitiveness is a central characteristic of all markets, a good VC analysis helps understand the specific process of value creation for a firm localised in a given region where a set of well-defined ESS originating from regional GIs has been found and delivers clear societal benefits. The study of the VC and the analysis of the resulting different values are essential building blocks for developing a long-lasting system for value proposition, capture, and distribution often called "business model".

4.4 Business models as tools to valorise green infrastructures

The Business Model (BM) concept (Osterwalder, 2005) represents the rationale of

[2] The transition mentioned here is one of the core-aspects in the section dedicated to business models for GIs in the framework of LUIGI.

how an organisation – such as a firm – creates, delivers, and captures value for itself, its clients, and society. All BMs aim at explaining and possibly replicating the way in which economic value is created and prosperous economic activity conducted by business organisations. A BM attempts to explain the reasons of business success that cannot be directly related to a single dimension responsible for value creation. A BM is a unit of analysis that captures various interdependent sources of value, including efficiency, complementarities, lock-in, novelty and focuses on how transactions, structures and governance are designed within an organisation (Amir & Zott, 2012).

- The concept of Sustainable Business Model

BMs can be analysed with two different purposes: first, they can deliver sustainable values associated with financial value (e.g., ecological and social values); second, they can be used to support the implementation of sustainable actions or projects – including financing GIs' construction, management and maintenance.

BMs show a significant ability to address some of the limits to obtaining satisfactory markets for ESs. Firstly, BMs can increase the number of participants in the market by incentivising new firms to supply ecosystem-based goods and services and a larger number of buyers for those goods and services embedding ecosystem benefits. Secondly, BMs can help to disclose some previously invisible ecosystem benefits and indicate directions for their economic use by realigning the market price of ecosystem-based goods and services with the shadow price incorporating the positive effects of those benefits. This directly addresses the safety dimension of markets by increasing and detailing the information available on traded goods or services. Thirdly, BMs focus on the design of business transactions, their efficiency and novelty by reducing market failures linked to informational problems and by creating values from the resulting gains. BMs can embed novel methods that reduce those transaction costs that hinder the markets for ESS to reach the needed critical mass and fluidity, such as the scarce frequency and uncertainty of transactions. The discussion on the benefits brought to ESS markets by BMs applies to the case of GIs. They show special characteristics that require to be considered when addressing both the above-mentioned purposes, of great relevance for markets for GIs.

Concerning the delivery of non-strictly economic values, GIs can supply a plurality of benefits to several groups localised in a territory, whose quantification is vital to stimulate financing of GIs.

Concerning the generation of funding for sustainable actions, projects and GIs, BMs can support the mobilisation of private and public finance needed to build, manage or maintain regional GIs over time. Sometimes smaller GIs projects can be aggregated and scaled up to the regional level with an increase of the willingness to invest in an aggregated portfolio from both public and private actors due to the smaller number of larger transactions.

In spite of the evidence of the multiple benefits provided by GIs, the tools for financing and supporting their development are not well consolidated yet. In particular, the BM tool shows some limits in addressing GIs-specific features, especially regarding value capture, lack of understanding on its applicability to GIs, and establishing a sound economic case where short-term actions and long-term goals are coupled and economically viable (Connecting Nature, 2019).
By combining the existing theoretical and practice-oriented contributions focusing on these two purposes, two specific tools have been developed to support the investment in GIs by private and public actors: the *GI-business model canvas*, and a few *GI-business model archetypes*.

- The LUIGI GI-BM Canvas

The Business Model Canvas (BMC) is a strategic management tool that can be used to define a business idea or concept, based on the fundamental blocks that shape the business, and explain its functioning and market success. The classical BMC is a reference model based on the similarities of BM concepts (Osterwalder and Pigneur, 2010). It typically includes nine categories, whose structure and reciprocal relations aim to create value. Depending on specific purposes, a few categories can be added.
The *LUIGI GI-based Business Model Canvas* is an experimental tool, designed in collaboration with some pilot regions[3], combining the Osterwalder and Pigneur's original BMC with the Sustainable BMC and the NBS Canvas. It aims to disclose the economic opportunities deriving from a comprehensive view of GIs. A special emphasis is assigned to the categories of *Value Proposition* where non-economic values belong, as potentially intercepting special social groups' demands; *Key Resources* where special assets and competencies for GI management can appear; *Key Partners* and *Key Beneficiaries* including intermediaries for ecosystem services and benefits and different social groups; *Cost Structure* and *Value Capture* where mechanisms for covering management costs and intercepting formerly invisible benefits can be hosted; *Governance* where alternative governance structures available to manage different GIs are reported.
The categories of the LUIGI GI-based BMCs are described in *Table 4.2*.

- The GI-BM archetypes

A Business Model Archetype is a wider concept than a BM. It includes some general characteristics common to different BMs oriented to achieving similar results (e.g., sustainability), that have been identified by a long-lasting tradition of applied research. Different BMs showing the common features set by the archetype can be included in it.

[3] Tests were done in the pilot region of the Metropolitan City of Milano (Italy), on the three pilot areas on the occasion of stakeholder meetings.

Table 4.2. *Categories of GI-based Business Model canvas and their descriptions (own elaboration, 2021)*

Category	Description	Questions
Value Proposition	How the value is generated, what is the trajectory that the value covers	What are the ecosystem services that create value? How can I valorize the ecosystem benefits of the GI through my business? What type of values can create my business (organisation) working on GI?
Key Activities	The activities related to GI, and that interacts with the GI.	What activities related to the GI will be improved, enabled, or supported?
Key Resources	The resources, both human and natural on which the business is based on.	What are the resources you need to make your activity working? How can you obtain them?
Key Partners	All the partners that cooperate with the organisation.	What are the stakeholders that contribute to activities on GI?
Key Beneficiaries	Beneficiaries that are connected to the organisation.	Who are the beneficiaries of your activity on GI?
Governance	The set of policies and plans that constitute the local governance.	Who are the agents interested in the GI? How is it managed? What are the tools to plan and program? How do they interact with our activities?
Channels	All the channels on which the products or service are sold.	How can we reach our clients and our organisation's targets? Through which channels? How can we integrate different channels?
Customer Segments	All the targets that are in the organisation range.	Who are the beneficiaries who are, or can become, clients, supplier, end-users of my value-creating activity?
Cost Structure	The architecture of costs of the organisation.	What are the main items of expenditure? How will you cover the costs? How will the beneficiaries pay products or services of our activity?
Value Capture	The kind of values and to whom they are generated.	What type of value will create your activity? How can it be measured? How will it be economically sustainable?
Socio-ecological Harms	The different harms that are present in the organisation.	How does your activity create negative consequences on the socio-ecological context in which it operates? What are these consequences? How do you reduce them?

Therefore, an archetype is meant as the set of features for the categories of a canvas, where just some categories are filled that define the archetype (Bocken, 2014).
In the framework of the LUIGI project, three business model archetypes, based on different GIs and territorial contexts have been delineated. Each archetype represents business features that are likely to be significant for the creation of value in specific territorial contexts. The archetypes highlight the importance of some categories of the GI-based BMC in three territorial contexts which are common in the Alpine Space: peri-urban farmsteads, natural parks and urban peripheries. In the following chapter, the three archetypes are described in detail.
The general methodology for applying the GI-based BMC to a concrete situation where an archetype is to be used includes the following steps:

- among the GI-based BMC categories, find the ones more specifically characterising the archetype,
- find the standard questions to be answered in order to provide the information needed to fill in the specific archetype categories,
- fill the other GI-based BMC (secondary) categories.

A possible scheme with standard answers is shown in *fig. 4.3*.

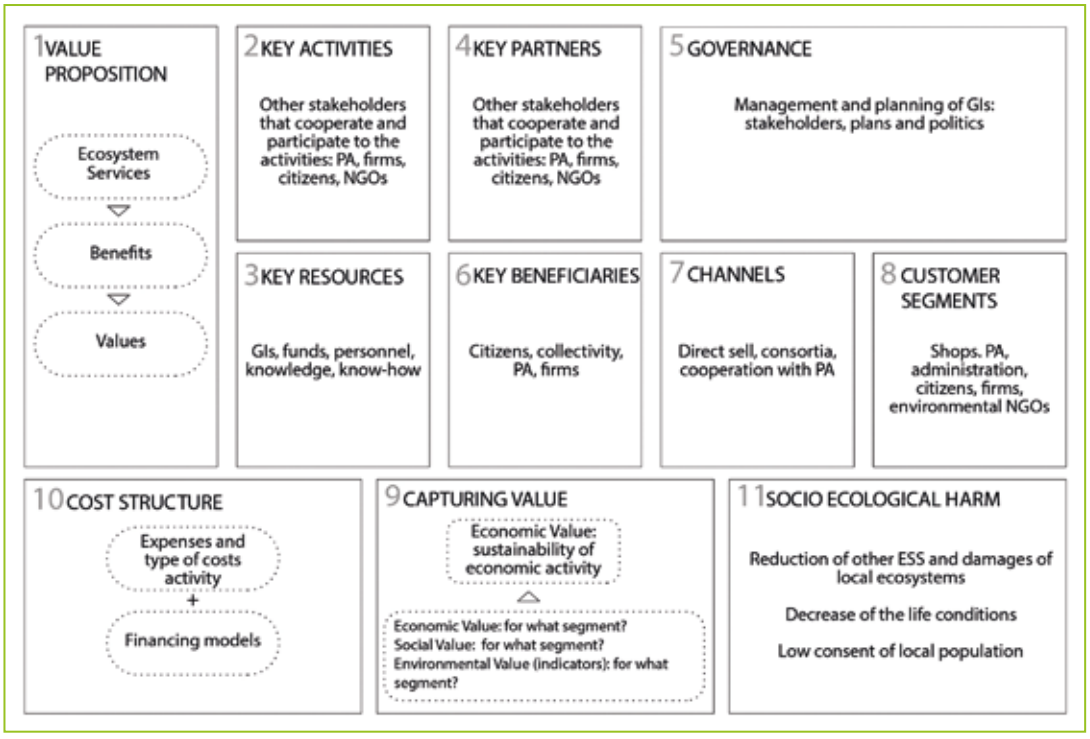

Figure 4.3 - *An example of filled BM canvas ((own elaboration, 2021).*

It is possible to use the "BM ecology" approach (Bocken *et al.*,2019) as an integration to the application of the GI-based BMC. Since often a GI (such a large park) can

generate several different ecosystem services and benefits that can be translated into economic values by appropriate BMs, the BM ecology approach is especially efficient when multiple activities are highly integrated into the GIs on which a part of their value generation capacity relies (*e.g.*, where an actor such as a park is the most important asset and the gravity centre of several activities run in the surrounding region). In order to perform an analysis of a BM Ecosystem, these steps have to be followed:

- define the "institutional context", including public administrations and non-business actors, and the "area of interactions of BMs", including the interactions among businesses in the area under investigation,
- define the agents from the "institutional context" and the agents included in the "area of interactions of BM",
- define the nature of the relationships occurring among the different BMs and for each agent. The defined interactions can be qualified as potential collaborations, synergies, and conflicts, by answering a set of questions (reported in *tab. 4.3* below).

Table 4.3 - Questions to frame BMs into the Ecosystem (adapted from Bocken et al. *2019)*

Question	Aim
What types of value (economic, social, and environmental) can be generated by GI in the area, considering the social and environmental territorial problems?	Types of value generated
What management methods for GIs are already in use in the area? How actually is the GI managed and how does it generate value? How does it improve the provision of social, economic, and environmental values?	Management methods
Which other organisations would you like to cooperate with for improving the quality of management of GIs? What are the organisations you would like to cooperate with? With which organisations there are conflicts or possible divergences?	Types of relations existing

4.5 The idea of the ecosystem stock exchange

The combination of the activities described is expected to frame the basis for a "regional ecosystem stock exchange" that is expected to provide elements in support to the proper functioning of markets for regional GIs and their benefits by meeting the three basic conditions required by the theory of market design: *market thickness* (involving a large enough number of potential buyers and sellers to produce satisfactory transactions), *market safety* (requiring as much confidential information as possible on the traded goods or services to be disclosed to buyers and sellers), and low transaction costs (overcoming congestion by giving market participants the means to conduct satisfactory transactions) (Roth, 2007). The regional ecosystem stock exchange is intended as an informative tool incentivising regional investment

and new business creation. Regional ecosystem market potential is estimated through a set of economic, competitiveness, demographic and ecological indicators that shape a simple framework for understanding the principal market conditions and interested stakeholders in a region. The ESS stock exchange can be considered as an infrastructure needed to increase the volume and efficiency of trade of GI and ESS-based goods and services since it can facilitate the meeting of regional demand and supply for them, increasing the financial sustainability of business ideas based on the use and delivery of ES benefits. It does not affect nor determine the value of what can be traded, rather it creates the conditions for value to disclose as perceived by potential buyers and sellers. The framework for analysing the regional VCs and their interactions with GIs provides useful information to be disclosed to potential private and public investors and entrepreneurs on the industries being potentially interested in regional ESS and benefits and on their incorporation in the respective production processes. Additionally, it helps to identify the multiple values associated with the investigated VCs that include economic and non-economic values jointly determining a "shared value".

The concept of a GI-based BM intends to address the major issue of value creation that refers to translating the multiple ecosystem benefits from GIs into values. Under the point of view of market design theory, BMs seem suitable to support market thickness by indicating novel business opportunities for entrepreneurs, increasing market safety and full information by disclosing those benefits that can intercept a significant private or public demand for ecosystem goods or services, and reduce transaction costs by introducing innovative payments schemes and transaction management methods in the markets where organisations adopting GI-BM participate.

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SECTION II

Chapter 5

LUIGI VALUE CHAINS AND BUSINESS MODELS

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Abstract

This chapter focuses on the multiple values generated by the GIs in the pilot regions of LUIGI. The conceptual background about GI VCs, BMCs and archetypes has been already introduced in the previous chapter(s?). The Alpine GIs guarantee a multitude of ESS that are essential for social well-being and natural ecosystems, providing tangible benefits to human and non-human beings. Public local and regional bodies, private companies and non-profit organisations can intervene on the GIs with the aim of supplying ESS, improving the territorial wellbeing in the areas where GI-benefits show up, and creating "shared value" for both firms and the society.

The next paragraphs present the main activities and outcomes of the LUIGI project, concerning the VC analysis and the BM archetypes. The next paragraph presents some schemes elaborated on ESS-based regional VCs, starting from the information gathered in the pilot regions. More specifically, the schemes represent four recurring types of GIs found in the pilot regions, highlighting the ecosystem benefits, the values and the stakeholders that are interested in terms of potential supply and demand. The following paragraphs describe the three BM archetypes mentioned in the previous chapter: peri-urban farmstead, natural parks, and urban peripheries, building on the fieldwork made in the case study areas located in the Metropolitan City of Milan.

5.1 The LUIGI Value Chains

The project LUIGI involves 10 pilot regions across 6 European countries. The regions represent the large territorial variety of the Alpine Space as a whole, including metropolitan areas (*i.e.*, Milan), National Parks (*e.g.*, Parc Naturel Régional du Massif des Bauges, and Ticino Park) and mountain regions (South-Tyrol, Canton of Grisons). Each pilot region has defined a few implementation areas whereby specific GIs are targeted. The Austrian, Swiss, German and Slovenian pilot regions mainly target orchard meadows and fruit trees, aiming to study and valorise a type of landscape which has clear potential in terms of cultural, provisioning and regulating ecosystem services in the Alpine valleys that link urban and mountain areas. The Italian and French pilot regions, being located in more urbanised and flat areas, privilege riparian parks and areas around water courses, hedgerow landscapes and high natural value (HNV) farmlands. This section mainly refers to the four most recurring types of GIs: orchard meadows, riparian areas, HNV farmlands and hedgerow landscapes (*see table 5.1.*).

Table 5.1 - *Recurring types of GIs & Pilot Regions in the LUIGI project (own elaboration, 2021).*

GI Type	Pilot Regions
Orchard Meadows	Central Area of Salzburg South Burgenland Canton of Grisons Metropolitan Region of Munich Parc Naturel Régional du Massif des Baùges Goriška Region
Riparian Areas	South-Tyrol Metropolitan City of Milan Metropolitan City of Turin
NHV Farmlands.	South-Tyrol Metropolitan City of Milan.
Hedgerow Landscape	Canton of Grisons Metropolitan Region of Grenoble Metropolitan City of Milan

For each of these GI types, a study of the ecosystem values and of the stakeholders' demand has been performed. Starting from the information gathered in a questionnaire filled out by the representatives of the pilot regions and from the activities promoted in the framework of the project, a set of ecosystem benefits has been delineated for each GI type.
In order to comprehend the process of value creation, the stakeholders have been divided into co-providers - i.e. the actors that contribute to manage, maintain and plan GIs – and beneficiaries, which are those who take advantage from the GI benefits. With an idea of the ecosystem benefits, of the beneficiaries and of the actors that contribute to generate them, a first idea of ESS-based VC may be sketched for each type of GI, in line with the general framework provided for GI-VCs in the previous section. Some of the benefits that are related to demand may hence be considered social, environmental and economic values, quantifiable with monetary and non-monetary indicators. A subset of the beneficiaries may thus represent a demand for ecosystem values. In turn, the GIs become the source of multiple values, eligible for the creation of VCs akin to the GI-VC model described in the previous chapter.
In the following, four schemes on orchard meadows, riparian areas, HNV farmlands and hedgerow landscapes are presented and commented with relevant examples from some regions across the Alpine Space. These general schemes help comprehend the elements that characterise the GI-VCs and constitute a tool to study and improve the VCs based on ESS in the Alpine Space.

- Orchard Meadows

Orchard meadows are characterised by an extensive and sustainable land use of fruit trees plantation, defined as "Cultivated parcels planted with fruit trees and shrubs, intended for fruit production, including nuts. The planting pattern can be by single

or mixed fruit species, both in association with permanently grassy surfaces" (Corine Land Cover class 222). No use of pesticides and soil tillage are allowed. They often support ancient or rare fruit varieties, and species-rich grasslands. Orchard meadows guarantee provisioning, support, regulating and cultural ESS. The fruit trees provide food to local markets and to food extractors and represent symbolic Alpine species with a significant cultural value. Moreover, the variety of species and the low impact agricultural techniques favour pollination and biodiversity. The trees contribute to temperature and climate regulation, while the orchard meadow landscape is also an attractive place for visitors and tourists. Several stakeholders take advantage and are interested in the benefits provided by the orchard meadows and, accordingly, diverse economic, governmental and civil subjects may be considered as a demand for the value created from this kind of GI: the agri-food sector, the local administrations, NGOs, the tourist sector, researchers and scientists. Farmers, private owners, local governments, tree nurseries, local associations may therefore be interested in providing social, economic and environmental values, in order to meet their targets, in terms of revenues, public policies, or social initiatives. In the scheme represented in *fig. 5.1*, some values with their indicators are listed, as well as the activities that contribute to turn the benefits into values.

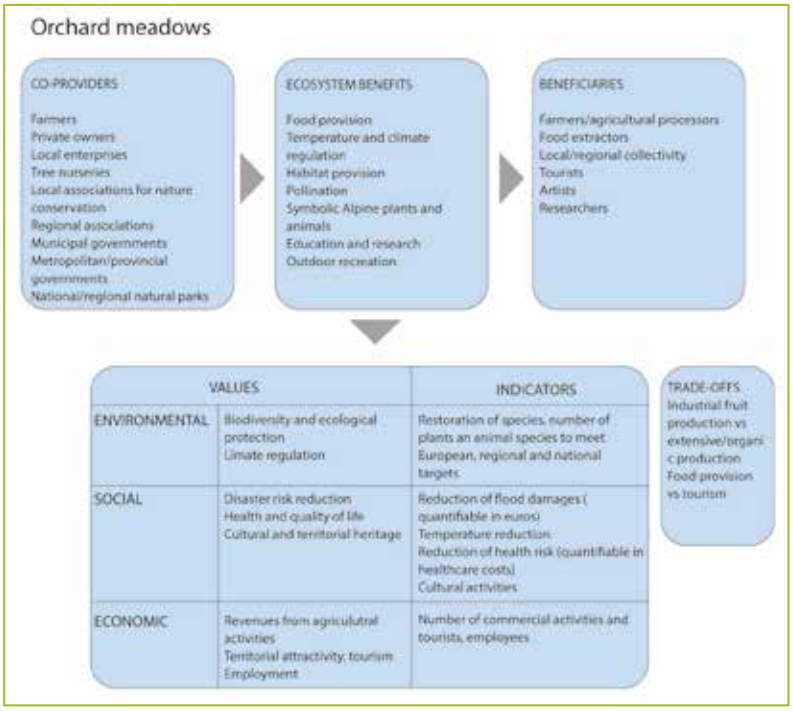

Figure 5.1 - *Orchard Meadows: values with their indicators & activities that contribute to turn the benefits into values (own elaboration, 2021).*

- Riparian Park

This GI element is defined by its location and by the fact that under this context some of its functions become particularly important and beneficial to societies (*e.g.* flood prevention), assumed as is composed of trees, shrubs, grasses, and hedges. Riparian areas are defined as the interface between land and freshwater ecosystems and are characterised by distinctive soil, hydrology, and biotic conditions. The ESSs provided by riparian areas are mainly regulating and support services. Erosion control, flood prevention, and regulation of soil quality are the most evident benefits guaranteed by this type of GI. The peculiar landscape at the interface between land and water is rich in biodiversity and is also attractive for recreational activities, like fishing, cycling and birdwatching. This kind of GI has a clear impact on the local and the regional territorial conditions: local administrations, parks and other public bodies have the responsibility to manage the GI, in order to provide local populations with important ESS. At the same time, other stakeholders, such as bars, restaurants and small businesses located in the area may be involved, as well as tourists and users. These stakeholders may collaborate in order to co-create and exchange multiple values, such as the restoration of important ecosystem conditions to meet environmental laws and regulations, the reduction of flood damages and of atmospheric and water pollutants, the tourist attractivity and the growth of the local economy.

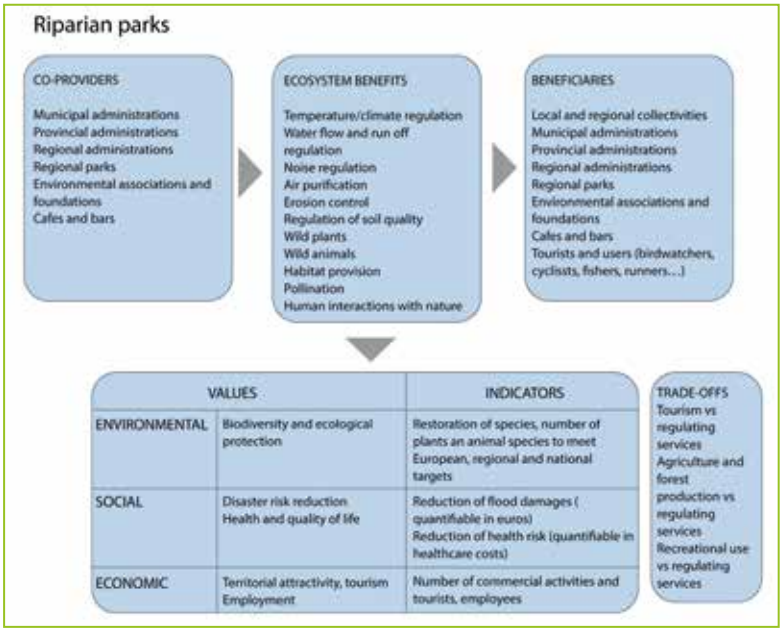

Figure 5.2 - *Riparian Parks. values with their indicators & activities that contribute to turn the benefits into values (own elaboration, 2021).*

- High Nature Value (HNV) farm

High Nature Value (HNV) farmlands are landscapes where low-intensity agriculture is

dominant (low levels of agrochemical inputs and low livestock stocking levels, minimal mechanisation, and rotational use of the land). HNV farmlands are characterised either by a high cover of semi-natural vegetation/habitats (HNVf type 1), a high density of small-scale landscape elements such as shrubs, hedges or field margins (HNVf type 2), or those landscapes, often more intensively managed, that support species with high conservation interest (HNVf type 3) (Lomba 2020; Andersen *et al.* 2003).

This type of GI combines provisioning services, with support and regulating ones. The provision of edible and non-edible crops and animal farming, following strict ecological principles, contribute to regulate soil quality, water condition, to control the erosion and mitigate extreme events, and to foster biodiversity. Moreover, HNV farmlands are often variegated landscapes, much more attractive than intensive agricultural lands, in terms of recreational activities and of possibilities to interact with nature.

Farmers and their associations are clearly the main stakeholders, as well as the whole agri-food sector. Public institutions are also involved, given the significance of the abovementioned regulating and support services for the social and territorial conditions.

The methods to transform the benefits of HNV farmlands in values that could be potentially co-created and exchanged by the stakeholders include: the scientific assessment of the environmental benefits, as well as the assessment of disaster risk reduction and agricultural productivity, and of the short VC economic benefits.

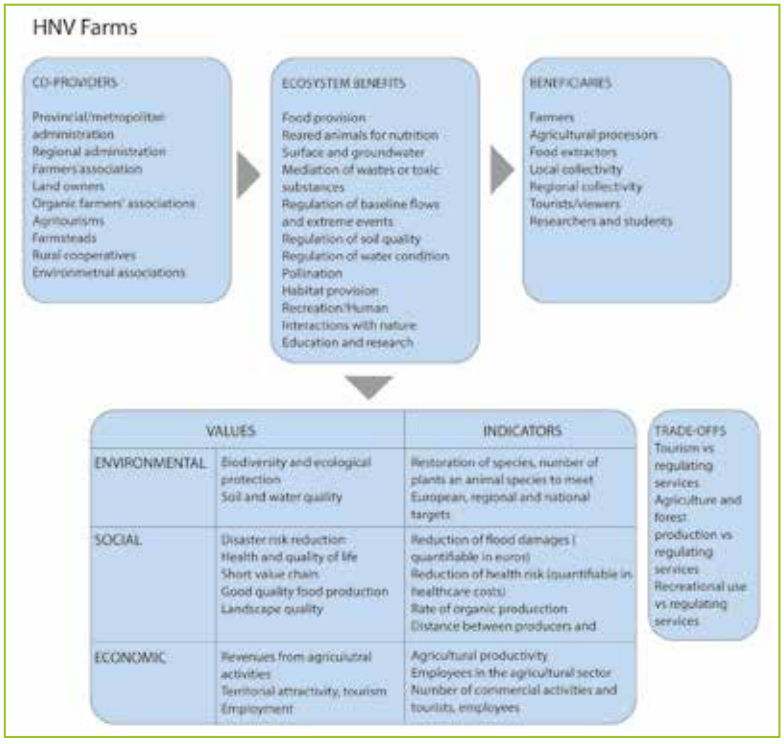

Figure 5.3 - *HNV Farmlands: values with their indicators & activities that contribute to turn the benefits into values (own elaboration, 2021).*

Hedgerows Landscapes

"Hedgerows" encompass lines of trees as well as classic shrubby hedges. It also includes associated basal and marginal vegetation were clearly influenced by the existence of the shrubs and trees, and any associated earth banks and ditches. As such, hedges can be up to 9 metres wide or more. This definition encompasses those linear boundary features known as windbreaks, together with thin shelterbelts. It also encompasses many buffer strips where these have shrubs or trees in addition to permanent herbaceous (usually grassy) growth. Even where buffer strips do not support any woody growth, they have some similar functionality to hedges. (Wolton *et al*. 2014) Hedgerows are important GIs for the services they can provide concerning erosion control, runoff regulation, noise regulation and habitat provision. Hedgerows also provide fruits and timber and foster the biodiversity of rural areas. Farmers are the main stakeholders involved, as well as the whole agrifood sector, the wood transformation local industries. Local administrative bodies are also interested in this kind of GI, as it provides relevant regulating and support ESS. Innovative collaboration between farmers, local institutions and local associations may be based on the recognition of environmental and social values, such as the restoration of animal and plant species, or the reduction of flood damage.

5.2 The LUIGI GI-based Business Model Archetypes and their application

While the previous paragraph analysed the VCs in the LUIGI pilot regions, the following one focuses on a set of BM archetypes developed from the experience with the Milan pilot region. This tool addresses business opportunities deriving from the

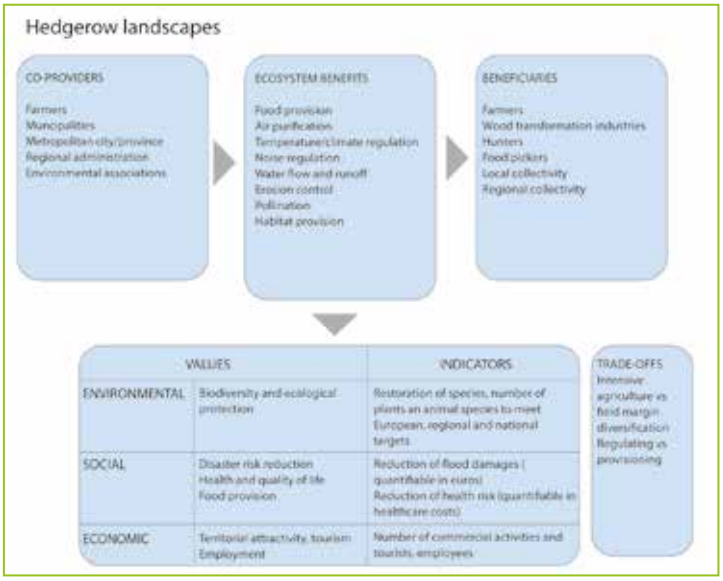

Figure 5.4 - *Hedgerows Landscapes: values with their indicators & activities that contribute to turn the benefits into values (own elaboration, 2021).*

specific features of GIs from three territorial contexts. A GI-BMC and a BM Ecology analysis have been run in these areas, all localised in the Metropolitan City of Milan. The first area is Cascina Nibai, in the Agricultural District Adda-Martesana, North-East of Milan along the Naviglio Martesana. The BM archetype proposal refers to a farmstead supplying high-quality agricultural products through multiple channels, by employing workers from disadvantaged groups and creating economic, ecological and social values. The second area is the Ticino Regional Park, which is a protected area on the South-West border between the Metropolitan City of Milan and the Piemonte administrative region. The third area is South-East Milano / Santa Giulia district (Santa Giulia-Parco Sud Milano), a district in the South-East area of the municipality of Milan, on the border between the Southern Agricultural Park of Milan and a recently urbanised district of the city with significant shares of green spaces and agricultural land.

- Archetype I: Peri Urban Farmsteads (PUF): social work, high natural value and economic sustainability

The distinctive categories for this archetype are *Value proposition, Governance, Cost structure* and *Capturing value*[1]. Economic activities mainly rely on food production and processing based on commodities (agricultural products) produced in farmsteads. The farmstead production depends on labour being in part supplied by disadvantaged people from the area, products are sold in situ or transformed to be served in a restaurant hosted in the farm, some side services also exist (e.g. hospitality). The farmsteads produce their own agricultural products by using specific resources that contribute to qualify the archetype itself (e.g. social workers). Peri-urban environment is usually complex and varied, it represents a mosaic of different activities and different uses of the soil. The peri-urban context is composed of small and medium urban centres whose concentration is progressively reduced with the distance from the city. Small agricultural parcels gravitate around farmsteads, these places have been used for manufacturing and storing products. In the peri-urban context some agricultural businesses only operate in production and wholesale, for others the agricultural activities are a basis for activities on different levels, such as retail, food manufacturing and catering where sometimes the farmstead turns into a restaurant. The farmsteads are surrounded by jeopardised ecological elements, where the different tiles are made of hedgerows and agricultural plots with diverse plants. These GIs provide services and benefits on which the farmsteads uprise their activities. The resulting GI-based BM depends on ESS provided by the GIs.

The PUF BM archetype is based on the combination of the Canvas categories as shown in *fig. 5.5*.

The description of the BMC categories used for the PUF archetype is given below:

- *Value Proposition*: the value proposed through the activities of PUF includes the

[1] The first archetype has been developed based on a case study performed in the area of the agricultural district in the area of the Naviglio Martesana.

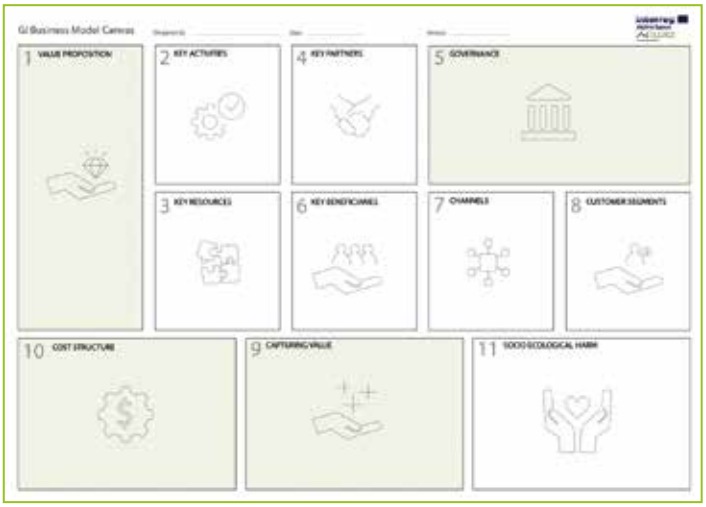

Figure 5.5 - *PUF Business Model Archetype (own elaboration, 2022)..*

quality of local products, the social value generated from the social workforce, the integration of farmlands within areas and districts subject to increasing urbanisation, possibility of consuming and buying local transformed products in situ.

- *Capturing Value*: the value included is the high value added extracted from organic production (food quality), the commercialization of local and locally processed products (reduced dispersion through short supply-chain), food services and catering (increase of value) and the potential for new channels of distribution of local products (creation of new highly valuable supply chains).
- *Governance*: the corporate governance structure is not aimed at profit; the farmstead is managed as a cooperative business in the legal form of "social cooperative" and "cooperative community firm".
- *Cost Structure*: includes aspects of the typical farmstead and the related activities (*e.g.* food processing, restaurant, etc.). The use of public funds and subsidies for farms and disadvantaged workforce supplied by local to national governments can show effects on both fixed (*e.g.* investment, extraordinary maintenance) and variable/staff costs (*e.g.* salaries).

- Archetype II: Building together Natural Parks (BTP): coordinating different activities to reach common goals

In the second archetype, local economic activities are based on the multiple GIs present in a protected area[2]. The distinctive categories for this archetype are *Value proposition, Key partners* and *Governance*. In this situation, the perimeter of the park is also the border of the ecosystem of businesses operating in the territory and using specific territorial assets and GIs. The ecosystem concept directs attention towards the multiple ways in which a variegated set of actors (or in our case, BMs) interact, ranging from competition to mutually supportive connections. It also indicates that the relationship between these interactions and the system-level behaviour is not straightforward: individually desirable outcomes can produce unintended system results (Boons & Bocken, 2018). In this archetype, the economic activities are based

[2] Based on the experience of the Ticino Regional Park, in the Metropolitan City of Milano.

on the added value ensured by the quality of a protected area. Additionally, the economic actors in the park are called to recognise the individual economic benefits that they can receive from sharing a set of sustainability principles with the park administration and from establishing a sound cooperation among the different activities run by businesses operating in the same area. By networking the activities taking place in the park, the quality of the park's GIs can be improved with a positive return for both the businesses involved and the society at large. The partners are relatively important in this case, because many activities rely on organisations other than the park administration for improving the efficiency of the services (or products) supplied by the GIs. Natural parks are usually larger than urban and peri-urban parks, anyways, they can be located close to large urban settlements, and offer the citizens a wilder experience of relaxation and amusement. These parks can also be the domicile of different economic activities, most of them based on the ecological services provided by the park. A natural park is a GI that offers several and different ESS. All the benefits strongly relate to the existence of rivers, forests, paths, and other elements. The activities involved in the extraction of ESS belong to different sectors, such as food production and retail, research and education, trails, sports and activities related to social cooperative firms. The mutual presence of these businesses in the park allows the coexistence of more activities. Moreover, the interactions among these activities allow to achieve common targets that benefit most of the firms and stakeholders active in the park. In the analysed area, the park is crossed by the Ticino River, which is used for different activities - mostly related to water. Moreover, most of the river corresponds to the border that divides two administrative regions of Northern Italy, Lombardia and Piemonte.

The BTP is a BM based on the combination of the Canvas categories shown in *fig. 5.6.* A distinctive category for the archetype is Key partners, primarily indicating the organisations inside the park that cooperate with the park administration and among themselves, aiming to achieve beneficial results for everyone, the local and regional administrations being responsible for directing resources and operating in support to the natural park and the surroundings, and all the surrounding administrative systems not formally belonging to the governance system of the park that play a role in mobilising finance and setting regulations with potential impacts on the local business ecosystem.

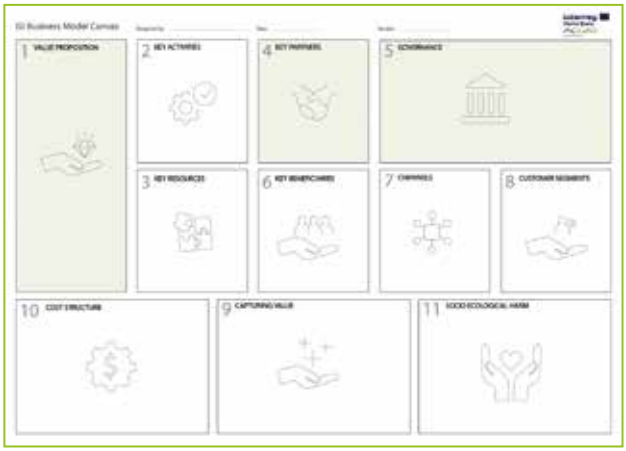

Figure 5.6 - *BTP Business Model Archetype (own elaboration, 2022).*

The Canvas categories that belong to the BTP archetype are listed below.

- *Key Partners*: include all the agents showing interactions that support the local business ecosystem and its actors (i.e. food producers, farms, tourist businesses, guides, sports infrastructures and promoters, guides, etc.), local public administrations, especially municipalities, and the regional bodies issuing regulations and mobilising funds.
- *Value Proposition*: refers to the ecologic, social and economic dimensions of the values provided by the park; social value derives from environmental education experiences promoting the acknowledgement of the ecological assets in the park, the awareness on the territorial features, local cultural heritage, landmark valorization, and on the existing local and traditional assets; economic value derives from proposals in the fields of proximity and sustainable tourism, including the agro-tourism and the commercialization of local products, some labelled by the park itself; ecologic value is produced by the knowledge of the park's biological assets and the instructions and rules for ensuring sustainability in the context of ecotourism, sports, water and forest management to maintain the park's GIs.
- Governance: the governance structure analysed refers to a plurality of organisations and stakeholders moving in the business ecosystem of the park that relate to each other based on the type of their mutual relationships (from cooperation to conflict), but generally described as a collaboration oriented to deliver "shared value", consistent with the sustainability objectives of the park and substantiating the ecologic, social and economic value proposition in the territory, based on the local GIs and ESS that they provide.

- Archetype III - Building territorial Networks to co-create values from GIs (TNCV)

The third archetype[3] refers to a complex territory that includes a cluster of different economic and non-economic activities that participate in the creation of different types of values, and particularly a form of "shared value". The distinctive categories for this archetype are *Value proposition*, *Governance* and *Key partners*. The area is an emerging district in a metropolitan area, where the change in population is leading to larger social differences, in terms of salary and city facilities. People living in peripheral areas tend to show higher levels of inequality and differences than in the areas closer to the city centre. The presence of inequalities brings to consider the citizens of the district as a particularly critical variable. The impact determined by local transformations and development on the local population is felt as pivotal in the area.

The case study area of Santa Giulia district and the South-East area of the City of Milan represent an interesting case for this kind of archetype. The district suffers from the stigma of being a problematic area, also due to the high crime rate. The area is characterised by a park (Vettabbia) in which there used to be a waterway/ canal (Redefossi), which also includes significant cultural and religious sites (such as

[3] Based on the analysis of the South-East Milano (SEM) / Santa Giulia district CSA, in the Metropolitan City of Milano.

the Chiaravalle Abbey), and it is located on the Monk's (or Abbey's) trail. The focus of this CSA and the relative BM is on urban planning and urban regeneration as a means for the creation and valorisation of green spaces and their funding, where promoting and consolidating territorial networks is an essential condition for social, economic and political motives.

The BM archetype is based on three Canvas categories, the distinctive one being Key partners, including cooperative firms and local groups, no profit organisations, residents in the district where the BM ecosystem is centred. Residents in particular play a central role in the actions of local organisations and firms, and can directly benefit from new infrastructures (*e.g.* cycling trails) and enhanced cultural and natural assets, such as parks, waterways, monasteries and abbeys. The Canvas categories that belong to the BM archetype are listed below.

- *Value Proposition*: refers to social, economic and ecological values of the CSA. Social values include social cohesion achieved through the activities promoted in the area, spaces for leisure and tourist activities associated with economic offers, the improved territorial network of trails and the recovered traditional assets, such as old farmstead and green areas. Economic values connect to the significant transformation of the Santa Giulia district, the jobs and real estate in the site and the mentioned tourist and leisure activities. Ecological values mainly refer to the establishment and enhancement of green areas, the sustainable management of the parks implying gains in biodiversity that are likely to be managed by residents or financed by some of the companies based in the area.
- *Governance*: the local governance structure includes several actors of different types ranging from non-profit organisations and cooperative firms to large companies located in the area. Public administrations at different levels, including several municipalities, can also play a role in the significant ongoing transformation of the area where a new district is built and significant actions for renovation and improvement in the quality of life for local dwellers and new citizens are planned, also due to the prior crime and social problems of the area.
- *Key Beneficiaries*: include disadvantaged people employed in new economic activities, residents and other citizens expected to use the renovated local infrastructures and assets, people, firms and real estate companies investing in the new district and in the surroundings.

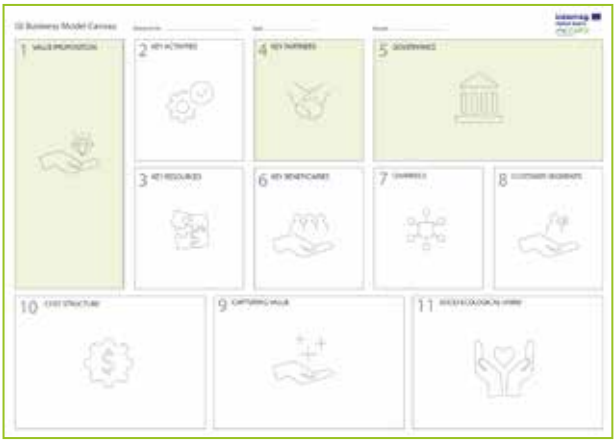

Figure 5.7 - *TNCV Business Model Archetype (own elaboration, 2022).*

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SECTION III

Chapter 6

The Governance of Green Infrastructure

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Abstract

Governance describes the way how state and non-state actors work together. Governance structures vary significantly depending on the goals and actors involved, the form of interactions among them encompassing knowledge, overview, information or resources, as well as rules they agree upon in order to achieve certain – and often common – goals. The following chapter will introduce in participatory and governance approaches for spatial development of Green Infrastructure. It builds a synthesis of the state of the art on governance of Green Infrastructure in selected case study areas of the LUIGI pilot regions and identify relevant governance mechanisms.

Keywords: participation, stakeholder, network, stewardship

6.1 Introduction: what is governance and why does it matter?

In the past decades new arrangement of governance amerged as an advancement to traditional governing mechanisms and lead to governance shifts in private, semi-private and public spheres at different levels, from local, across regional, national, transnational to global levels (van Kersbergen and van Waarden, 2004). As part of the EU Strategy for the Alpine Region (EUSALP), the improvement of governance approaches belongs to one of the specific objectives of the Action Group 7, to develop a "strategically planned network of natural and semi-natural areas, including features in rural and urban areas which together – functionally interconnected – ensure diverse advantages for nature, as well as social benefits and economic prosperity for humans". Its main aim is to apply EU Strategy on Green Infrastructure and to develop "the Alps as an outstanding candidate for GI in Europe" (EUSALP, 2020).

In urban contexts, the involvement of citizens in green space governance has developed public participation in government and local governments policy initiatives towards a much more active citizenship, and in order to maximize the range of benefits of urban ecosystem services (van der Jagt *et al.*, 2016). For GI planning, participatory governance concerns the arrangements in which different actors make decisions and manage green space networks (Ambrose-Oji *et al.*, 2017). The arrangements comprise a mixture of actors, involving citizens, entrepreneurs, and NGOs, with or without the active involvement of government authorities and public agencies. These vary in resources, in terms of time, money, skills, and other tangible and intangible assets (*e.g.*

political and social relationships around those resources). In addition, these differ in ways how relationships and actions are managed (including legislations, regulations, social and cultural norms) as well as discourses (beliefs, values, objectives and other, motivations). Thus, governance arrangements can be very diverse (ibid.).

Approaches of environmental governance, as a subset of governance, have become a major concern to change decision-making processes towards sustainable development (*e.g.* Lemos and Agrawal, 2006, Newig and Fritsch, 2009, Tacconi, 2011, Armitage *et al.*, 2012). They are related to environmental stewardship as "actions taken by individuals, groups or networks of actors, with various motivations and levels of capacity, to protect, care for or responsibly use the environment in pursuit of environmental and/or social outcomes in diverse social-ecological contexts" (Bennett *et al.*, 2018). Evidence clearly suggests that governance strategies considering the perspectives of local ecosystem stewards are effective to safeguard biodiversity and ecosystem services (Kenward *et al.*, 2011). Hence, a systematic way about the role of actors and their relation to landscape change, is crucial (Plieninger *et al.*, 2016).

In order to enhance governance approaches they need to be investigated in a systematic and structured manner. In *chapter 5*, we would like to address the following aspects and illustrate these based on the investigation in our ten LUIGI pilot regions in the Alpine Space:

- What are the different actors and what are their roles?
- What are the different types of governance arrangements?

By answering these questions, we can we investigate governance approaches to better plan, manage and maintain GI in the Alpine Area.

6.2 What are the different actors and what are their roles?

Six stakeholder groups can be distinguished that are active or share responsibilities in the field of GI (*Table 6.1*).

According to this in-depth analysis, it is evident that governmental actors play an important role within the governance approaches and build a supporting pillar. The land users' group as persons or organisations maintain or cultivate GI, have a management or caretaker role. Land users seem to become less relevant, since associations or the public start to take over more responsibility. Businesses do not directly manage GI but are an important part of the whole value chain by processing and marketing goods and services that are GI-based. They have a role as producers, processors, marketers, consultants or initiators. Consequently, they are an essential partner to maintain and promote GI management.

All non-governmental organisations and associations that are primarily active for the interest of nature conservation can sometimes have the role as initiators. The group of non-governmental organisations and associations is characterised as being active towards concerns within the region, such as land care associations. Furthermore, there are representing producers' and consumers' cooperatives, in case they are

Table 6.1 - *Description of different stakeholder groups, their roles, functions and relevance (own elaboration, 2021).*

Stakeholder group	Description	Role	Function	Relevance
Government 	State administration at all levels and across all areas of responsibility: authorities, territorial administration such as municipalities, counties, regions, districts (DE), departments (FR), cantons (CH), countries or the EU.	• (Co) Initiator • Support through own resources like money, knowledge, property, network	Implementation of the state interest, implementation and control of compliance with laws.	• Important supporting pillar in all study areas: if not initiator, usually have an important supporting role • Limited room for manoeuvres due to legal mandate, mostly reactive and less proactive action
Land Users 	All persons or organisations that maintain or cultivate GI.	• Manager/ caretaker	Production of raw materials, barter products or otherwise utilize GI.	• main pillar, most important group of actors in the maintenance of GI. • Actors group is slowly losing importance, as other stakeholder groups, e.g. associations, public take on more responsibility.
Business 	All persons or organisations that do not directly cultivate orchards but process and market raw materials or products from them.	• Producers / Processors/ Marketers/ Consultant • Initiators	Production of planting material, processing of raw materials into products, marketing of products, consulting of stakeholders.	• Supporting pillar: forming the value chain, marketing platform, advertisement, etc.
Nature Conservation 	All non-governmental organisations and associations with broad activities in nature conservation, without a specific focus on GI of concern within the case studies.	• Initiator • Supporters through money, knowledge	Representation of the interests of the members: primary focus on the protection and maintenance of wildlife and habitat.	• Actor group plays secondary role in almost all regions • Mostly supporting activity
Associations 	All non-governmental organisations and associations with a specific focus in the GI, also producers' and consumers' cooperatives	• Initiator • Supporters through knowledge, manpower, network, property, money	Representation of the interests of the members: harmonize social and economic aims with ecological targets in the GI of concern.	• If active: mostly supporting pillar if not active: secondary role • Room for manoeuvre not limited, mostly acting proactively
Science & Education 	Non-governmental institutions that conduct research or teach knowledge.	• Initiator • Supporting through knowledge	Development and transfer of knowledge.	• Actor group plays secondary role in almost all regions • Mostly supporting activity
Public 	All parts of the population who are not included in any other group of stakeholders.	• Initiator • Support through property, labour, money in the form of donations or consumption	Mostly laymen in the field of GI, but often involved as private landowner or urban dweller	• Independent projects on own land • Secondary role as supporter • Potentially supporting pillar currently gaining more importance

active, they mostly have a supporting role, if not active rather a secondary role. Their room for manoeuvre is not particularly limited and they are frequently proactive.

6.3 How can we investigate governance approaches?

To understand different models of governance for GI-planning, it is important to take the respective governance arrangements into consideration. Governance for GI-planning can be analysed with emphasis on the arrangement according to Buijs *et al*. (2016) and Ambrose-Oji *et al*. (2017), adapted from (Arts *et al*., 2006; Liefferink, 2006). According to Ambrose-Oji *et al*. (2017), governance can be considered as a tetrahedron, in which each of the four corners represents different dimensions that are interwoven (*Figure 6.1*). For instance, does a change of actors involved in the coalitions, may also alter availability and distribution of resources and power (Liefferink, 2006). The structure of a policy arrangement can be analysed along the four dimensions as in *Figure 6.1*. Any change on one of the dimensions will affect other dimensions (Arts *et al*., 2006).

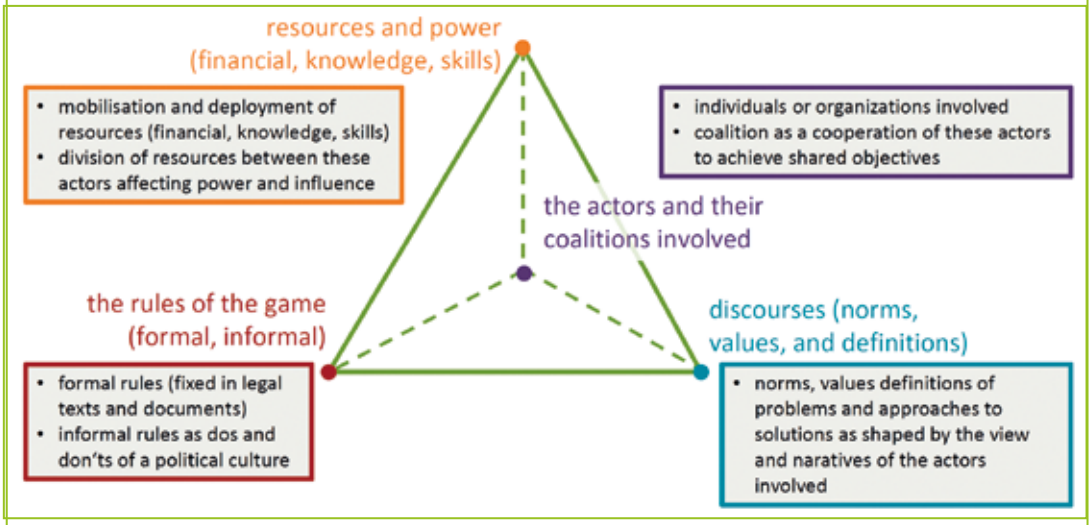

Figure 6.1 - *Tetrahedron of four different dimensions of governance. Based on Arts* et al. *2006; Liefferink, 2006.*

Accordingly, a number of key questions need to be answered to understand the governance arrangement (Böcher and Töller, 2012, Blum, 2013, Dye, 1978, Arts, 2013, Haase, 2004). First, we need to find out who participates and who might be excluded. It is important to understand which resources are available and whom they are controlled by. Another important question concerns the decisions and how they are made. Furthermore, we need to understand the basic assumptions of the policy programme. What are the main assumptions of the actors and what the decisions are based upon? This relates to the legal frameworks and contents of the policy documents as well as how the different actors interpret them.

- The Actors

Actors are individuals and/or organizations involved (Buizer, 2008). As an outcome of the Status Analysis in selected Alpine Metropolitan regions, a broad number of relevant stakeholders have been identified, such as public authorities (at different levels from local to national), non-governmental organisations & associations, community groups, business partners / SMEs, education and research groups, citizens (public, inhabitants, recreational visitors). These actors can be a part of a certain governance arrangement and can be more or less influential. They may act in coalitions to achieve (more or less) shared objectives (Buijs *et al*., 2016).

To look beyond the involvement of different actors and stakeholders, coalitions are of another concern. Across the LUIGI case studies investigated, governmental actors are the most important cooperation partners. While looking at organisations and associations as second most relevant cooperation partners, it is important to acknowledge that these need to have a clear focus towards GI management. Therefore, nature conservation organisations with very general focus do just play a minor role for network coalitions. Despite a comparable low representativity as active network members, the public is considered as being quite important for building coalitions. This is striking, as the public was generally less involved in the networks. However, they are almost equal as land users. In general, it becomes clear that organisations, initiatives and further stakeholders related to the management and valorisation, are generally perceived as important for coalition building.

- Resources and Power

Along with the actors involved, different resources may be available and effect the process. According to Buijs *et al*. (2016) resources can be mobilized by the different actors to achieve certain outcomes and can be found in different types. Besides financial resources these comprise knowledge, skills, land properties. Ownership or status are also sources of power (Van Tatenhove *et al*., 2000). Different resources were contributed and used by different actors. These have been categorized in financial resources, knowledge (skills and expertise), time and labour, legitimacy, access to land as well as social and professional networks.

While looking at the aims of the different stakeholders in the case study areas, the governmental actors were considered as the most important stakeholder group to unlock financial resources for the network. Although remarkably less, associations and nature conservation organisations are also able to financially contribute to the networks, often based on funding and membership fees. Furthermore, the public is considered as contributor, due to purchase and sales of products and services. Another crucial resource in most of the initiatives is knowledge in terms of skills and expertise. Here every stakeholder is considered to significantly contribute to the network, except the open public. It has been acknowledged across cases that expertise is very different. Governmental actors are in particular knowledgeable about legal regulations or funding opportunities, while land users contribute with

their skills to management and maintenance. Business partners contribute with expertise to marketing strategies. Associations can be very diverse, adding specific knowledge and skills to the network. Next, stakeholder's time and labour was seen as a vital resource in most of the initiatives. Although all stakeholder groups contribute with time and labour, in particular three of these groups are outstanding: the land users, business partners helping to maintain GI and to create market values. The third group, the public also plays an important role contributing with labour. Owed to the fact that across cases citizens are considered the most relevant network partner, as private landowners contribute to the land availability to maintain and develop GI.

When it comes to land availability, it comes to the ownership structure. Land ownership and labour contribution are clearly reflecting interdependencies of these resources. Landowners may represent a network partner that is often missing skills and equipment needed for appropriate GI management. Stakeholder groups representing the land user on the other side are not just more knowledgeable, but usually well equipped for appropriate management and maintenance. In some cases, associations are significant landowners too. Furthermore, the public is contributing to land being provided, often by municipalities or other administrative levels, like from federal state level. In addition, businesses often contribute with land that may not provide primary GI but land that provides necessary processing opportunities.

Another relevant resource mentioned refers to the access to social and professional networks. Not surprisingly most important network partners in this regard are the associations. In addition, the governmental actors are of relevance. All other stakeholder groups are considered as contributing to the access to network, although considerably less in comparison to the ones mentioned.

Next, legitimacy was identified as ones' resource, in the means of acceptance and appreciation of an actor by other actors. Most important in this regards are governmental as well as business representatives. Furthermore, associations and NGOs including nature conservation partners play an important role, which may be the case because these represent a number of members, i.e. individuals and the society.

- Discourses

The analysis of discourses comprises the norms, values and definitions of problems and approaches to solutions as shaped by the views and narratives of the actors involved. According to Buizer (2008) it is important to consider how these visions are perceived, socially constructed and to how they are embedded in social and institutional practices (Buijs *et al*., 2016). In general, the spectrum of different intentions of the actors, representing visions, values and norms can be broad and relate to ecologic (biodiversity, ecological connectivity), social (heritage, welfare, well-being, health, recreation…) and economic (potential of products & services and/ or ability to mobilize financial resources…) intentions. While looking at the aims of the different stakeholders in the case study areas, the goals to be achieved by the

commitment of the different network partners can be broadly categorized in three dimensions: ecological values (preservation of natural resources, including biological diversity, agricultural biodiversity), social/cultural landscape values and objectives, such as identity, education, recreation and aesthetics.
It seems, that all stakeholder groups commit to the different ecological, economic and social aims in general, although their accentuations and prioritizations are different. For example, a higher relevance of economic values by business stakeholders. Consequently, the networks and coalitions are driven by common achievements that are shared by the different stakeholders. While comparing the different cases, it seemed even more obvious that the different aims are not equally balanced. Still, it is obvious that prioritisations and imbalance of either ecological or social/cultural targets vary much stronger, while the relevance of economic aims appears to be addressed always in a significant amount.
Regarding ecological values, it is striking that in half of the cases aims were primary focusing on the promotion of biodiversity but no further regulating functions of natural resources, such as soil, water or the climate. Although challenges of climate change were mentioned by several different actors and stakeholders, the work of the networks addressing these challenges are barely mentioned. Accordingly, potentials of regulating functions with relevance of climate change adaption were just significantly mentioned in some cases. Hence, potentials in this regard are not fully taken into account by most of the networks.
Overall, it can be stated, that the GI-strategies are considered as multifunctional aims. The definition of multiple aims was found in all cases and build narratives, guiding the networks. These are sometimes manifested in visions such as "protect and use" or the development of "ecological and healthy products".

- Rules of the Game

As next dimension of governance approaches "the rules of the game" are considered as a set of boundaries within which actors operate and that can be both, constraining and enabling (Buijs *et al.*, 2016). A number of formal rules that are fixed in legal texts and documents, as well as informal ones have been identified within the case study areas.
While looking at the aims of the different stakeholders in the case study areas, the in-depth-analysis conducted give insights in the rules for cooperation i.e. the different types of agreements that coordinate activities and interaction between the network partners. In this regard, a distinction was made between formal procedures of decision-making implementations on the one hand, often in form of written contracts, and rather informal rules and routines, often verbal agreements on the other hand. In business and public groups informal / oral forms of cooperation seem to play a bigger role. Looking across the regions, it becomes evident that formal rules play a major role across cases. These formal rules can be contracts between partners addressing financing, compliance of regulations and rules or formalisation

of management standards. These are often between government institutions and land users. In addition, formal standards concern associations and organisations regarding statutes and/or membership rules. Furthermore, agreements can be instruments to coordinate processes between different partners and even sectors. Hence, they support the organisation processing along the value chain with regards to supply and demand between land users and marketing businesses, or to harmonize certain product standards.

Formal instruments can work in two opposite directions in the network. While some are perceived as supporting the network others are rather considered hindering. Latter ones occur in particular if instruments are connoted as excessively formalised, less flexible, which leads to reduced acceptance and even rejection. Others are rather considered as simulating, supporting stability and appreciation within the network. Legally binding agreements and contracts can give guarantees to the partners.

Besides the formal instruments, informal rules are substantial in most of the cases. Hence, their relevance should not be underestimated. In particular verbal agreements play an important role and have often been mentioned by network partners. They indicate trust among partners and mutual appreciation. In most cases, the cooperation partners do not see the necessity to formalise a cooperation that has informally existed for a long time. Furthermore, informal instruments are intentionally used as a strategy to overcome barriers creating trust and mutual respect, in particular to find and confidence new network partners. They may also emerge in the form of new, spontaneous and flexible cooperation between partners.

6.4 What are the different types of governance arrangements?

The different institutional and non-institutional, public and private actors constitute different types of governance arrangements (Arnouts *et al*., 2012). The spectrum ranges in-between government led approaches on the one side and non-government led approaches on the other side, with various forms of co-governance in between. The LUIGI case studies showcase several different governance arrangements. They can be assigned to six types, adapting Arnouts *et al*. (2012); Buizer *et al*. (2015); Buijs *et al*. (2016) and Ambrose-Oji *et al*. (2017): 1) Government led, 2) Market oriented, 3) Closed Co-Governance, 4) Open Co-governance, 5) Green hub, and 6) Grassroots initiatives.

The assignment to these types is based on the actors in the arrangement i.e. involvement and cooperation. Furthermore, the functions of actors involved are considered, in terms of resource provision and finally the aims of the network and how they are shared. These different types and their characteristics will be described in the following.

- Government led approaches

Government led approaches refer to the situation when all tasks are directed by the government, with non-state actors playing a subordinate role (Kooiman, 2003).

Often it is considered as a quite efficient approach (Ingram *et al*., 2018). Non-state actors can be involved in such a governance process, but within the framework set by the government only. Decisions are enforced in the top-down principle (Arnouts *et al*., 2012). Accordingly, this type can be considered as the most classic top-down approach.

In the LUIGI pilot regions four of the eleven cases study regions have been identified as Government led approaches. In these regions many processes and interactions among the actors are steered by governmental institutions. Furthermore, they act as main supporter of activities, for instance by providing resources (like funding, knowledge), or even initiate them. The levels of steering institutions often vary between the regional and municipal level expect one case, where even the national institutions also play an important role. Whereas some cases are based on long history of established structures or traditional planning policies, initiatives can be newly established. Although activities often underlie formal processes, individual actors are invited to become involved and can act quite flexibly within the network, even playing relevant roles by providing resources etc.

- Non-government led approaches

Non-government led approaches on the other end of the scale, are related to self-governance, describing the predominance of non-state actors while the government holds back (Kooiman, 2003). Therefore, the coalitions are mainly composed of non-state actors. Self-governance pursues common goals that are scaled up or linked to societal goals (Ingram *et al*., 2018). It is not necessarily the case that the power in self-governance arrangements lies with the non-state actors alone. The government can still control resources. However, non-state actors, who can thus influence events to a considerable extent, mainly mobilize them. This gives actors a high degree of autonomy. State actors in principle do have the possibility to interfere, but only if the control of activities exceed certain limits, *e.g*. by laws and regulations. The rules of interaction ensure that the non-state actors involved have the freedom to steer as they see fit. This means that decisions are implemented according to the bottom-up principle and access is more open to non-state actors (Arnouts *et al*., 2012).

These approaches are mostly under active citizenship. In the case that citizens are initiators, it is considered a grassroots initiative, such as self-organised urban agriculture or guerrilla gardening. These are relatively small-scale initiatives, focused on a specific site, often located on public or municipal land. Such initiatives are often started and maintained by local residents autonomously. However, grassroots initiatives appear to face significant threats to their existence in long term. To tackle this challenge such initiatives may seek to become more formalised over time (Buijs *et al*., 2016). Another variant can be considered as organisation-initiated grassroots initiatives, in case larger NGO's or social enterprises take the initiatives to mobilize citizens (Ambrose-Oji *et al*., 2017). Furthermore, Green Hubs can be considered as rather experimental and creative approaches, where citizens, businesses, and non-

governmental organisations may come together and from its cooperation to emerge innovations, such as new networks, enterprises or business models.
The situation in the District of Freising, Munich Metropolitan Region can be considered as a Green Hub. Although different governmental institutions are involved, the Land Care Association as a non-governmental organisation takes a leading role and cooperation in maintaining orchards as GI within the region. New innovative approaches emerge with increasing number of new partners and coalitions, and management approaches that increasingly enable involvement of citizens, helping to maintain the GI. Particularly the situation of the Schafhof is perceived as a front-runner in the region, setting innovations on how management and cooperations can look like. The appearance of different research and education institutions appear to be supportive in this regard, but do not seem obligatory.
Another kind of grassroots initiatives can be witnessed in the situation of Malles/ Vinschgau Valley, South-Tirol. Here, non-governmental actors recently started to build new coalitions in order to transform current widely established high intensity farming methods and management practices due to negative externalities that go along with them. The aim is to transform these into less intensive production forms and farming systems, aiming to reconcile economic objectives with biodiversity as well as with social and cultural landscape values. Yet, non-governmental actors are predominant and take a leading role, cooperate and build coalitions with each other. Although governmental actors are involved, they keep their distance. Informal instruments are of comparably high relevance.

- Co-governance approaches

Co-governance approaches build a form in between non-government and government led approaches, where both state and non-state actors participate in decision-making processes and take on administrative tasks (Arnouts *et al*., 2012). These types are characterised by situations where actors can only achieve a certain goal if they work together and all actors thereby negotiate the goals pursued between each other (Ingram *et al*., 2018). To characterise the variants and further distinguish, Arnouts *et al*. (2012) divide these approaches into two types: closed and open co-governance. Whereas closed co-governance is characterized by a rather restricted, structured and fixed form of cooperation between governmental and non-governmental actors. Open co-governance implies a more accessible and flexible form of shared governance. Buijs *et al*. (2016) and Ambrose-Oji *et al*. (2017) consider co-governance as sub-type and differentiate with market governance as another sub type of co-governance, that has been introduced earlier by Buizer *et al*. (2015). Co-governance in urban green space planning and management are considered as partnerships between citizens or citizen organisations and municipalities with power being shared between those involved, usually located on municipal land and may involve additional public assets.
As co-governance we can distinguish between closed and open variants. The situation

of the Raab-Örség-Goričko Nature Park in South Burgenland demonstrates closed co-governance because cooperation depends on the initiation of the nature park as most important actor. While the governmental actor group sets the direction, different stakeholders and local non-state actors become incorporated. The Parks administration provides a framework, coordinates and maintains the network, and is in charge of funds. Within this frame, different non-state actors and stakeholders act autonomously, supporting to reach a common vision.

Open co-governance can be witnessed in two cases, the Trin/Domleschg region (Canton of Grisons) and the Zone Albanais Haute-Savoie (Parc Naturel Régional du Massif des Bauges). Here, governance is characterised by an open network, based on numerous actors that intensively interact with each other, cooperating and collaborating. Processes of interaction are depending on many different actors and forms of cooperation that work independently and on a very flexible base.

Market oriented governance can be witnessed in two cases, the Central Region of Salzburg and the County of Rosenheim (Metropolitan Region of Munich). A somewhat outstanding case is the Rural Park South Milan, where characteristics and mechanisms of marked oriented approaches can be witnessed besides the government led approach. In all three cases primarily market-oriented partners along the value chain are involved and drive processes within the network to maintain and develop GI. Non-governmental associations are included by representing producers' and consumers' initiatives. In these cases, a high motivation among different actors can be observed. Governmental actors are also active, for instance by setting framework conditions in which the market can maintain and further evolve. The network furthermore characterises as being fertile in terms of the development of new products and services with economic, future oriented businesses, offering potentials reconciling economic, ecological and social/cultural interests.

6.5 Conclusions: How can this knowledge help to better plan, manage and maintain GI in the Alpine Area?

Our investigation of ten LUIGI pilot regions in the Alpine Space revealed six different stakeholder groups with different roles, functions and relevance. Furthermore, this work describes the different dimensions relevant to understand the governance approaches. Analysis of good practice examples in LUIGI shows a range of different types of governance approaches, from government led approaches on one side to non-government approaches to the other side with a number of variations in-between (*Figure 6.2*). Thus, results suggest that there is no one-size-fits-all solution but that governance, in order to better plan, manage and maintain GI in the alpine area, depends on a number of different factors, such as framing conditions and historic developments. However, these different approaches should not be seen strictly separated, as transitions are fluid. Furthermore, approaches can stimulate each other to further enhance governance of GI.

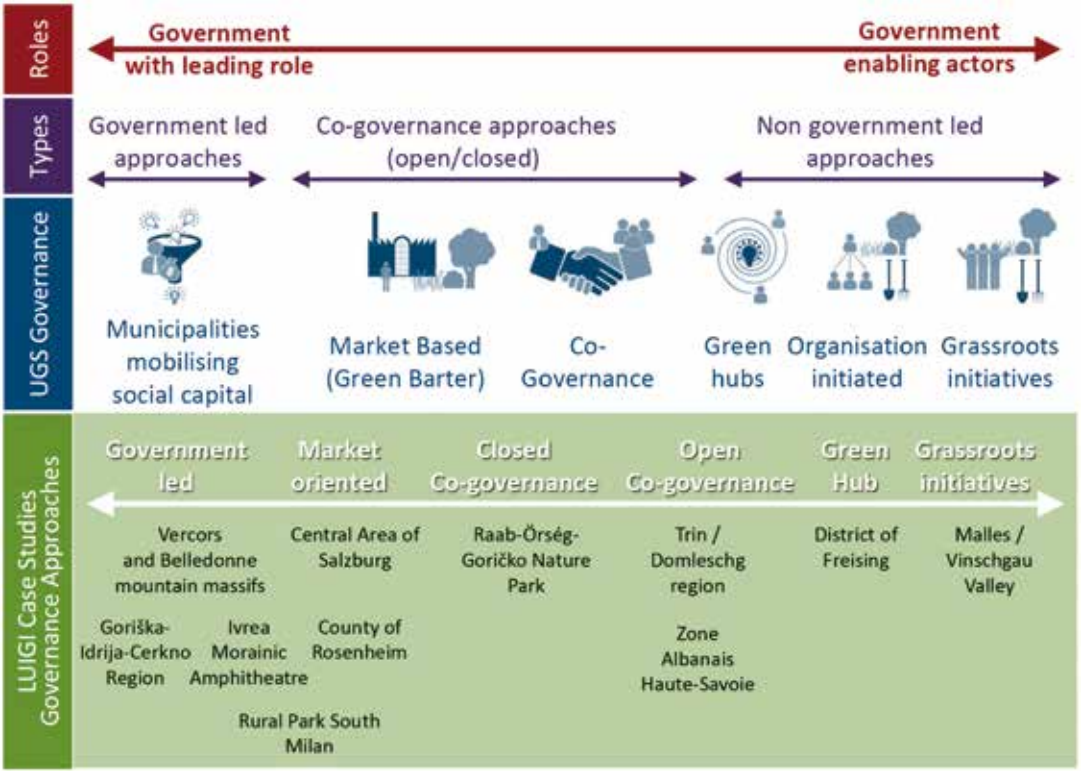

Figure 6.2 - Governance Arrangements within the different LUIGI case study regions. Source: based and extended according to (Arnouts et al.*, 2012; Buizer* et al.*, 2015; Buijs et al., 2016; Ambrose-Oji* et al.*, 2017).*

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SECTION III

Chapter 7

Examples for urban green infrastructure governance from selected case study areas in the Alpine Space

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Abstract

As different governance approaches applied within the LUIGI case study areas, four of them are depicted as in-depth cases studies. The variety of governance structures, differences of involved stakeholders, their interaction, goals and the network between them are highlighted. The differing landscapes and the socio-economic contexts result in a disparity of resources for GI-management shown in the case studies. Among the examples are rural regions, where traditional land-use forms are still in practice, but threatened by intensification of land use. Meanwhile, private initiatives reinvestigate the rudimentary traditional land use forms in their more developed periphery from a different point of view, regarding recreational values and ecosystem services.

Keywords: agroforestry, orchard meadows, governance, stakeholder engagement, social network analysis

7.1 Introduction

The planning and management of GI, comprises various dimensions, which are interwoven to one another. The type of governance with or without the active involvement of government authorities affects stakeholders as mentioned in the last chapter. Depending on various other factors, each stakeholder has its own discourses as motivation, values and believes that drive their actions as well as the presence or absence of certain resources as time, money, knowledge and last but not least, the land property. The tetrahedron of governance dimensions (Arts *et al*. 2006, Liefferink 2006) in chapter five exemplified the complexity of the topic. In this chapter, we want to add more practical value to illustrate the topic with examples from the LUIGI case study areas. These investigated the complexity of these networks in eleven areas, a classification of challenges of GI management in the Alpine Space (Schrapp *et al*. 2020). For the analysis of the network structures to relate to the governance model, the outcomes of qualitative content analysis of, was used as input for social network analysis (SNA) as well as the identification solutions for management (Hübner *et al*. 2021). Chapter 6 will show selected results for four out of eleven case studies.

A somewhat common background the case studies share is that orchard meadows face severe economic challenges; they are often abandoned due to the lack of economic reasonability for farmers. This goes along with a lack of awareness for

GI, which is detectable among many stakeholders and among the public. Across cases and governance approaches, the lacking dialogue and coordination has to be commonly tackled. Therefore, it is important to share information among the stakeholders and get different groups, although with seemingly different or divergent aims and interests together to evolve a strategy for a common vision of resource use. How to encounter with such situations in government-led, marked based, green hub and in grassroots' type of governance show examples from Idrija Goriška, Milan, Freising and Vinschgau valley (*Fig. 7.1*).

Government led-type of governance: Raab-Örség-Goričko Nature Park

a) Use and management of orchard meadow in mountain areas is a challenge thus they are tconstantely declining.

Market based-type of governance: South MIlan

b) A mixed landscape needs to integrate mixed functions and expectations by the stakeholders involved.

Green Hub-type of governance: District of Freising

c) Intertwinement of leisure activities with the protection of biotopes with an information board at Schafhof.

Grass-root Initiative-Type of governance: Malles / Vinschgau Valley

d) Public tree planting action day – besides training this creates a permanent relationship and sense of responsibility.

Figure 7.1 - *Examples of urban-rural green infrastructure from the selected case studies. (Photo credit: a) Pri Jeramu, ICRA, b) AR Paesaggio Collinare, MCM, c) L. Schrapp, HSWT, d) V. Rohringer, PTE Icons: adapted from (Ambrose-Oji* et al*. 2017), courtesy of Green Surge project consortium)*

7.2 Government-led Approach in Goriška Idrija Cerkno Region

- Background of the governance in place

TThe Goriška region extends over the western part of Slovenia with the territory of 2,325 km² with its diverse Alpine landscape character, ranging from Alpine, pre-Alpine across Karst-Dinaric to sub-Mediterranean. The region is composed of 13 municipalities, which are organised in four sub-regions.

Orchard meadows are one of the most widespread traditional land uses in Slovenia that gives a unique mark to our landscape. One of the most important measures for maintaining orchard meadows are grazing by livestock and mowing. Today, land use changes and lack of interest for maintenance are threatening the existence. In Idrija-Cerkno region, because of rugged terrain and unfavourable soil composition, agriculture can hardly develop, therefore the main activity on farms is livestock, and fruit growing represents only a supplementary activity. Regarding this region, the most inhibiting factors are the economic viability, the lack of/not-good cooperation and the knowledge gaps. On another side, the social/political change, poor planning and the lack of care are the mentioned inhibiting factors with less negative impact.

- Key challenges

According to the in-depth analysis of conflicts, the situation of orchard meadows has deteriorated considerably, due to the decrease of population and abandonment of management. Motivated pensioners often maintain the remaining management. Nevertheless, the situation of processors and marketers has improved slightly, such as new juice pressing facilities. The lack of local marketing opportunities is an obstacle. Furthermore, it is difficult to acquire local varieties for replanting. For most stakeholders, the lack of governmental support and a systematic approach to the conservation of orchards are the most important obstacles. In addition, there is a very high pressure for intensification in cultivation. Due to the severe challenges, the region cannot be considered as good practice example but rather as a case study that expects to develop solutions to overcome those challenges. Still, there are single projects that prove perspectives in successfully maintaining orchard meadows.

- Characterisation of the network and governance approach

According to Network Analysis, governmental actors are considered as most important network partners in the Goriška-Idrija-Cerkno Region and seem to be well connected with almost all groups of actors. Economic partners, such as land users, companies and associations are relevant network partners in GI management. In addition, the public is frequently perceived as being important. In total, governmental and business representatives build the most relevant cooperation partners within this network. This steers many processes and interactions among the actors.

Stakeholders

Local public authority (municipalities), national authorities (ministries and institutes), cooperatives (*e.g.* Cerkno Idrija Fruit Growers Association) and the wider public (landowners).

- **Government & Administration**: Ministry of the Environment and Spatial Planning, Spatial Planning Directorate; Ministry of Agriculture, Forestry and Food, local municipal authorities, national authorities (ministries and institutes) and the wider public (landowners).
- **Associations**: Cerkno Idrija fruit Growers Association
- **Nature Conservation**: Institute of the Republic of Slovenia for Nature Conservation
- **Research:** University of Nova Gorica

Governance dimensions

- **Discourses**: In the Goriška Idrija Cerkno Region, a very complex picture of multiple values seems to drive the discussion whereas none of the objective appears to dominate the discourses. Economic objectives are targeting to develop sustainable market shares and products based on land use management that preserve landscapes, contribute to natural resource management. Public awareness building and capacity building appears as another relevant objective. Appreciation of the landscape and biodiversity serves as a strong motivator in the Goriška-Idrija-Cerkno Region. Economic benefits of GI are similarly often mentioned across all stakeholder groups. Science & education rather follows the economic trail in the discourse but in good company with the associations.
- **Resources**: LLabour is a valuable resource in the Goriška-Idrija-Cerkno Region, often ab-sent in the other LUIGI pilot regions, mentioned by the government and land users. Government also distributes funding opportunities (e.g. National Rural Development Programmes – NRDP, European Regional Development Fund – ERDF). All other partners contribute with knowledge and skills, especially the sciences. Surprisingly, legitimacy is largely with business partners. Associations play a minor role in the debate over resources.
- **Rules of the game**: Whereas businesses, associations and the public work frequently with informal agreements and verbal deals, may it be because of a lack of formal structures or of choice, however the government agents are struggling, but will eventually allow for it, *e.g.* concerning practical implementations in the field.

7.3 Government-led and market oriented governance type in the Rural Park South Milan

- Background of the governance in place

The Rural Park South Milan (*Parco Agricolo Sud Milano*) is a 470 km^2 large protected park and green belt in Lombardy, Italy. Its landscape is characterised by dominating agricultural production on arable land, besides traditional grassland systems and a variety of different cultivation methods. An almost thousand-year-old traditional wetland meadows cultivation technique, is still maintained by farmers. Due to a dense network of rivers and canals, the Metropolitan City of Milan (MCM) is considered a waterway region. The key GI-elements identified in the region are mainly rivers and canals, riparian buffers, hedgerows and rows of trees. HNV-farms

provide multifunctional services, Nature Parks, Natura 2000 sites and related land management rules. The park management aims to maintain this rural landscape character while promoting agricultural activities. The park brands certified products and services support agricultural businesses and combine modernity with tradition, provide local products and services for rural tourism. Therefore, the Rural Park South Milan represents an outstanding example linking rural and metropolitan areas.

- Key challenges

In the Rural Park South Milan, the identified inhibiting factors were a lack of awareness and appreciation and a lack of or not-good cooperation. Apart from the gaps in the value chain, which had a minor acknowledgement as an inhibiting factor, other typical regional inhibiting factors are considered to have similar but low effects. Within the region, several examples of sustainable and/or local product labels exist as well as a great opportunity to create synergies between existing historical and touristic itineraries, sustainable transport ways (*e.g.* cycling, pedestrian and horse ways) and GI for the sustainable development of the greater region Metropolitan City of Milan (MCM). Key challenges towards GI maintenance and management are:

1) A high degree of urbanisation and infrastructures, threatening the connectivity of GIs and their potential enhancement;
2) A complex planning and management framework, which is composed by a series of public and private actors often with contrasting interests, while lacking dialogue and coordination;
3) A limited knowledge by public and private sectors around GIs, the important services they provide and their potential for the local economy.

- Characterisation of the network and governance approach

The interviewed expert in the region of Rural Park South Milan mostly referred to government representatives and a better integration and cooperation amongst stakeholder groups seems possible (*Fig. 7.2a*). The network structure of experts around GI-management is less developed compared to other regions analysed. Specific laws do still not regulate Green Infrastructures and planning instruments adequately in Italy. The legal framework is the territorial and landscape planning, which in Italy is a complex multi-level governance system. Each plan must be coherent with the upper level provisions and strategies. To this framework, additional governance bodies and their instruments exist for Regional Parks and protected areas, such as the Ticino Park, regulated by a consortium of public authorities, with its own plan. Overall, the Rural Park South Milan shows characteristics and mechanisms of marked oriented approaches but also government led approaches.

Stakeholders

The governance framework is primarily built up by Metropolitan City of Milan (MCM), the Rural Park South Milan, associations (*e.g.* Association for the South Park Milan), land users and the science and education sector.

- **Government & Administration**: Superintendence of Cultural Heritage (Soprintendenza Beni culturali), Lombardy Region, MCM, 133 Municipalities of the pilot region
- **NGOs & Associations**: Italia Nostra Onlus & the Centre for Urban Forestation, Cultural Associations
- **Community Authorities**: Ecomuseum, Regional Authority for Agricultural and Forest Services – ERSAF
- **Nature Conservation**: Northern Adda Park; Parco Ticino, PLIS
- Infrastructure operators: Ferrovie Nord; FLA – Fondazione Lombardia Ambiente, LPT – Local public Transport Agency
- **Consortia**: Water Reclamation Consortia
- **Others**: Developers, Landowners, Landscape professionals, Public and private actors/entrepreneurs.

Governance dimensions

- **Discourses**: In the case of the Rural Park South Milan the reconcilement of agricultural businesses with biodiversity is primary driving the discourses. Quality of life do not suit to motivate stakeholders in this region. Biodiversity protection and the protection from environmental hazards are much more suitable in order to maintain rural landscape as green belt. The government agent is keen on economic arguments, *e.g.* to promote local products and services for rural recreation and tourism.
- **Resources**: Knowledge is a main resource in the Rural Park South Milan, coming from government, science & education and the land users themselves. Associations seem primarily in charge of financial resources, even more than the government responsible. However, legitimacy in the region is clearly with the government.
- **Rules of the game**: No informal agreements are mentioned in the Rural Park South Milan, in line with a strong role of government.

7.4 Non-government-led Greenhub approach in the District of Freising

Contextualisation of the governance in place

The City of Freising is part of the Metropolitan Region of Munich, Germany and situated about 30 kilometres North of Munich. Since the 19th century, orchards were established as a dual land use system in combination with grazing systems. One of them being the surrounding areas of the "Schafhof" (German for sheep barn). The Schafhof 5 hectares of agricultural land form a traditional orchard maintained by the Land Care Association Freising (LCA) by low-intensity sheep grazing. Additional land users are traditional farmers as well as citizens of Freising. A regional juice company processes the harvested done by volunteers. In future, the LCA is planning to extend its current environmental education efforts by establishing a "Landscape School" to actively involve children in the maintenance of the trees and increase nature awareness.

Key challenges

As indicated by the local experts, the existing orchards are in a bad maintenance condition. The value chain with further processing and marketing has slightly improved. While farmers tend to give up orchard management, private persons enter into the management. Hence, motivation is less economic oriented. Due to different new activities at the Schafhof and in the surrounding orchards, the site is considered a flagship project Potentials lay in possible collaboration with research institutions in

Weihenstephan as well as the proximity to the urban market

The District of Freising was the region that gave special emphasis to the conflict of interest as the main inhibiting factor. The next inhibiting factors with special relevance considered were the knowledge gaps and the funding deficits. However, the social/ political change and the bureaucracy were of minor relevancy as inhibiting factors for the GI.

Characterisation of the network and governance approach

The SNA of the District of Freising revealed a very diverse group of different governmental and non-governmental actors (*Fig. 7.2b*). These interest groups work together on a voluntary and equal basis. In addition, the Bavarian State Research Institute for Agriculture is located in Freising and considered as an important partner for innovations besides further scientific cooperation partners

In the District of Freising, in particular the LCA takes a leading role to maintain and promote orchard cultivation in the region. LCA represent regional non-governmental organisations and implement regional nature conservation measures together with local farmers, nature conservation organisations and municipalities. However, visible cooperation within the region rely on different governmental and non-governmental actors on an individual basis. Some of them are organised in associations, such as the LCA – some others are not without a fixed network. Hence, the governance approach can be considered as a green hub.

Stakeholders

Land Care Association of Freising, com-munity groups (family businesses, business partners, various research organisations/ schools, quite substantial involvement of the wider public.

- **Government & Administration**: Bavarian State Ministry of the Environment and Consumer Protection – Dep. 25, Bavarian State Research Centre for Agriculture (Lfl), Bavarian State Ministry of Food, Agriculture and Forestry
- **Community Authorities**: City of Munich – Department of city planning and building regulation; City of Freising;
- **Associations**: European Metropolitan Region of Munich e.V. association– Working Group Environment; Land Care Association Rosenheim, Hochstamm Deutschland e.V.; German Association for Agroforestry (DeFAF)
- **Nature Conservation**: Friends of the Earth Bavaria (NABU)

Governance dimensions

- **Discourses**: Three main targets drive the discourses in the District of Freising: protecting biodiversity, including agrobiodiversity, promoting businesses, maintaining landscapes. Governmental actors target on GI as a strategy to tackle the depletion of abiotic resources and climate regulation. Further mention also address awareness raising and increase public participation. Idealism, quality of life and joy motivates the stakeholders amongst the associations, but not with the land users. Maintaining orchards as habitat and development of regional market for local products is a common goal. Business together with science & education mention economic benefits of GI.
- **Resources**: Government provides various funding programmes for nature conservation and preservation measures. Associations like the Land Care Association provide knowledge, labour and property. Networking is done by the association and little among the other stakeholder groups.
- **Rules of the game**: Formal and written are more often in place than informal / verbal rules of the game. For the land users the written form and legally binding contracts are important. However, GI-management advise from government runs on the base of mutual understanding and good-will. No contracts exist, but rather voluntary offerings of advice, workshops, support.

7.5 Grassroots initiative in Malles / Vinschgau Valley

- Background of the governance in place

South Tyrol, also known as the Province of Bolzano (Bozen), is situated in the central area of the Alpine Space Region, in Northern Italy. Most of the territory is mountainous and 37% of the territory is on elevation above 2,000 m. Besides semi-natural high mountain and Alpine pastures, the landscape is characterised by forests in the slopes and agricultural land use primary in the valley. The tourism industry of South Tirol is a very relevant economic factor. Agricultural production is based on intensively used grasslands, apple plantations and vineyards. Orchard meadows as traditional low-intensity fruit tree plantations are characteristic landscape elements for the region and of high aesthetic value. They are composed of high-stem fruit trees (apples, pears, chestnuts), a species rich grassland, and provide high agro-ecological value due to the diversity of local fruit varieties.

- Key challenges

Due to intensification and replacement by more profitable intensive fruit plantations and vineyards as well as maize fields. Only a few low-intensity traditional land uses remain. Now, negative externalities of intensive agriculture are becoming apparent, and some citizens have started an initiative to ban pesticides in intensive apple orchards and promote organic and low-intensity farming.

The in Malles / Vinschgau Valley case study does not provide extraordinary good practice examples, but rather seeks to find solutions to address the current challenges,

such as by awareness raising for positive effects of low-intensity agricultural practices. The most frequently mentioned inhibiting factors to the region were the economic viability proceeded by lack of/ not good cooperation and knowledge gaps. By contrast, the least referred inhibiting factors were poor planning, lack of resources (money/time) and the conflict of interest. In this region, the inhibiting factor conflict of interest was less relevant.

- Characterisation of the network and governance approach

Outstanding in the SNA of GI-Stakeholders in the Malles / Vinschgau valley, South Tyrol, was a strong presence of associations, that frequently relate to partners from the sciences and education (*Fig. 7.2d*). Due to the active involvement of the associations and the public, one can consider the governance arrangement in as grassroots initiatives.

Stakeholders

Associations and science & education are the most frequently mentioned stakeholder groups. The government agents play a minor role.

- **Government & Administration**: Dep. 31. Agriculture department, Office for telecommunications and infrastructure, Civil protection, Dep. 32. Forestry, Dep. 28. Nature, landscape and rural development
- **Municipality consortia**: Consortium of municipalities
- **Association**: South Tyrol Farmers Association, Beratungsring, Bring, Bioland
- **Business companies**: Pur Südtirol; Red rooster, La Bottega dei Contadini; Biosüdtirol
- **Nature Conservation**: Association of Nature Conservation and Environmental Protection
- **Research**: Museum of Nature South Tyrol

Governance dimensions

- **Discourses**: The discourses are primary shaped by the objective to promote businesses that maintain agrobiodiversity, protect biotic and abiotic natural resources and aesthetic landscape values. Joy, quality of life and idealism are a crowd puller in in the case study area. Associations, the public are at the forefront. The appreciation of the biodiversity also serves as a motivation in the discourse across stakeholder groups. All of the categories are mentioned at least once.
- **Resources**: Knowledge is the outstanding resource for GI-management in Vinschgau Valley. It is provided by the regional associations, but also by science & education. Property is the second main resource more often mentioned than on average across all 11 regions. However, as the land users provide land, it is not automatically supporting GI development, especially as labour and financial resources are scarce.
- **Rules of the game**: Informal and verbal agreements are quite frequently in place within the GI-governance framework. However, the cooperation relies on strong and fundamental written agreements. The same is also about cooperation crossing administrative levels, *e.g.* municipality to the canton.

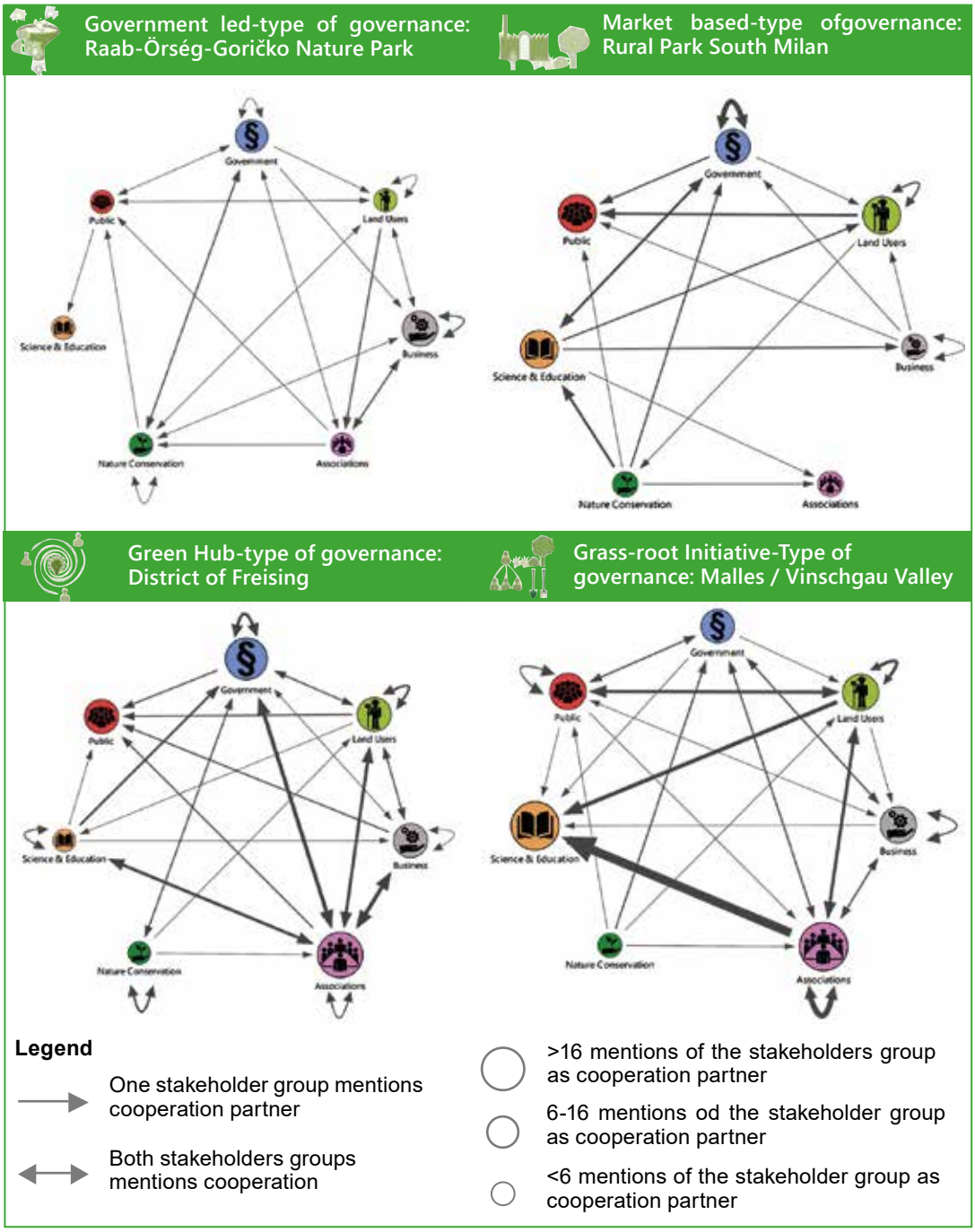

Figure 7.2 - *Sociogram of stakeholder groups from four selected case study regions (own elaboration, 2021)*

7.6 Conclusion and outlook

As the challenges in the management of UGI in the Alpine Space are classified

(Schrapp *et al.* 2020), differencing governance regimes for their maintenance could be identified (Hübner *et al.* 2021). The uneven distribution of stakeholders in networks, varying resources and "rules of the game", ranging from very informal agreements up to very formal and sometimes strict statutes. These differences call for specifically tailored solution pathways. Each governance model has established its own set of instruments that work well within the current setting in the various regions of the Alpine Space. It seems worthwhile to consider solutions that are well established and have proven to be successful within other governance models.

Orchard meadows, a prominent type of GI in the Alpine Space, face severe economic challenges, thus are often abandoned due to the lack of economic reasonability for farmers. Here, government agents can provide attractive programmes to support the maintenance and care of orchard meadows in order to withstand the counterattraction of alternative income sources. Funds from the Common Agricultural Policy (CAP) can be backed up by national or regional funds. In addition, rules and regulations can be a more efficient form of government intervention and are especially necessary, when the economic incentive would exceed the factors of income forgone or additional effort for management. For example, when high prices for land triggers intensification of production or when the areas are seen a potential development land for infrastructure thus in danger being sacrificed. Key for a relevant consideration in planning is the communities' aspiration for the surrounding land for the well-being and quality of life of their inhabitants. Coming back on rules and regulation, one may be cautions that, 1st strict rules may result in the crowding out of initiatives by entrepreneurs and farmers, and 2nd legal obligations often prohibit incentive based instruments. Therefore, dialogue needs to assess which measures are backed up by the stakeholders, often the land owner, in order to maximise the overall gain.

As commodity products form orchard meadows do not resemble mainstream food products in appearance, size, shape etc. and being at the same time "rather expensive", they are often seen incompatible with "modern" consumers' preferences. Here information and convincement of the consumer, for example about the taste of old varieties, the environmental benefits and its value for society, seems adequate topics for NGOs and the education and information sector from various directions. Businesses and the trade sector could make sure that such old varieties become recognised and marketing initiatives could boost sales of such products, labels may help, such as the label for Protected Geographical Indication (PGI).

As planning and management framework for GI is complex and sometimes with contrasting interests, lacking dialogue and coordination, it is of great value to improve Inter-sectoral and interagency cooperation in order to minimize conflicts of interests. The goal must be to create strategic and proactive visions. Here sometimes the creation of special agencies in charge seems a solution to balance between interests, going from environmental protection, regional economic development

and infrastructure and the needs and wishes of society. A green hub governance model often resembles such approaches with a stronger lobby for environmental concerns. The involvement of society seems to be a major driver and resource in grass-root based governance models. The general conflict of land share vs. land spare is also likely to be addressed through such constellations. As societal pressure and NGO activities sometimes collide with farmers' self-perception, eventually triggering protest actions, there is a great necessity to overcome such conflicts.

The widely visible lack of awareness and non-valuation for GI is detectable among many stakeholders and among the public. However, this will presume a greater challenge going beyond the realm of GI management and governance. There are many bricks in the puzzle. A very important one, and maybe the keystone, is the ecological value and the ecosystem functions. Awareness rising is the overall mantra, especially among the youngsters. There are many good examples that have proven successful. However, at the same time the professional sector needs to recognise the cultural achievements of producing so many varieties and regionally endemic land-use practices, some are in acute danger to disappear before they are recognised.

Finally yet importantly the maintenance and development of GI contributes to the valuation of culture and landscape. As typical remnants of the rural cultural landscape even today in danger of disappearing, such efforts could be moved higher on the agendas, independent of the stakeholder in charge or the overarching governance model.

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SECTION IV

Chapter 8

CHALLENGES TO GREEN INFRASTRUCTURE VALORISATION AND POLICIES TO OVERCOME THEM

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Abstract
In this chapter we explore the challenges and possible solutions emerging from the LUIGI project in developing a coherent network of green infrastructure across the Alps. Our focus is on how to valorise GI elements and networks through the practical lens of three aspects: mapping and quantifying, enabling and governing. We first outline five major challenges for policy makers and relevant stakeholders and then investigate a number of possible solutions across all three aspects to implement at the local, regional, or transnational level.

Keywords: valorisation, policy recommendations, policy integration, capacity building, stakeholders cooperation

8.1 A snapshot of GI valorisation challenges

In the Alps, and at a European level, the establishment of a coherent network of Green Infrastructure (GI) is considered a key instrument for the long-term conservation of ecosystems and biodiversity. Besides the contribution of GI to biodiversity, it can also deliver a wide range of ecosystem services and so contribute to a regional green economy. Nevertheless, the implementation of the GI concept is struggling, as several aspects of the concept still remain unknown and unclear to policymakers, politicians, and relevant stakeholders. The goal of this chapter is to discuss how to establish the conditions for the creation and capture of value in GI, addressing three key aspects: mapping and quantifying GI and their benefits, enabling GI through knowledge transfer and improved economic viability, and governing GI sustainably. This chapter will therefore be divided into three sections to discuss the topic under each of these elements.

This short introduction outlines five major challenges for policymakers and relevant stakeholders in the effective implementation of GI. These challenges have been identified from practice by the team dealing with hedgerow development at Grenoble Alpes Metropole. This chapter is not meant to represent an exhaustive list of challenges nor potential solutions, rather a snapshot of some of the key issues and solutions emerging from the LUIGI project. The five challenges will be addressed through the lens of our three aspects.

8.1.1 Mapping and Quantifying challenges

- 8.1.1a Achieving real ecological functionality

In order to ensure a real ecological functionality of GI networks and guarantee that

the proposed GI elements meet the requirements of the targeted biodiversity needs, sound ecological expertise is needed. The corresponding knowledge is usually available within an expert community – scientific research centres, consultancies and (nature protection) associations. The challenge consists in mobilising the necessary expertise and the corresponding knowledge transfer. Ecological interrelations are often not easily apprehended and usually the implementation of a one size fits all solution is not possible. The resource and time demanding process of identification of the main ecological interactions and principal target species is necessary. In the context of the development of a real functional green infrastructure the nature protection dimension is not one dimension among others (economy, social, cultural, etc) and requests the contribution and consideration of the corresponding expertise.

- 8.1.1b Embedding socio-economic data in GI management

Sustainable GI management is directly linked with highlighting the social, cultural, and economic dimensions of the provided ecosystem services. Addressing challenges by applying the methods proposed by the TEEB (The Economics of Ecosystems and Biodiversity challenges) approach seems to be pertinent. First, in order to be considered as driving policy element, the value of functioning ecosystems and biodiversity needs to be recognized. The ecosystem services approach, analysed within the LUIGI WP1, offers a way to apprehend this issue. In a second step, the value needs to be demonstrated: using economic tools and methods to make nature services economically visible in order to support decision-makers wishing to assess the full costs and benefits of land-use change. Finally, the capacity of capturing the value by incorporating ecosystem and biodiversity benefits into decision-making through incentives and price signals.

8.1.2 Enabling challenges

- 8.1.2a Economic viability

So far, funding for GI network implementation is mainly based on public funds. Because GI is more effective when it is widely implemented – on public and private land – people's willingness to accept and contribute to GI funding is crucial. In order to reach this, viable economic models of GI creation and long-term management need to be developed and the willingness to pay for the multi-functionality of GI increased.

In the context of climate change consequences – in particular in the alpine context - the cost of not investing in resilience initiatives (or the cost of no action) will increase, and the implementation of GI is considered as a promising solution. This seems to be an interesting opportunity to fund GI development but a change in perception is required from stakeholders across the board to use GI in addressing climate change.

8.1.3 Governing challenges

- 8.1.3a Regulatory pathways and innovation

The long-term legislative context will considerably impact the success of implementation for GI networks. Further mainstreaming of GI elements in the alpine context faces the challenge of finding a suitable regulatory environment. So far, jurisdictions have no clear processes for regulating GI and its assumed benefits. There are no legal arrangements that give authorities enough confidence in the longer-term benefits of resilience measures, including GI. Legal arrangements need to have clarity on the new distribution of responsibilities and on the sustained maintenance commitment in the long term.

Even in the case of a well-planned GI network the traditional sector-focused approach of different regulatory bodies may hinder a successful implementation and long-term management of the GI elements. Indeed, the relatively poor integration of regulatory bodies into a cooperation system that fully appreciates the multidimensional benefits of GI remains a key challenge.

GI network development can form an integrated part of nature-based solutions to address strategic planning challenges including reconciling different agendas and priorities, such as public health, water management, biodiversity loss, climate change or even economic growth. Innovative approaches offering GI policies a prominent place within a larger and complex policy framework are required. This includes aspects of modern community participation, along with citizen-led knowledge consideration.

8.1.4 Mapping & Quantifying

When it comes to understanding GI elements and GI networks, data and expertise must be considered a crucial and strategic element. Decision-makers must be able to identify GI elements (whether existing or potential), how they connect with each other, and the benefits they provide to communities and to other GI elements and networks. Mapping and quantifying this information also enable better communication of the importance of such GI elements. In this short section we briefly develop the two challenges presented in the introduction (achieving real ecological functionality and embedding socio-economic data in GI management) and offer emerging recommendations from the LUIGI project.

- 8.1.4a Achieving real ecological functionality

What do we mean by achieving real ecological functionality? For non-specialists, there might be a tendency to think that everything that is green is good for nature, but the reality is a lot more complex. For example, tree planting has come into fashion as a way to capture carbon from the atmosphere and fight climate change but randomly planting trees can also have negative impacts on the environment, notably if they are not maintained correctly or if forests come to replace other valuable ecosystems. This means that when developing GI elements or making plans to maintain and restore them, attention should be brought on the ecological functions and processes at play. They will notably depend on the type of ecosystems that are present. Of

course, as has been highlighted in Section 1 of this book, ecological connectivity is also a key factor to take into consideration when developing GI networks.

The challenge around achieving real ecological functionality through GI networks therefore resides in the need for technical expertise: what ecosystems are there, in what state are they, what species are present and how do they interact, and how is that all relevant to human life?

In fact, this knowledge and accompanying data is not always easily accessible and field research is often required. Once available, it must also be used meaningfully. This means organisations seeking to develop powerful networks of GI elements must not only seek to access solid data and expertise to help inform decision-making, but they must also be trained to maximise the potential of this data.

Moreover, each local area will present a unique set of GI elements, inherited from many factors such as geography, geology, historical settlements, and land uses, as well as culture. For example, although we can find traditional orchards dotted across the Alps, they differ in size, species, altitude, and the environment they sit in. This means that we cannot advocate for one GI management solution across the entire Alps, but rather that GI management decisions must rely on sound, local expertise, and technical data, meaning one size does not fit all.

What are therefore the recommendations emerging from the LUIGI project to address this challenge?

At a local and / or regional level, a powerful approach is that of engaging with local experts and citizen science activities. In practice this can be working with universities and research centres as well as consulting organisations and groups of volunteers to help improve local understanding of ecosystems and ecological functions.

In parallel, developing technical skills amongst public servants (such as minimal ecological expertise and mapping / GIS use) could prove useful to help decode the information and make it more relevant to politicians to support GI projects. This would also enable public servants to identify and focus efforts on the assets that will bring most ecological value. Beyond these recommendations, there is a call for better consideration of GI data in territorial planning activities – this could be achieved through training / information sessions but also perhaps through legislation (*e.g.* to consider GI networks as an integrated part in every territorial planning activity).

At a more strategic level (national or transnational), this challenge represents an excellent opportunity to capitalise on the Interreg Alpine Space activities and further the work that has already been achieved through previous projects and LUIGI. An online platform dedicated to Alpine Green Infrastructure, gathering knowledge and experience from pilot regions and research, as well as useful data sets and methods could be a very powerful tool for GI practitioners across the Alpine Space.

8.1.5b Embedding socio-economic data in GI management

The introduction to this chapter highlighted the need to consider the links between GI and the social, cultural, and economic benefits they provide. The ecosystem service

approach has already been presented at length in *Section 1* of this book. Besides its widely accepted use nowadays by the scientific and environmental community (despite some shortcomings), this concept allows stakeholders to share a common language and formalise the description of environmental processes and related benefits provided by GI.

But beyond environmental value, what do these benefits mean for local communities and local economies? Translating ecosystem services into more tangible benefits for local policymakers and their communities is paramount to ensuring the success of the GI concept. Importantly, this brings us to strongly recommend that the full spectrum of benefits must be considered when planning GI networks: ecological information and value is not enough to convey the full potential of GI and the positive impact they can generate for societies and for other GI elements and networks. The social and economic value of such networks must be highlighted and presented to decision-makers and politicians.

Identifying socio-economic and environmental benefits is not enough however and the LUIGI project has focused in large part on defining and better understanding suppliers and beneficiaries of such outputs. Bringing attention to the parties impacted by GI development and more importantly involving them in the process and the ongoing management of GI networks can be a very powerful way to generate engagement and consensus and further improve the valorisation of GI elements.

On this point, the recommendation emerging from the Interreg Alpine Space work is that of commissioning further research into improving the understanding of sectoral potential for GI, notably around agriculture and tourism, but also health and education. As such, link with previous and ongoing research such as BioCanteens (Urbact), ECONNECT, greenAlps and others can easily be made. At a local and regional level, this can be translated into involving local practitioners from varied sectors to help develop GI networks and harness their full potential.

8.2 Enabling

Green infrastructure management is not natural per se for public policy actors nor for residents, associations, and other involved stakeholders. Having the knowledge on GI or needed funds are not the only condition for participation in their management – it also relies on key actors to enable this management at different geographical levels – local, regional, and transnational. Enabling is considered here as a set of practices to deploy resources to ensure cooperation, develop training for specific actors, enhance educational activities, willingness to pay but also trigger new business models for companies seeking to promote and manage GI. In this section, we will explore:1. Who are the key actors who have to be enabled (*i.e.* who can manage GI)?; 2. How to enable those actors to better consider GI and to act at their level, showing best practices on knowledge sharing, capacity building, new business models or raising awareness?

Talking about enabling, we have to think about different geographical levels to manage GI. If GI is mainly a concept coming from a transnational level, maintenance of GI is both local and regional. For example, regional parks, containing forests, rivers, and orchards often have to be managed by multiple municipalities. Regulations, funds, also crucial, can come from the transnational level (Alpine Space or European).

8.2.1 Who are the key actors that can manage GI?

It is not mandatory to manage GI in a top-down approach. In fact, a diversity of actors can intervene, such as policy makers, at different geographical levels and with different responsibilities. Local policymakers have the knowledge of their territory, of local NGOs, but are also anchored in local and national regulations and can act as managers for GI.

Civil society is also a key actor for managing GI: residents have a specific knowledge of their territory and can support GI promotion through collective actions. For example, residents can organize events around GI, rooted in local traditions, such as village festivals. Within the Regional Nature Park Massif des Bauges, orchard apples are a local and former specialty the inhabitants are proud of (good exposure which gives them a particular taste), and which gives rise to village festivals celebrating the harvest or the transformation into juice such as the apple festival in Saint-Ferréol. Also, many orchards are located on plots of residents, who have recovered an old farm, for example. Citizens are therefore a special public to be alerted and trained on the issue of GI.

It also evokes the question of socio-cultural knowledge: it is important to value, through this type of event, the local culture in terms of GI, that is to say all the past and ancestral practices of the territory aiming at developing and maintaining the nature around the man. People start to re-understood the historical meaning of those practices that can preserve landscape and local communities: such as a proper irrigation system for example. This concerns civil society but also local entrepreneurs, that start to draw on these practices.

Finally, companies are also an important player in maintaining GI because they have the potential to invest – human resources, finances, regulatory improvements – in GI. A producer of apple or pear juice, for example, developing its label or affixing a territorial label to its products, will participate in the promotion of this green heritage – which is a good support forming part of the local cultural history.

8.2.2 How to enable those key actors and face challenges

GI has already been the subject of reports by research teams who have worked on the barriers or challenges to overcome to ensure their maintenance: understanding of the stakes, financing and perception of GI and tensions between different legislation, for example. The LUIGI project and the research already carried out on GI (*e.g.* AlpBionet 2030, AlpES and MagicLandscape) show that knowledge sharing

is essential between stakeholders. Scientific research on the mapping of GI, or on their benefits, should be communicated also to elected officials and development stakeholders, as well as to local associations. This sharing is key to triggering actions. This can go through learning-by-doing workshops, for example on orchard pruning, or knowledge-sharing workshops on the benefits of GI. The online course developed by Grenoble Ecole de Management, available to all through the LUIGI website, can allow everyone to become aware of these issues and means of action.

Also, territorial political actors must show the way and a clear vision of what green infrastructure should become, both at the transnational level (a clear European or transalpine vision for example) and at the local level. Actions already in place at the local level – such as the promotion of orchards in local village festivals – must also be encouraged and supervised by communities, even financially, to create a real local impetus in favor of GI protection, which thus forms part of the local heritage. They can also refer to socio-cultural elements and practices to inspire actions from civil society and local entrepreneurs. These actions can be replicated in other territories.

To date, the maintenance of green infrastructure is in part reliant on the goodwill of collectives and public financing of projects aimed at enhancing these infrastructures. Legal obligations to preserve ecological connectivity exist but they are not always enough to generate action at scale.

It is necessary to create economic levers to make investment in green infrastructure attractive, to promote the emergence of profitable and sustainable business models that are not based solely on convictions: preferential taxation, insist on the cost of not investing in resilience initiatives, for example. The valuation of a forest for therapeutic purposes as is the case of the Development Agency of Idrija and Cerkno is an example of how the economic world can meet the valuation and protection of these infrastructures. Finally, we must be aware that this GI promotion should be carried out at the local, regional but also transnational level. The means of action are therefore varied to concern different actors to maintain GI, it now remains to go down this path.

Forest Selfness (LUIGI project, 2021).

8.3 Governing

Governing is the implementing part of the policymaking cycle. It requires decision-making and monitoring of results and this can be done more effectively if the stakeholders are actively involved, meaning policymakers, civil society, SMEs, and academia.

8.3.1 A quadruple helix approach for a better GI governance

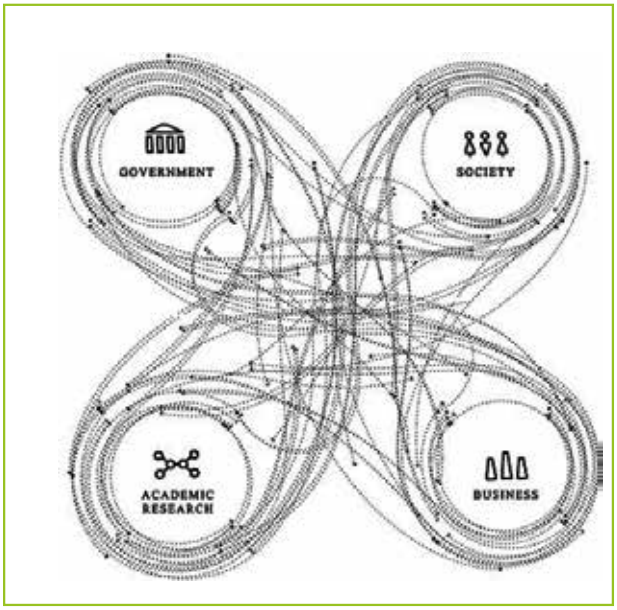
For long time, government was perceived as a provider and regulator in most countries. However, especially in Europe, public administration often plays a role of coordinator and facilitator (Borrás and Edquist, 2013).

The Quadruple Helix approach in the Regional Events of the Metropolitan City of Milan.

The Metropolitan City of Milan (MCM), project leader of the LUIGI Project, oversaw three pilot areas: Valle del Ticino, Adda-Martesana, Sud Est Milano. With the help of FLA (Lombard Foundation for the Environment), MCM organized a local event in each of the three pilot areas, involving local business (from large companies to social cooperatives), association and activists, and public agencies. Relevant local initiatives and barriers to further foster GI were identified and presented at the final event by a representative of each pilot area. MCM policymakers in charge of economic development, parks, agriculture, and youth were there to listen and respond anticipating some of the initiatives of the next months. This has been a crucial process for all relevant stakeholders to meet, often for the first time, learn about successful local initiatives and identify the elements of a shared vision which will not hamper specificities of each pilot area.

While tThe traditionaconventionall approach relied on the government to make decisions and take care of thempeople and resources, but the increasingly complex political and environmental issues to be addressed require a broader involvement of stakeholders such as businesses, research institutions, and the citizens. In several developing countries there are communities managing natural resources such as forests, though with varied level of success due to the fact that they do not work neither in isolation nor in an ideal world (Baynes *et al.,* 2015).

Therefore, wWe advocate for a Quadruple Helix approach, where



The quadruple helix framework model (Schültz, Heidingsfelder & Schraudner, 2019).

helices represent academia, business, civil society, and government (Nordberg *et al.*, 2020).. Indeed, economic activities have been often perceived as a barrier for GIs, and vice versa, while they should be reconciled. The role of research institutions and universities is to provide expertise and develop awareness and knowledge on the best way to maintain GI, moreover they provide credibility to the other parts of the policymaking process and somewhat legitimate it. Citizens should be involved also, individually or through associations and NGOs, with a number of methods that may include e-tools to ensure they understand and support GI schemes. An interesting framework proposed by introduces the Natural Environment as a Quintuple Helix. Though such an addition would be relevant to the management of Green Infrastructure, the Quintuple Helix theory is currently not developed enough to be applied to policy-making or even policy analysis (Carayannis *et al.*, 2021).

8.3.2 Existing challenges for effective GI governing

However, a strong barrier to effective policymaking was introduced in the first section of this chapter: an unfavorable, ambiguous and/or fragmented legislative context. The broad meaning of GI does not help, as too many different things can be defined as green infrastructure.

The Alpine space is characterized by heterogeneous institutional settings, where each country has a different approach to green infrastructure and often there are regional differences even inside the same country. Moreover, to the best of our knowledge, there is no place where a GI-dedicated legislation exists, and this should cover not only its establishment but also its maintenance, often forgotten by policy initiatives because less visible.

Another key dimension to consider is the fact that GI are relevant at a number of levels, going from the very local to the transnational. This multi-level governance implies different resources and responsibilities that are often difficult to identify clearly because they may overlap and vary from place to place.

A review of existing policy documents on the alpine space shows that GI governance poses two main challenges: 1. Conflicts of interest between land uses and between the public and landowners; 2.A lack of engagement and cooperation across stakeholders (at varying degrees depending on the local context).

8.3.3 Towards a better GI governance at a local, regional, and transnational level

To address these conflicts of interest, recommendations are different whether the area of interest is local, regional, or transnational. At the local and regional levels, proposed recommendations include the increase of direct engagement of public administrations with farmers and landowners, working with them from the onset of the policy making cycles, which implies the development of a vision for the local areas where a harmonious development is possible and desired. GI should be part of a clear vision and thus of the ambition shared by all stakeholders for a better territory.

The multifunctionality maps charted in the mapping and quantifying part of the policymaking process will provide key information to set priorities. Synergies and trade-offs between ESS provided by GI should be taken into account, though no policy can automatically be determined by a certain configuration of the territory, again one size does not fit all. Sustainable transport infrastructure planning is another key element of a harmonious management of GI, so that mobility is ensured without detriment of natural spaces.

To limit the frictions between cities and villages, urban-rural partnerships could be created with the aim to spread economic activities more effectively, while making easier the access to ecosystems and their services to inhabitants of cities. Good examples are the projects financed by the German program Stadt-Land-Plus where practitioners and researchers work together to develop innovative solutions for the joint sustainable development of cities, their surrounding areas and rural territories .

At the European level, the METREX Expert Group 'Metropolitan Landscapes' explores the characteristics of rural areas and how to value them in the context of metropolitan regions. Moreover, the Expert Groups focuses on new ways to include rural territories in metropolitan governance. This A better balance between urban and rural areas should be part of a global vision to limit cities expansion and human activities that may havewith detrimental impacts on GI.

At the transnational level, it is important to foster political initiatives such as the Alpine Convention to make institutional settings and actions converge on the common good. Tourism policies should be more closely related to sustainability, where landscapes should be part of the offer. GI management can help make places more attractive for international tourists but also for local ones.

Moreover, legislation with an impact on GI and ESS that does not take them explicitly into account is at the best missing at an opportunity and at the worse making damages that may be costly to repair. Policy integration of GI and ESS is not a policy recommendation per se, but it reminds of the systemic nature of these issues.

Lack of engagement and cooperation may be due to low awareness on the value of GIs and ESS, or to different interests, often political or economic. However, if correctly informed, all stakeholders would argue that GI and ESS are in the interest of everybody in the long term. Therefore, it is important to rely on a strong network of experts and policy makers (as for Mapping & Quantifying GI, but these competences are useful to the enabling of GIs and ESS too). Because GI have long cycles, engaging young people is crucial, landowners and entrepreneurs may come with innovative ideas. Here, storytelling and attachment to the place may be effective to raise awareness and engage people.

Inter-municipal cooperation in spatial planning, notably to support ecological connectivity improvements, is something to do at the local and regional levels. Cooperation is crucial also between public administrations and inside the departments of each administration.

At the regional and transnational level, links between existing professional networks could be useful and must be mobilised to reinforce cooperation and integration and help local administrations to implement strategic decisions on biodiversity and GI connectivity. To enable these exchanges, virtual meetings and specific cooperation hubs may be necessary. These policy recommendations may be relevant to EU and Interreg programs decision-makers who with their project budgets are often the key driver of research and action. Moreover, they could ensure continuity of action and consistency between project cycles, by supporting technical assistance and certification initiatives of transboundary cooperation and by involving local communities on both sides of borders. The creation of an Alpine 'GI knowledge and networking hub' to support the three policy phases (mapping & quantifying, enabling and governing) could be a further recommendation to EU decision-makers. At all geographical levels, a starting point for policymakers could be to assess the current GI governance model and the stakeholders involved as well as the dynamics between them applying the methodology developed in the WP3 of the LUIGI project. This will ensure that relevant interlocutors and their interests are considered in order to minimize the risk of lack of engagement or overt hostility.

8.4 Conclusion

In this chapter we have conveyed key challenges on GI valorisation, from mapping and quantifying issues to enabling and governing problems. We have also proposed a series of emerging recommendations and solutions to address these challenges. At the heart of all our recommendations lies a common theme: we are not yet harnessing the full potential of the green infrastructure concept. GI represents an enormous opportunity to improve the management of our landscapes for sustainability, but we must continue to improve our understanding and our capacity to work together in order to enhance GI benefits for all. The LUIGI project has been a great step in the right direction.

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SECTION IV

Chapter 9

Delivering LUIGI through education: the Modules as effective tools for sustainable capacity building

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Abstract

The purpose and goal of the LUIGI WP4, Education and training for sustainable GIs management and ecosystem services (ESS) provisions, was to identify the shortcomings and needs on green infrastructure (GI) in existing educational systems, develop modules, as well as educational resources and execute them in LUIGI pilot regions. Among the first steps we identified how the knowledge on green infrastructure (GI) is transferred, and through which channels. We have found that the main knowledge transfer is performed by universities. Its share of knowledge transfer actively contributes also different types of schools, associations and other organisations such as a society.

The outtake was that business and social engagement did not have as big of an educational output as ecology, planning or management did. As a result of the research the following four important, missing or less articulated areas had been identified:

- *ecology and environmental aspects with landscape planning training: to develop/ provide knowledge/competency/information/methodology on why/how to connect protected areas with other natural and semi-natural areas with corridors and steppingstones, to form a functioning network, that supports ecological connectivity.*
- *management aspects: to provide information on how to better manage grasslands, meadow orchards ie. tree-based GI elements and wetlands, for the knowledge on maintenance has been lost between generations.*
- *business models: to provide knowledge on establishing profitable businesses, which are characterized by preserving natures inherit value, sustainable management enhancement, are modern, resource-efficient, and competitive with others and*
- *society participation engagement: to share know how on creating engaging events for different target groups, for example holding an exhibition and GI-products tastings. On one hand the module provides the needed resources to organise such an event, while it provides tips on how to set the event timetable on the other.*

These modules were later adapted and executed in LUIGI project pilot regions. Each executing workshop contributed to awareness raising and knowledge dissemination as a success story well received among all participants.

Key words: educational modules, knowledge pools, capacity building, green infrastructure,

9.1 Introduction

Within the LUIGI WP4 we first explored the educational landscape in project pilot regions to identify different green infrastructure related knowledge transfer pathways

within the official education system or other knowledge transfers like trainings for professionals and open courses (Hladnik *et al.*, 2020).

The results showed the largest share of modules were related to ecology and environmental aspects of GI, followed by landscape planning training, and less represented courses on management aspects, business models and society participation engagement. The described order of importance is similar in all pilot regions. The exceptions are French northern Alps where the largest number of existing modules is dedicated to GI management and South Tyrol in Italy where the largest number of modules is related to landscape planning.

Based on these results we developed four GI-related educational modules: Training module for GI oriented sustainable landscape planning (Bertoncelj *et al.*, 2021), Training modules for practical and sustainable GI management (Hladnik *et al.* 2021), Training module on possible business models and value chains of GI (Rekič *et al.* 2021) and Training module on possible secondary products from local GI and society participatory engagement (Hladnik *et al.* 2021).

To raise GI knowledge and awareness the four modules were adapted to local needs and implemented in project pilot regions within the proposed forms of knowledge transfer such as course dedicated to GI-related topics, individual lecture within regular educational courses, independent lecture, practical workshop or field training.

9.2 Exploring the existing knowledge pools and transfers in Alpine Space Regions

As educational institution in the frame of LUIGI we defined all organizations and experts which produce, gather, and distribute knowledge related to GI planning, management, use, and other activities related to GI.

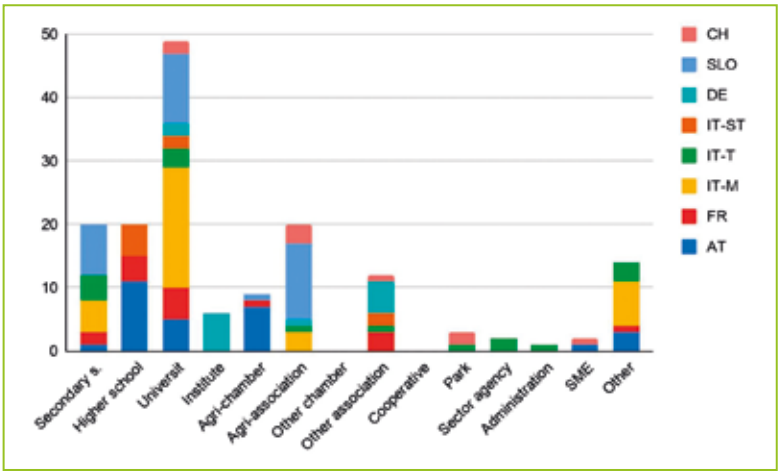

Figure 9.1 - *Number of identified educational institutions providing GI-related knowledge in 14 categories in project regions: AT - South Burgenland; FR - French Northern Alps; IT-ST - South Tyrol; IT-M - Metropolitan City of Milan; IT-T - Metropolitan City of Turin; DE - European Metropolitan Region Munich; SLO - Goriška statistic region; CH - Canton of Grisons (Hladnik* et al., *2020).*

Our exploration of the educational landscape showed that the main GI-related knowledge transfer is performed by universities (*Figure 9.1*). Follows knowledge transfer by secondary schools, higher schools, and agricultural associations. An important role, in the knowledge transfer, also played by other organisations, like local administrations, sectoral agencies, parks and small- to medium-sized enterprises (*Figure 9.1*). These organisations usually possess reasonable amounts of knowledge but according to our findings do not organise teaching and training activities.
From courses offered by educational institutions in the Alpine Region (*Figure 9.2*), the largest share was related to ecology and environmental aspects of GI, followed by landscape planning approaches and modules related to GI management aspects. As expected, we detected very few modules on possible GI-related business models and society participatory engagement.

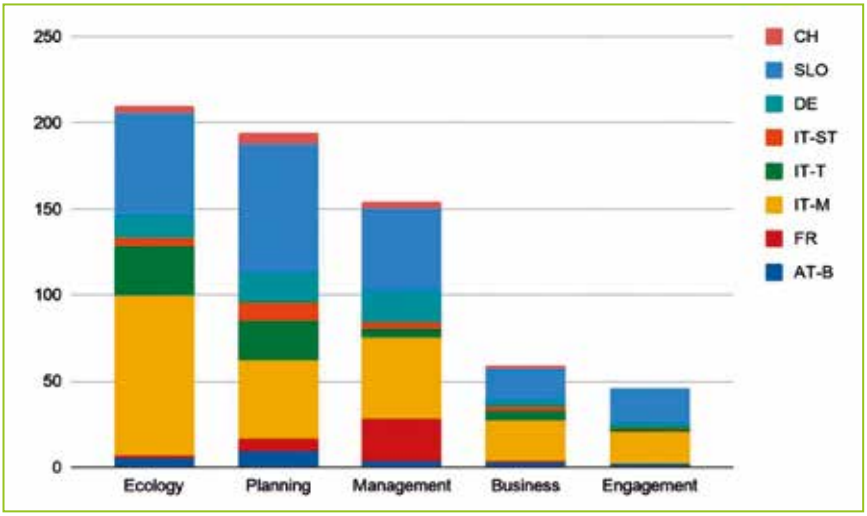

Figure 9.2 - *Number of modules per module topics as identified in different project regions: AT - South Burgenland; FR - French Northern Alps; IT-ST - South Tyrol; IT-M - Metropolitan City of Milan; IT-T - Metropolitan City of Turin; DE - European Metropolitan Region Munich; SLO - Goriška statistic region; CH - Canton of Grisons (Hladnik* et al.*, 2020).*

With preparation of educational modules, we gathered missing content and prepared starting points for holding various events in project pilot regions. To properly direct the most appropriate execution of GI-related knowledge transfer we identified existing knowledge transfer paths on the educational level, where the most spread form of GI-related knowledge transfer as shown in *Figure 9.3* were lectures dedicated to GI and practical trainings.
However, the story does not end with choosing the content and the most used type of execution of knowledge transfer. Fundamental players are the end-users, which can be various organisations or individuals who are using the provided GI-related knowledge, skills in their daily work. Major role in GI creation, maintenance, sustainability, and general public perception plays decision-makers and planners.

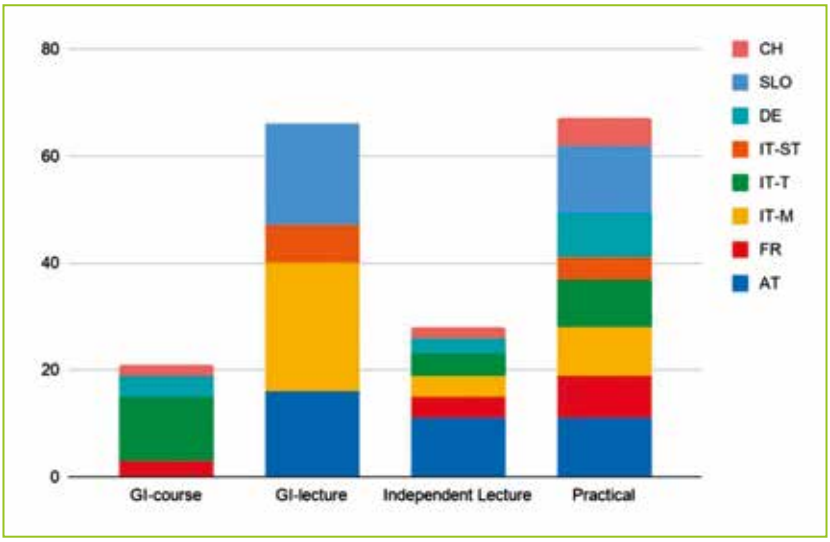

Figure 9.3 - *Number of courses in four forms of G-related knowledge transfer in different project regions: AT - South Burgenland; FR - French Northern Alps; IT-ST - South Tyrol; IT-M - Metropolitan City of Milan; IT-T - Metropolitan City of Turin; DE - European Metropolitan Region Munich; SLO - Goriška statistic region; CH - Canton of Grisons (Hladnik* et al.*, 2020).*

Therefore, addressing their needs and thereby supporting their work and decision making have a direct influence on sustainability of GI elements.

In the report Existing Teaching and Training Modules on Green Infrastructure in Selected Alpine Regions we also envisioned several groups and knowledge end-users from ecosystem services providers to decision makers and awareness raising promoters (*Figure 9.4*). The most important segment of knowledge end-users are providers of ecosystem services such as farmers and landowners including their associations and advisory organisations. They work on or live from the land with GI elements and their appreciation and understanding of ecosystem services provided by GI elements is crucial for their long-term existence.

Identified GI-related knowledge end-users organisations play a crucial role in the creation, maintenance, use and sustainability of green infrastructure elements in project regions. Estimating their activities, we classified them into six sectors: food production, business, landscape planning, community participation in tourism and educational sectors.

The understanding of green infrastructure related knowledge pools and current transfer trough teaching and training in the LUIGI project pilot regions can support policy creation and decision-making on regional, national, and international level.

9.3 Modules as effective tools for sustainable capacity building

We prepared four teaching and training modules to be adapted and executed in project pilot regions focusing on landscape planning, management, business, and society engagement.

Figure 9.4 - *Envisioned groups of knowledge end-users with interest and benefits form GI related knowledge transfer (own elaboration, 2021).*

In each module we identified aims and objectives, who is this module for, suggested target end users and the proposed educational method.

9.4 Spatial planning related to Green Infrastructure

The aim of this module is to provide students of natural sciences and spatial planning with information on the ecological aspects of movements of organisms and the importance of ecosystem connectivity for their long-term functioning. University professors and lecturers can use this module for an introductory 90-minute indoor lecture and a half-day field trip with students.

Ecological connectivity refers to the spatial and temporal extent to which organisms can move between different habitat patches. Different species perceive a landscape differently, and so the degree of connectivity varies between species and communities (Bennett, 2003). Some species use several different habitat types during their lifetime, and must be able to move between them, either according to seasonal changes (e.g., spring and autumn migration of birds), time of day (*e.g.*, foraging habitats for bats) or annual cycles (*e.g.*, reproduction habitats for migratory fish species or frogs).

Ecological connectivity is often impeded by various human activities that alter and fragment species habitats. Fences, roads, highways, railways, urban sprawl, river dams in freshwater ecosystems, wind turbine fields, and other physical barriers are common disruptions of ecological connectivity. In addition, climate change is influencing species physiology, phenology, and distribution (Bellard *et al.*, 2012), to which species can adapt by shifting their range (Hughes, 2000).

Improving ecological connectivity within the landscape through the implementation of corridors and steppingstones is one way to mitigate the negative effects of fragmentation (*e.g.*, Beier, P. & Noss, R. F., 1998; J. Hilty *et al.*, 2020). The so-called green infrastructure (GI) was proposed with the aim of connecting protected areas with other natural and semi-natural areas to form a functioning network.
GI is a spatial planning concept that aims to preserve non-built-up areas by highlighting the range of societal benefits associated with these green areas (Slätmo *et al.*, 2019). GI implementation requires cooperative efforts from a variety of stakeholders, including governmental, non-governmental and the private sector. Conflicting interests and communication challenges through different alliances and agendas will, however, make implementation difficult. (Beier *et al.*, 2011) have proposed 7 steps for coarsely mapping regional linkages with regional connectivity maps as the end result. These steps are based on the identification of "natural landscape blocks" which are defined as areas of high conservation value due to their content and are similar to core areas. However, the authors emphasize, that the rules for mapping natural landscape blocks and deciding which blocks should be connected should be based on technical criteria, as well as the values and priorities of stakeholders.

9.5 Management of Green Infrastructure elements

The aim of this module is to provide landowners, professional gardening and landscape managing enterprises information's on practical management measures for establishment and maintenance of different GI elements. This module can be adopted and executed by agricultural associations and administrations, regional development organisation and local, regional and nature park administrative bodies. The suggested educational method is indoor lecture and practical training session.
With planning or integrating GI elements into various shapes and dimensions of the environment the job is not quite done. Management of Green Infrastructure elements (Hladnik *et al.*, 2020a) as a module, should also be considered. Some GI elements are simply natural ecosystems adapting to human needs, while others were intentionally designed for human needs.
Green infrastructure elements have evolved over time and has also been influenced by local historical developments. And to maintain or manage GI elements, information on practical management measures for the establishment and/or maintenance are crucial, especially for younger generations where the transfer of this knowledge has been lost between generations.
Knowledge gap was most noticeable in the care and maintenance of meadow orchards which are an important element of cultural landscape. Without proper maintenance their existence is questionable, especially since they are rather delicate, due to their age and therefore decay very quickly. Once they begin to decay, their recovery is almost impossible. With the loss of meadow orchards, irreparable damage will be reflected in the appearance of the landscape. Meadows without orchard trees

will be more susceptible to soil erosion and the biodiversity will drastically decrease. Meadow orchards represented an important resource for farmers in the past. They sold the fruits on the market, store them for the winter or processed them into juice or vinegar. Many villages planted orchards as a community to provide fresh fruits for the wellbeing of their villagers. Therefore, the maintenance of these GI elements was of great importance in the past. But with moving of young people to the cities and by increasing the fruit supply in the stores due to import throughout the year, the knowledge of maintaining and awareness of the importance was lost. Young people don't even notice the apple tree when they pass by on the street, let alone the small profits that can it bring. The production and marketing is concentrated in intensive production with the desire for maximum profit.
Detailed management instructions for maintaining tree-based GI elements are provided in this module and encourage participants to execute the necessary measures in their local tree-based GI independently.

9.6 Management of grassland

Tree-based GI-elements mostly have grassland underneath them, but clear grassland can cover substantial areas of GI elements on its own. However, mixed landscapes dominated by grasslands have the highest level of plant and animal biodiversity per unit of surface area (Plantureux *et al.*, 2005). Due to the favoured conditions for woody plants and/or the absence of a sufficient amount of grass feeding wild animals, grassland is seldom found naturally in the alpine space area. To guarantee long-term stable ESS provision, grassland areas need proper planning and management strategies. Such as ploughing and reseeding, liming, and fertilizing, watering, grazing, cutting and if necessary, also the use of pesticide management of grassland.

9.7 Management of wetlands

Wetlands are home to some of the most biologically diverse biotopes on earth due to the unique land and water characteristics found in marshy areas. However, wetland management serves several functions beyond feeding and sheltering wildlife biodiversity. They serve as floodwater storages and filters, helps prevent erosion during storms, provides natural resources, and generates economic benefits through tourism and recreation. Wetlands are delicate ecosystems that are susceptible to even subtle disturbances. Nutrient oversaturation can occur when storm water runoff containing fertilizers, livestock waste, grass clippings and other pollutants enters a wetland ecosystem. This may lead to excessive growth of invasive plants that are fast growing unlike native species, lack natural predators that could ensure the species' balance within the habitat.

9.8 Establishment and care for tree-based GI elements

Trees play an important role in many of GI elements. They grow and develop naturally,

but they need to be properly managed in order to facilitate their ESS function. This is especially true for fruit bearing trees in parks and orchard meadows.

Establishment of new tree-based GI elements. Young trees in newly established GI elements, as well as new trees in existing GI-elements, require planning, planting, and care. New tree plantings must be approached with good preparation and adequate knowledge. It is important to select the appropriate variety suitable to a specific area. After planting it is important to take care of this young and delicate plants. They must be irrigated if there is no natural rainfall and pruned to form a proper canopy.

Tree pruning is very important, and it keeps the plants vital and healthy for many years. Understanding the laws of growth, it the basis for a successful pruning. Through pruning, we influence the growth of the tree, regulate its fertility over time, ensure uniform size and health, reduce the risk of diseases and pests, rejuvenate the tree, and prevent decay and of course, form the canopy. For pruning we have to have a proper tool. Different saws and scissors are used with mandatory protection gear.

Rejuvenation pruning of older trees. Many GI landscape elements have trees that are neglected and do not exhibit sufficient vitality to perform the expected ESS. They had not been pruned for a long time and the canopy had become thickened with drooping branches and/or too many vertical shoots. The aim of rejuvenating pruning is to achieve good light penetration into the frame branches, remove old and damaged branches and encourage the trees to grow more intensively

9.9 Business models related to Green Infrastructure

The aim of the module "Business models related to green Infrastructure" (Rekič *et al.* 2021) is to equip teachers and trainers with knowledge on establishing profitable business that have positive impacts on biodiversity, is modern, resource-efficient, and competitive examples of well adapted business modules in natural and semi-natural environment, rural environment, agricultural environment, and urban environment. Introductory or inspirational lecture followed by a workshop for developing business models in mainly designed for young farmers, landowners and entrepreneurs who have prior knowledge and experience in the field of agriculture.

By preserving natures inherent value and enhancing its sustainable management, as well as halting biodiversity loss, economic policies and decisions can be implemented for delivering positive impacts on biodiversity as well as economic growth. The globalization of the world economy, population growth, and the impact of climate change are all posing new challenges to business recording to Rekič *et al.* 2021. As well as the dynamics of market changes determine new perspectives that businesses must follow quickly and innovatively. The virtues that ensure success are to be flexible, competitive, and innovative (Volles *et al.*, 2019). Among many other things, agriculture is a prime example of a set of economic activities of unique social and environmental importance. The conservation of agriculture contributes to the vitality

and population of rural areas through economic and social cooperation (Bishop, 2008).

Methods that support managers in different environments in developing their business in a sustainable way, which means being more profitable while still benefiting the local society and maintaining or increasing natural and cultural values is called Pro Biodiversity Business (PBB). According to Bishop *et al.* (2008) Pro Biodiversity Business (PBB) is a commercial enterprise that generates profits via activities which conserve biodiversity, use biological resources sustainably, and share the benefits arising from this use equitably. PBB therefore recognizes the benefits of protected nature and its biodiversity and integrates it into the business model and constantly strives to minimise the negative impact of its business while increasing the positive contribution it makes to biodiversity (Volles *et al.*, 2019).

A good idea is the foundation of any business opportunity. Based on a Five step design thinking process by the Hasso-Plattner Institute of Design at Stanford, you can find good business opportunities and create game-changing innovations. To create a good business model, basic steps of a business model development must be followed. With practical workshop of business model development students are guided from the generation of good ideas, through selection and evaluation, to the creation of a business plan and the search for a founding partner. The given roadmap encourages the development of improved or brand-new GI related business models. Economically viable examples of good business models using various GI elements and environments as a source are key examples for young farmers, landowners, managers, and entrepreneurs. Green business models depend on several conditions which relate to classical business model assessment schemes (Ferranti *et al.* 2020) but also consider the ability of a business model to bring positive impacts on the environment and society. Successful business idea is based on goods that are in the immediate vicinity and no excessive input of energy is required.

Getting started or just enhancing existing business can be challenging but many options are listed in the module to finance business by different funding programmes such as direct funding, grants, contracts, indirect funding, other EU supportive mechanisms, EU support for finding an investor, EU grants, and many others.

Use of Green Infrastructure products and Society Engagement

The aim of this module is to provide event organisation the tips, suggestions, and to-dos to organise a general-public-engagement event on the topic of GI and ESS. With different GI activities general public is empowered with knowledge about GI products and other ES provided by local GI elements.

How to raise awareness of local GI elements? How to encourage the public to get closer to our roots and reconnect with nature? One of the many answers can be found in the module "Use of green Infrastructure products and Society Engagement" (Hladnik *et al.*, 2020b).

Engaging event for different target groups are where the awareness raising, and

promotion of local GI elements go hand in hand. Exhibition and tasting of GI-products can encourage local GI element product consumption and where good relations between growers and customers are forged.
The aim of this module is to give step by step organisation tips, suggestions and to dos for making any event memorable. The suggested food-preparation event aims to immerse participants in the most engaging way: through food and discussion of its origins. The event can be part of a broader event promoting local GI-products and raising awareness about the importance of local GI-elements.
Activity 1 provides extensive resources for the organisation of engaging events. The key steps for organisation are listed, from conceptualising to final clean-up and follow-ups. The planned engaging event revolves around a GI-related theme. The provided information may be used as a checklist for organisers or as an outline for the training of organisers. Instructions haw to set the stage, what are the main objectives of the event, which is the target audience and haw to take care of the safety and insurance of the attendees.
Activity 2 is presenting the outline for an engaging event on the topic of GI. The aim of this event is to raise awareness of local GI-elements, their importance, and to promote GI-products and their managers or growers. It can be executed independently or in conjunction with other happenings and events. How to set the event timetable is very important, it should consist of introduction and greeting of the host, followed by the presentation of the LUIGI project, explaining the focus of local GI-element and the GI-products. Later, participants are engaged in a discussion about presented subjects at the event. Alpine Space recipes that can be used in the proposed event are a good way to appeal the audiences and raise awareness of the importance of GI.

9.10 Module execution and improvements in pilot regions

Based on research and scarcity on existing knowledge pools and transfers in Alpine Space Regions we conducted knowledge transfer in form of a course entirely dedicated to GI-related topics, individual lecture, independent lecture, practical workshop, or field training. We envisioned various knowledge end-users (*Figure 9.4*) to have the interest and would also benefit from GI-related knowledge transfer. Among many, local administrations were recognized as an important target group for knowledge transfer.
How to quickly expand knowledge about GI and GI-products and raise awareness than through media, we have also confirmed in practice by organizing a press event. Or how to better pass the knowledge on than to organize active workshops with experts passing the knowledge about GI management to younger generations. During the LUIGI project we carried out many educational, awareness rising activities in ten project pilot regions that turned out success stories because of different approaches and adaptions taken by partners.

The implementation of the educational modules was by the partners. They selected the module, target group, method according to the needs of each pilot region. Together the partners have executed 13 different workshops (*Figure 9.5*) of which 3 were related to spatial planning trainings, 3 to management training events, 4 to business models workshops and 3 to engaging events. The most inspiring among them were the awareness raising and engaging event in South Tyrol, city of Bolzano, Italy, the pruning and grafting training event in orchard meadows in Orehek, Slovenia, the business event in Milan, Italy, and the student project in MSc program Nature Conservation and Landscape planning in Munich, Germany.
In their own way each workshop contributed to awareness raising and in knowledge dissemination for better landscape planning, management of GI elements, business, and community engagement according to the aims of LUIGI project.

Figure 9.5 - *Visuals of LUIGI module execution and improvements in project pilot regions (LUIGI project, 2021).*

9.11 Conclusions

Raising awareness about the importance of green infrastructure, its benefits and business possibilities among ecosystem services providers, decision makers and general public, is a lengthy process that is slowly progressing. The knowledge of spatial planning, management and business related to GI needs to be well understood first, then passed on to wider society, not only professionally oriented groups.
Because of the educational modules are based on a detailed identification of knowledge pools and transfers related to green infrastructure elements and they

have been executed several ways in the project pilot regions the modules are filling the missing knowledge gaps and transfers to the identified end-users. Above all, we contributed to transfer the knowledge that had begun to be lost mainly due to generational leap, loss of interest or many other factors.
The four modules comprehensively cover GI-related knowledge. From spatial planning its management and business aspects to society engagement they emphasize the importance of ecosystem connectivity. Long-term functioning and management of specific GI elements designed for human, needs to establish a profitable business with positive impacts on biodiversity. and to raise awareness of local GI elements in engaging events for different target groups. To encourage stakeholders and to raise awareness of local GI elements and its use, engaging events for different target groups are beneficial.
As a result, the capacities of LUIGI project have been developed by project partners in numerous practical workshops in all ten project pilot regions. The knowledge was successfully spread among various target groups. According to the feedback received from participants the modules are good foundation for transferring the needed knowledge for better GI management within and even beyond LUIGI borders.

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Conclusion

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