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PLACE Report on Spatial Planning & Ecological Connectivity

an analytical overview across the Alpine Convention area

November 2019

An expert report commissioned by the Platform Ecological Network of the Alpine Convention, with contributions of the Platform members, under the scientific coordination of Irstea and the operational coordination of ALPARC

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Promoters and funders of the project

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Coordinators of the project

Yann Kohler (ALPARC) was responsible for the operational coordination of the project and played an important intermediary role with the Platform "Ecological Network" of the Alpine Convention. He was assisted by Marianne Badura (blue! advancing european projects) for meeting facilitation tasks.

Nathalie Bertrand (Irstea/CGEDD), with the contribution of Mathieu Perrin (Irstea), was in charge of the scientific coordination of the project.

Contributors to the project

All the parts of the PLACE report were conceived and prepared on the basis of Mathieu Perrin's and Nathalie Bertrand's scientific expertise, mutual reflections, analyses and cross-reviews throughout the project's life. The report was mainly drafted by Nathalie Bertrand (Irstea/CGEDD) for the Introduction and Part 1, and Mathieu Perrin (Irstea) for Parts 2, 3 and 5. The lessons learned available in Part 4 were conceived by both of them and discussed with the members of the platform during the meeting held in Munich in December 2018. Mathieu Perrin (Irstea) produced the original maps available in the report.

Serena D'Ambrogi (ISPRA), Filippo Favilli (EURAC) and Rayna Harizanova (Italian Ministry for Environment, Land and Sea Protection) took charge of the fieldwork of the Italian case-studies and wrote in Part 3 the sections relating to these case studies (i.e. Friuli Venezia Giulia Region as well as Orobie Bergamasche and Altopiano Valsassina - Alpine Valleys). Pierpaolo Zanchetta (Friuli Venezia Giulia Region - Biodiversity Unit) and Paola Cigalotto (Architect), as well as Luisa Pedrazzini (Lombardy Region - General Directorate for the Territory and Civil Protection - Landscape Office), Sandra Zappella (Architect), Rossella Radice (Architect) and Barbara Grosso (Architect) were also involved in the preparation of theses sections. Yann Kohler (ALPARC) took in charge the fieldwork of the German case-study and wrote

the section relating to it (Berchtesgaden Alpine Park) in Part 3.

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Foreword

Ecological connectivity, implemented as green infrastructure, is an important concept to support the maintenance and development of biodiversity in the Alpine region. In a context of rapid climate change - as regularly revealed by the Intergovernmental Panel on Climate Change (IPCC) and the dramatic loss of biodiversity, recently established by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) - ecological connectivity is essential to guarantee species survival and adaptation. The identification and consideration of connectivity-creating measures like ecological corridors or stepping stones in spatial planning is important to ensure their quality and long-term operability.

Given the diversity of spatial planning systems across Alpine states, members of the Platform Ecological Network of the Alpine Convention decided to investigate current considerations of ecological connectivity in spatial planning in the region. This included the qualification of spatial planning approaches with regard to ecological connectivity and the identification of challenges at the interface between planning and connectivity.

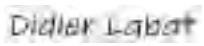
In response to this decision, the PLACE study was implemented, based on contributions from member states of the Alpine Convention, with scientific and methodological support from the French Research Institute of Science and Technology for Environment and Agriculture (Irstea), and coordinated by the Alpine Network of Protected Areas (ALPARC) with financial support from the French Ministry for the Ecological and Inclusive Transition.

The results of the study showed that, in general, recognition for the need to integrate ecological connectivity into spatial planning systems increased. However, findings disclose substantial differences across Alpine countries in terms of approaches used. When looking at the actual implementation level, a number of interesting case studies from different municipalities across the Alps reveal not only great challenges, but also remarkable innovative approaches to address ecological requirements in planning processes within given frameworks. This publication aims to share the study's findings and to provide a basis for mutual exchange among Alpine Convention member states. It intends to further contribute to the inclusion of ecological connectivity into planning scenarios, in order to guarantee the maintenance of ecosystem functionalities.

The study was carried out in a collegial and shared manner. It is a good example of a partnership that developed to promote a common understanding of the challenges of the Alpine region and to offer suggestions to better control the use of space, while respecting natural ecosystems and limiting its fragmentation.

Meanwhile, the Alpine Convention's ecological network platform gave way to the Alpine Biodiversity Board of the Convention, to address biodiversity and ecosystem services and their conservation in the Alpine region in a broader sense. We hope that the important matter of integrating ecological connectivity and spatial planning will be taken up by the Board as well as by Action Group 7 of the EU Strategy for the Alpine Region (EUSALP) that specifically focuses on ecological connectivity in the Alps and their wider surroundings including the huge metropolitan area.

The Chair and Co-Chair of the Platform Ecological Network of the Alpine Convention warmly thanks Irstea and ALPARC for the scientific, methodological and logistical guidance provided and for preparing this report. They also kindly thank the members of the Platform who have actively contributed to making this publication possible.



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Introduction
Motivations for a Report on Spatial Planning and Ecological Connectivity

A serious decline in biodiversity[1] is observed worldwide: the IUCN (2019) has identified more than 28 000 species threatened with extinction, representing 27% of all assessed species, and out of 9 735 species examined at the European level (Pan-Europe and European Union), 1 677 are considered under the threat of extinction (IUCN, 2015).

This biodiversity erosion must be seen in the light of the past and ongoing significant land-use changes and spatial development dynamics (EEA, 2017). Processes such as urban sprawl and land-take, mainly caused by the development of settlements and transport infrastructures, as well as agricultural intensification and landscape homogenisation have contributed widely to the fragmentation of landscapes and are therefore seen as drivers that largely explain the species loss and habitat degradation. Due to their impact on the functioning and functionality of ecosystems, these spatial dynamics have been recognised as significant threats to the achievement of biodiversity conservation (Flesness and Foose, 1990; Bennett, 1999; Jongman, 2002, Harrison et al., 2016).

In this respect, the only habitats and species protection strategy initially established has been viewed as inadequate for long-term nature conservation (Beier and Noss, 1998; Bennett, 1999). It became obvious that ecological connectivity between habitats and species populations was a major component to consider, calling for a new paradigm in nature conservation (Phillips, 2003; Crofts, 2004) and highlighting the value of an integrated approach based on ecological landscape principles (Jongman, 2002).

The Alpine area is all the more concerned by landscape fragmentation since its biodiversity richness is severely threatened by strong anthropic pressures linked to the development of transport infrastructures and urban sprawl, especially in the valleys, as well as economic activities (e.g. tourism). The resulting major land-use changes and barrier effects have weakened Alpine ecological connectivity. Different initiatives (projects, research programmes, think tank, etc.) have brought to evidence, considering the observed biodiversity loss, the need to maintain and restore the functioning of ecological connectivity in the Alps. Here are three initiatives that address this need: the platform "Ecological Network" of the Alpine Convention (2006), the Ecological Continuum Initiative ("Catalysing and Multiplying Alpine Connectivity") started by four active Alpine network organisations (2007) and the ECONNECT ("Restoring the web of life") project (2008-2011) aimed at improving ecological connectivity in the Alps. Various research projects have been carried out under the Interreg Alpine Space Programme and have produced publications such as "Alpine Nature 2030 - Creating (ecological) connectivity for generations to come" (Plassmann et al.,

1 Seen as an ecosystem, species and gene diversity.

2016). However less has been done on the way that spatial planning could take over the challenge of ecological connectivity and ecological network issues, and restoring them at different planning scales in the Alps, especially within the Alpine Convention area. However, less has been done on the way spatial planning could take over the challenge of ecological connectivity issue at different scales in the Alps, and especially within the Alpine Convention area. Until quite recently, biodiversity aspects were hardly considered in spatial planning other than through state of the environment reports and environmental impact assessments. However, a new impetus has been given to the topic in the last decades with the progressive recognition of the need to maintain and restore ecological connectivity throughout planning processes. Consequently, the issue has been increasingly addressed in national spatial planning systems with the introduction of rules aimed at encouraging or even constraining the development of ecological networks or related concepts at different planning scales. Nevertheless, questions arise about the extent to which such networks actually contribute to maintain or restore ecological connectivity.

In this context, the Platform Ecological Network of the Alpine Convention, under the initiative of the forthcoming French presidency, has mandated the French research institute Irstea to carry out a study on ecological connectivity and spatial planning throughout the Alpine arc. The resulting report, known as the PLACE report, is organized in five parts.

Part 1 introduces the emergence of ecological connectivity and ecological networks as scientific concepts and their recognition on the political agenda to improve biodiversity conservation. It highlights how they have become a major issue for spatial planning. Specifically, it focuses on various initiatives launched for maintaining or restoring ecological connectivity in the Alps.

Part 2 depicts the diversity of the main spatial planning systems that can be found in the Alpine Convention (i.e. Austria, France, Germany, Italy, Slovenia, and Switzerland) and provides a comparative overview on how the issue of ecological connectivity is considered in each of them.

Part 3 shows how ecological connectivity is addressed and ecological networks are developed in spatial planning practices on the ground at supramunicipal and municipal levels, on the basis of six case studies selected in or around the Alpine Convention area.

Part 4 draws a set of lessons that reveal current challenges and potential improvements for ensuring a better consideration of ecological connectivity and improving the quality of ecological networks in spatial planning.

Part 5 concludes the report by outlining the progress made in the context of the Alpine Convention regarding ecological connectivity in spatial planning. It points out too aspects not covered by the study, which can be seen as potential topics for future studies and as rooms for improving policies and practices.

Ecological Connectivity as an Important Issue for Spatial Planning in the Alpine Context

1

1.1. Ecological connectivity and ecological networks: transfer of a scientific issue into the operational field

The concepts of *ecological connectivity* (also referred as *habitat connectivity or landscape connectivity*), and *ecological networks* became in the early 1990s a cornerstone for conservation and landscape sciences (Forman and Godron, 1986). The increasing number of publications on ecological connectivity, especially in the 10 past years, attests this matter (Correa Ayram et al, 2016). This concept has been considered under different perspectives[2] (Crooks and Sanjayan, 2010), leading to diverse definitions that stress the importance of the habitat linkages and the movement of organisms among resource patches (e.g. Taylor et al., 1993; Fischer and Lindenmayer, 2007). The most frequently used definition of ecological connectivity in the scientific literature is given by Taylor et al. (1993) as *"the degree to which that landscape facilitates or impedes movement among resource patches"*. Two primary components of connectivity are distinguished (Taylor et al., 1993; Bennett 1999; Tischendorf and Fahrig 2000): a *structural* component related to the physical linkage between habitat patches and landscape configuration that facilitates or constrains the movement of populations, and a *functional* component as a behavioral response of populations, individuals or genes to the physical structure of the landscape.

Although structural connectivity is relatively easy to apprehend and implement, it does not suffice on its own to ensure the maintenance of ecological functions (Bennett, 1999; Bennett and Wit, 2001; Crofts, 2004). The functional connectivity on its own requires insights on movement of organisms and ecological processes. However, this is more difficult to establish and to evaluate considering the recurring lack of data to measure it, and the inherent incompatibility between species-specific needs or ecological processes.

In that respect, a need has emerged for the development of coherent spatial structures that protect biodiversity in ordinary landscapes. The concept of an ecological network (Jongman, 1995; Jongman and Pungetti, 2004; Crofts, 2010) has been seen as a coherent system of natural and/or semi natural landscape elements (Bennett and Wit, 2001) that promotes biodiversity conservation outside protected areas (Crofts, 2004; Benett, 2004; Boitani et al., 2007). Ecological networks have become operational tools in nature conservation and then later in landscape

2 Such as the metapopulation ecology aimed at understanding the spatial dispersion of and the interactions between populations of a same species, the landscape ecology investigating the landscape structure and its effects on ecological processes, or the movement ecology focused on the description and the understanding of movements of organisms at individual and population-levels.

or spatial planning. This transposition into the practical field raises some doubts amongst ecologists, in particular because of the risks inherent to the simplification of ecosystem functioning contained in the approach and of the tendency to consider that structural connectedness indeed ensures functional connectivity (Boitani et al., 2007, Vimal et al., 2012; Battisti, 2013; Gippoliti and Battisti, 2017).

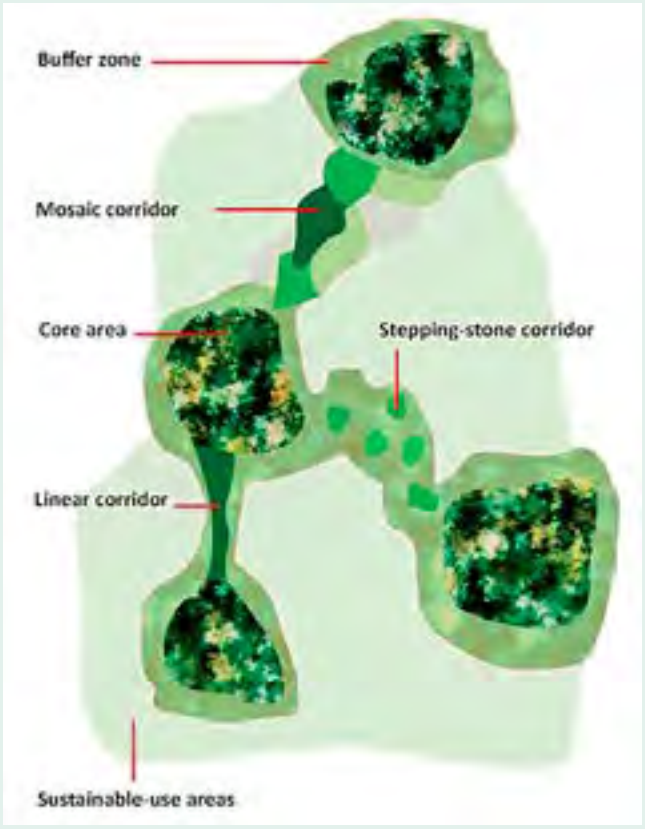

Fig. 01: Composition of an ecological network. (Source: Bennett, 2004 - with minor modifications)

This new view of conservation represents a paradigm shift in the protection and management of biodiversity in Europe (Jongman et al., 2004; Jones-Walters, 2007). Ecological connectivity is now considered as a strategic issue for ensuring the conservation and restoration of biodiversity in the future (Jongman, 2010; Rudnick et al., 2012). This can be seen as the basis of a new step in nature conservation (Bonnin, 2008). Initially focused on the protection of species, then on the protection of habitats, nature conservation intends today to protect, through the concept of an ecological network, the functioning of ecosystems by responding to landscape fragmentation and habitat isolation.

An ecological network is commonly understood as the combination of three components (Bennett, 2004) **(see Fig. 01)**: *core areas* "*where the conservation of biodiversity takes primary importance*", *corridors* "*which maintain vital ecological or environmental interactions* [...] *between the core areas*", and *buffer zones* "*which protect the network from potentially damaging external influences*". These three elements are sometimes associated with *restoration areas* "*for the recovery of damaged elements of ecosystems, habitats and landscapes*" (Boitani et al., 2007). Today, there is still a scientific and an operational debate about the corridors' capacity to address the major issue of functional connectivity on the multiscalar dimension of ecological networks and on their multi-species dimension. However, they have received (as green belts, greenways, etc.) close attention by planners and land managers (Bennett, 1999) throughout Europe.

1.2. An increasing recognition of ecological networks on the political agenda

Ecological networks have gained major political attention since the 1992 Rio Conference and found an increasing echo in nature conservation policies at European, national, regional and local levels (Burel and Baudry, 1999; Bennett and Wit, 2001; Jongman et al., 2004; Debray, 2011) in order to maintain or restore landscape ecological functions.

Different European initiatives have been set up in this direction. The Council of Europe launched in 1976 the European Network of Biogenetic Reserves "to guarantee the biological balance and hence the conservation, potential, genetic diversity and representativeness of the various types of habitat, biocenosis and ecosystem" (EC, 1976). These biogenetic reserves also aimed at providing the biological research with an improved knowledge of the ecolo-

gical dynamics and processes, and at better informing the public. The establishment of the Emerald Network[3] (Bern Convention 1989) as a network made up of Areas of Special Conservation Interest, paved the way to the European Habitat Directive[4] (1994), establishing a network of comprehensive and legally protected areas for European nature conservation - known as Natura 2000 (Article 3)[5]. A specific interest was given in the Directive in improving the ecological coherence of the Natura 2000 network, and the member states were encouraged to consider in their land-use planning and development policies a wider landscape approach for nature conservation (Jongman, 2004; Bennett, 2010). This involved managing "features of the landscape which are of major importance for wild fauna and flora" and "essential for the migration, dispersal and genetic exchange of wild species" (ECC, 1992: Article 10). In 1991, the Ministry of Agriculture of the Netherlands launched an exchange of ideas on the creation of a European ecological network (EECONET) that was taken over in 1995 by the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) (Council of Europe, 1996). On this basis, a political mandate has been given to the Council of Europe and the European Centre for Nature Conservation (ECNC) to coordinate the establishment of a Pan-European Ecological Network (PEEN) as a guiding vision for coherence in biodiversity conservation[6] (Crofts, 2004; Bonnin et al., 2007; Jongman et al., 2011). The European Commission directly contributed to the rise in awareness about landscape connectivity with its communication campaign 'Halting the Loss of Biodiversity' (European Commission, 2006), proposing "to reinforce compatibility of regional and territorial development with biodiversity in the EU" (p. 12). It explicitly suggested considering connectivity both inside and outside protected areas, and recommended "to strengthen coherence, connectivity and resilience of the network, including through support to national, regional and local protected areas" (p. 11).

Moreover, the successive documents adopted by the EU for territorial cohesion (Territorial Agendas, Green Papers, etc.) have defined, as one priority for the development of the Union, the need for specific attention to restoration or conservation of networks, understood as "trans-european green structures with adequate corridors and zones linking protected sites" (Territorial Agenda 2007)[7], "ecologically fragile areas" (Territorial Agenda 2007), or even "green infrastructure networks" (Territorial Agenda 2020)[8], etc. Since the beginning of the 1970s, various EU initiatives have shown an increasing effort to improve environmental considerations within European spatial planning and development policies (Wilkinson, 1990; Leibenath and Pallagst, 2003). It received a particular and explicit attention since the Amsterdam Treaty (1997) promoted "a high level of protection and improvement of the quality of the environment" (article 2). In this context, the importance of ecological networks has been widely acknowledged in different European spatial development strategies and policy documents (Leibenath, 2011), especially those related to territorial cohesion addressing the interface between nature conservation and spatial planning. For example, the European Spatial Development Perspective (ESDP, 1999) included early on proposals relating to spatial planning and biodiversity, such as the "Continued development of European ecological networks, as proposed by Natura 2000, including the necessary links between nature sites and protected areas of regional, national, transnational and EU-wide importance" (p. 32). Then, the "Guiding principles for Sustainable Spatial Development of the European Continent" stated that "spatial planning policy is concerned with re-establishing and conserving ecosystems including ecological networks" (Council of *Europe* Conference of Ministers responsible for Spatial/Regional Planning - CEMAT, 2000, p. 11).

3 Its implementation was launched by the Council of Europe as part of its work under the Bern Convention, with the adoption of Recommendation No. 16 (1989) of the Standing Committee to the Bern Convention: https://www.coe.int/en/web/bern-convention/emerald-network. Since 30 November 2018, six countries, Belarus, Georgia, the Republic of Moldova, Norway, Switzerland and Ukraine, have officially adopted Emerald sites on their territories.

4 Habitat and species directive, EC 92/34) has been implemented in the frame of the 4th Environmental Action Programme of the EU (1987-1992), as a reaction to the Convention on Biological Diversity, which was adopted during the Rio de Janeiro Summit in 1992.

5 The Directive was based, to a certain extent, on the 1979 Bern Convention adopted by the Council of Europe (Bennett, 2010) which already included a recommendation regarding the nature conservation outside protected areas, and the measures to restore or compensate the loss of ecological corridors.

6 The PEEN has been developed through three subprojects: Central and Eastern Europe, completed in 2002; South-Eastern Europe, completed in 2006; and Western Europe, also completed in 2006.

7 See: https://ec.europa.eu/regional_policy/sources/policy/what/territorial-cohesion/territorial_agenda_leipzig2007.pdf

8 See: https://ec.europa.eu/regional_policy/fr/information/publications/studies/2015/territorial-agenda-2020-put-in-practice-enhancing-the-efficiency-and-effectiveness-of-cohesion-policy-by-a-place-based-approach

Simultaneously to, or in the wake of, the programmes and orientations adopted at the European or EU level, various efforts have been undertaken in European countries to protect and reinforce biodiversity conservation and landscape connectivity. The European Territorial Cooperation programmes (Interreg) has provided a framework for the implementation of joint actions and policy to promote at cross-border, transnational, and interregional levels an economic, social and territorial development of the Union. Thus, one of the five priorities of the Interreg programme (2014-2020) intends "to protect the environment and promote a sustainable use of natural resources". It also provides opportunities for the implementation and management of the Natura 2000 network and support to ecological network projects, all the more important that species, as well as corridors and other connecting elements, go beyond administrative borders.

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1.3. Spatial planning as a lever for implementing ecological networks

There is a general consensus on the fact that the field of spatial planning is a major mean for organising and optimising spatial functions (Jongman, 2004; Fortier, 2009). Thus, spatial planning promises much in supporting the implementation of ecological networks and ecological connectivity (Gurrutxaga et al., 2015). Three dimensions in the interaction between spatial planning and connectivity issues are distinguished (Bennett, 2010): balancing biodiversity conservation with other objectives, organising arrangements as far as the operational scope of spatial planning (broad scales) and ecological networks (specific areas) are only partially shared; developing methods of achieving objectives. These various aspects make obvious that planning has a key role in restoring and maintaining ecological connectivity (Jongman 2002; Crooks and Sanjayan, 2002). Among other things, "[a]*s a policy goal, modern land-use planning legislation should require land-use plans to be consistent with the provisions of conservation plans*" (Lausche et al., 2013).

The planning of ecological networks largely involves considering biodiversity outside of protected areas. This can be seen as a major added value of the concept, but this also illustrates that biodiversity considerations outside of protected areas face multiple and divergent interests – (e.g. agricultural, recreational, natural hazard prevention, etc.) that may compete on space and time, as underlined by Jongman (2007): "[t]*he planning of ecological networks includes not only the ecological modelling, but also the societal debate on implementation and societal benefits and costs*". Establishing ecological networks thus requires efforts in terms of spatial coordination and landscape coherence as they deal with (and achieve) different visions and needs related to human societies, natural ecosystems and ecological functionalities. As a result, ecological network implementation requires a comprehensive approach (Jongman, 1995 and 2008; Clergeau and Désiré, 1999) to encourage and develop a multisectoral (economic, social, cultural and environmental) and multiscalar (national, regional, local) dynamic.

The idea of connecting nature areas, at least in its structural dimension, is not new in planning policies. The greenway concept was conceived at the end of the 19th century, in the American policy for nature conservation by landscape architects and planners as linear elements linking urban parks between other parks or to rural areas (Jongman, 1995; Mougenot and Melin, 2000; Fábos, 2004; Vanpeene-Bruhier, 2008). The greenway concept has thus been defined as multifunctional and planned infrastructures, considering soft mobility (pedestrians, cyclists, etc.), recreational,

cultural, environmental or aesthetical functions. During the 1960s, small-scale wildlife passageways which assisted species in moving across local barriers such as roads and railway lines were implemented to restore impacted natural connections (Vanpeene-Bruhier, 2008).

Several national ecological network programmes were launched in the early 1980s. Hence, a set of Eastern and Central European countries, according to their strategic spatial planning culture influenced by a Russian polarized-landscape perspective (Bennett, 2010), developed environmental approaches considering landscape as a whole to contribute to ecological networks. They progressively integrated them into their existing nature conservation policies (Froment and Melin, 1994; Jongman, 2004). As an example, Estonia established in the mid-70s the Estonian Network of Ecologically Compensating Areas (Külvik, 2002) and, like Lithuania, was among one of the first countries in Europe to integrate the basic principles of ecological networks in their spatial planning systems (Sepp and Kaasic, 2002).

Although the European Union has no formal competence in the field of spatial planning, its potential for implementing ecological networks has been pointed out in different EU communications and policy documents on nature conservation. The following are examples: the *European Community Biodiversity Strategy* (EC, 1998) highlighting the influence of spatial planning on the conservation and sustainable management of ecosystems (Bennett, 2010); the communication output "*Options for an EU vision and target for biodiversity beyond 2010*" (EC, 2010) underlining that the EU contribution to biodiversity should overcome conservation measures alone to maintain ecosystems functions and services, in particular by supporting a "*better coordination, in accordance with the subsidiarity principle, with the development of and investment in 'green infrastructure', that concerns 83% of EU territory falling outside the Natura 2000 network*"; and finally, the communication support"*Our life insurance, our natural capital: an EU biodiversity strategy to 2020*" (EC, 2011) focusing its second target on "*maintaining and enhancing ecosystem services and restoring degraded ecosystems by incorporating green infrastructure in spatial planning*" (p. 5).

Simultaneously, ecological networks have been largely developed in the context of national, regional and local spatial planning processes. However, concerns have been raised about the real degree of functional connectivity pursued and achieved; that is to say the concrete capacity of populations and individuals to move and spread through the landscape and the ecological networks developed through spatial planning processes. Much latitude is given in practice to the way networks are implemented at national or regional levels, as PLACE (see Part 3) reports it. The way ecological networks are understood and implemented through planning may differ from one country to another. Consequently, this variety of practices brings into play, in some cases, the ability of these networks to maintain functional connectivity to the benefit of biodiversity conservation (Boitani et al., 2007).

In this context, guidance documents have been formulated, containing recommendations or guidelines highlighting, among other things, the importance of adequate spatial planning policies and regulations for the maintenance of landscape connectivity features of major importance for wild flora and fauna (Kettunen et al., 2007, p. 64-68; Ullrich et al., 2009; Kohler and Heinrichs, 2011; Walzer et al., 2013). However, these documents are not focused exclusively on spatial planning, but apprehend it as a field amongst others for improving ecological connectivity. Consequently, the contained recommendations and guidelines are fairly general, and do not intend to identify specific levers and obstacles for better consideration of ecological connectivity in spatial planning processes.

1.4. Ecological connectivity and ecological networks in Alpine spatial planning

The Alpine Convention area is covered by about 1 000 protected areas (> 100 ha), representing about 28% of the total area covered by the Alpine arc. Although nature protection is not necessarily the primary focus of these various protected areas, national parks and natural reserves, which are specifically dedicated to the safeguarding of biodiversity, were spread out on more than 7% of the of the Alpine Convention area in 2008 (Kohler et al., 2009). Despite this remarkable network of nature conservation areas, Alpine biodiversity has been steadily reduced as

in the rest of Europe, in particular due to anthropogenic pressures outside protected areas. In this mountainous context, all the more subject to these pressures, ecological connectivity has been jeopardised by landscape fragmentation, especially in the valleys impacted by strong land-use competition (in particular for the development of urban areas and economic activities) and the concentration of linear infrastructures (such as roads, railways and electric lines) that constitute main barriers to species movement between habitats and protected natural areas (Vanpeene-Bruhier, 2008).

Major efforts have been undertaken in the past two decades at national, regional and local levels in the Alps to maintain and foster biodiversity. In a first phase, different projects were launched with the aim of mapping ecological networks that provide a description of the current situation in terms of connectivity features and habitat fragmentation, and in some cases a vision as to what connectivity could be in a given landscape. For example, Italy has undertaken the definition of its national ecological network *(Rete Ecologica Nazionale)* on the basis of a study focused on vertebrates published by Boitani et al. in 2003, the Swiss Confederation has drawn up a comprehensive ecological network for its whole territory in 2004[9] with the publication of the REN *(Réseau Ecologique National)* (Berthoud et al., 2004), and France has adopted the Programming Acts for the implementation of the Grenelle Environnement Agreements (Act I and II, 2009 and 2010), introducing into French law the concepts of ecological continuum *(continuités écologiques)* and green and blue framework *(trame verte et bleue)*. In Germany, the Bavarian Ministry of the Environment has initiated the establishment of a biotope network *(BayernNetzNatur Project)* at the state scale as early as 1986. At the local level, some early initiatives have been launched as well. For example, the Isère County (France) launched in 1999 the ecological network for the county *(Réseau Ecologique Départemental de l'Isère - REDI)*, which aimed at identifying the ecological continuum, corridors and conflict hotspots for wildlife movements over its whole area. These initiatives were first opportunities to establish ecological networks on the basis of scientific and/or expert methods and knowledge. However, little was done for maintaining or restoring ecological connectivity on the ground. This situation strongly calls for a better consideration of the issue in spatial planning practices and instruments.

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However, numerous projects have emerged, and a concentration of various Alpine initiatives has worked towards this transnational consideration for planning connectivity. The protocol *"Nature conservation and landscape planning"* of the Alpine Convention was ratified in 1994 by the eight Alpine countries and the European Union, and under its Article 12, "[t]*he contracting parties* [to] *take adequate measures to establish a network of existing national and transboundary protected areas, of biotopes and other protected elements or those to be protected. They*

9 This network, produced on the basis of existing data and models, aimed to develop an interconnection between habitats through the identification of the potential best areas for a future ecological network. This approach has diffused gradually in Europe (Europe, Central Europe, Eastern Europe, Alpine space) at different scales (national, regional, local, etc.). The REN has also integrated the data of the Emerald Network and contributed to the Pan-European Ecological Network.

commit themselves to harmonize the objectives and applicable measures in transboundary protected areas." (p. 87). Other initiatives and programmes have also contributed to building a common view on ecological connectivity.

The Ecological Network Platform of the Alpine Convention was set up by ministers during the 2006 Alpine Conference as an expert forum to develop common strategies in order to contribute to the preservation of Alpine biodiversity and to support measures ensuring connectivity between natural habitats. Moreover, the initiative "*Ecological Continuum: Catalysing and Multiplying Alpine Connectivity*"[10] was launched in 2007 by three Alpine organisations (ISCAR, CIPRA international, ALPARC) (Scheurer et al., 2009) to improve ecological connectivity in the Alps (Kohler et al., 2009). It has laid the foundation for a common Alpine-wide framework (know-how, databank, methodologies) to raise awareness on protecting and restoring corridors between habitats (Walzer et al., 2013). Different generations of Alpine space programmes have also contributed. For example, the Alpine space project "ECONNECT - *Restoring the web of life*" (2008-2011), intended to protect, maintain and restore a pan-Alpine ecological network in the Alps (Kohler, 2005). Its aim was to set up a think-tank for future strategies establishing continuity between areas of ecological importance in the Alps, which have already taken the first steps in implementing biotope connectivity in their respective regions. A number of pilot regions were selected with the aim of developing a methodology applicable to the entire Alpine region. It contributed to the further development of a more dynamic approach to nature protection, which can be effective beyond the limits of the protected areas as they are defined today.

Last, the German Presidency of the Alpine Convention and ALPARC provided a guide - entitled *Alpine Nature 2030* (Plassmann et al., 2016) - for improving ecological connectivity in the Alps by giving keys and scenarios to understanding and mitigating the threats to Alpine biodiversity and ecological connectivity. It underlined the key role of an integrated spatial planning process to guarantee biodiversity conservation and ecological connectivity. These various European initiatives aimed at maintaining or restoring ecological connectivity in the Alps and stressed the importance of spatial planning given the current erosion of Alpine biodiversity due to anthropogenic pressures. However, the spatial planning has not been recognised in its capacity to biodiversity conservation at the same level in the different Alpine countries. This is true both within their legislative framework and the implementation of ecological connectivity at regional and local levels.

The PLACE study was launched in response to the need of improving the knowledge of how ecological connectivity is legally addressed by spatial planning in the different Alpine countries, as well as how ecological networks are actually developed in regional and local planning practices. Among other things, this work has aimed at highlighting the efforts and progress made in the field, as well as identifying rooms for improving the consideration for ecological connectivity and the development of ecological networks in spatial planning. Thus, the PLACE report provides a valuable double insight. It shows how differently, both in terms of intensity and ways, the issue of ecological connectivity is integrated in the various legal frameworks that govern spatial planning in the Alpine countries and regions; and how much leeway is actually given to local and regional communities in the way that ecological connectivity is looked at in their planning documents, thus permitting them to largely ignore the issue in some case or to develop innovative approaches in others.

10 http://www.alpine-ecological-network.org/about-us/ecological-continuum-initiative

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2 Spatial Planning Systems and Considerations for Ecological Connectivity in the Different National Contexts

Introduction

Definition and scope of spatial planning

There is no single definition of spatial planning but rather multiple perspectives on the idea. The concept varies in the different European countries based on their particular planning terminologies and traditions (Keller et al., 1993; Faludi, 2014). However, the term has increasingly come to be used in the last decades as a generic designation covering various forms of planning: town and country planning, city and regional planning, land use and physical planning, etc. (Taylor, 2010) This broad understanding has notably gained impetus with the establishment of first definitions at the European Union level: "*spatial planning refers to the methods used largely by the public sector to influence the future distribution of activities in space. It is undertaken with the aims of creating a more rational territorial organisation of land uses and the linkages between them, to balance demands for development with the need to protect the environment, and to achieve social economic objectives. Spatial planning embraces measures to coordinate the spatial impacts of other sectoral policies, to achieve a more even distortion of economic development between regions than would otherwise be created by market forces, and to regulate the conversion of land and property uses*" (European Commission, 1997: 24).

Spatial planning has traditionally been, and sometimes still is, viewed essentially as a technical task focused on the analysis, planning and governance of space. However, this activity should also be seen as an open field of interaction and an opportunity for sharing knowledge, visions and ideas (Friedmann, 1993; Othengrafen and Reimer, 2013; Luukkonen, 2014). Consequently, the performance of this planning-as-learning should not only be measured in terms of material outcomes, but also evaluated in the light of its contribution to a better awareness and an increased understanding of present and future problems (Faludi, 2000).

European diversity in spatial planning systems and traditions

Drivers of convergence in the field of spatial planning and development have been observed in Europe over the last three decades. The adoption of the European Spatial Development Perspective (European Commission, 1999) and the Territorial Agenda (German Presidency of the Council of the European Union, 2007) provided the European Union with a non-binding framework aimed at guiding spatially significant policymaking at different spatial scales (Faludi, 2002; Sykes, 2008). Various programmes (e.g. INTERREG, URBAN, ESPON, etc.) also fostered transboundary

cooperation in the field of spatial planning across the European Union (Dühr et al., 2007). In addition, the multiplication of cross-border metropolitan planning initiatives (e.g. Greater Geneva Area, Greater Basel Area, Konstanz-Kreuzlingen Agglomeration, etc.) contributed significantly to vision sharing and mutual learning (Sohn et al., 2009). These common programmes and place-based processes have progressively proven to be relatively influential drivers of convergence, when it became apparent that the development of a non-binding framework would not have as much impact on planning policies throughout Europe as anticipated (Faludi, 2014).

However, spatial planning practices still reflect national and/or regional views and approaches in some aspects (Stead, 2013). Differences can be observed between spatial planning systems, which are understood as organisational architectures and sets of legally established norms (objectives, tools, procedures, etc.) according to which spatial planning is supposed/allowed to be performed in each country. This diversity in terms of institutional technologies (Janin-Rivolin, 2012) has been highlighted through taxonomic efforts. Some classifications are based on the degree of legal certainty/discretion provided in the different legal families, and then on the distribution of planning powers between levels of government in the different administrative structures (Nadin and Stead, 2008). From a legal perspective, distinctions can essentially be made in the European context between the continental legal systems (i.e. Germanic, Nordic and Napoleonic), which are based on pre-established and complex sets of rules and principles compiled in legal codes that determine regulation, versus the common law system (i.e. British), in which the law is essentially derived from judicial court decisions (Newman and Thornley, 1996). From an administrative perspective, differentiations can be made between unitary, regional and federal states, even though such a differentiation does not capture the whole range of relationships between the central/federal state and regions or the ways planning powers are distributed (Farinós Dasi, 2007). Another classification distinguishes four planning traditions/types within the European context, namely regional economic planning, comprehensive integrated planning,

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land-use management, and urbanism (CEC, 1997; Farinós Dasi, 2007; Nadin and Stead, 2008). This typology is very useful for understanding the numerous approaches of spatial planning. However, recent developments in planning practices have tended to blur the national distinctions that used to be made on this basis.

While spatial planning is expected to address more environmental issues in the different contexts, landscape planning can be seen in some regards as an aspect that can counterbalance the forces of convergence sometimes observed between countries. Societies do not always share the same landscape culture. Consequently, they are influenced by different landscape planning traditions and tend to link this activity to spatial planning in heterogeneous ways (Seguin, 2017). On the one hand, there is a significant tradition of landscape ecology in central Europe and more particularly in Germanic countries (i.e. Germany, Switzerland, Austria) (Ewald, 2001; Bastian and Steinhardt, 2002; Wende and Walz, 2017). This approach has historically examined the landscape more from a scientific and quantitative perspective, with the aim of addressing environmental and especially ecological issues, even on larger scales. In such contexts, landscape planning has generally been assigned the task of collecting and representing environmental data. The discipline is commonly seen in connection with landscape management and essentially focused on rural areas and ecosystems. On the other hand, there is a tradition that relies more on the aesthetic dimension of the landscape (France, Italy, and to some degree Slovenia) (Novarina et al., 2004; La Riccia, 2017; Perko and Urbanc, 2004). This approach evaluates the landscape in a more aesthetic and therefore qualitative manner, with the aim of highlighting the historical heritage of excellence, outstanding components and particular relationships between human communities and their environment. This rough and binary distinction between landscape traditions is no longer very clear given that countries have progressively introduced exogenous features in the last decades, with or without the influence of European and international conventions. However, such traditions still influence the way societies understand the landscape and partly explain the role assigned to landscape planning in or alongside the spatial planning system (Schröder et al., 2010; Kovács et al., 2013; De Montis, 2014; Sala et al., 2014).

Spatial planning dynamics and on-the-ground experiences

The practice of spatial planning, as part of social processes, largely relies on cultural features (Keller et al., 1993; Booth, 1993 and 2011; Fürst, 2007; Sykes, 2008; Ernste, 2012; Knieling and Othengrafen, 2015). Planning systems, which are institutional technologies, have a certain influence. However, on-the-ground planning practice relies on many other key factors such as the local political culture, the negotiation customs and habits, the relationship between public and private stakeholders, the relationship to land, etc. The importance of previous planning experiences in the development of local/regional planning traditions should also be highlighted. On another note, many innovations and profound changes have been observed at the heart of planning practices in the last decades, sometimes regardless of any modifications in the national planning systems and sometimes because of the recognition of regional/local innovative resources within reconfigured planning systems (Haughton and Allmendinger, 2007; Allmendinger and Haughton, 2009; Novarina and Zepf, 2009; Zepf and Andres, 2011). The ways of operating have diversified, particularly at the metropolitan scale, and no longer always reflect the legally established approaches (Scherrer et al., 2008).

2.1. National spatial planning systems and ecological connectivity

2.1.1. Austria

Spatial planning system

Spatial planning is not explicitly listed in the Constitutional Act as one of the areas of competence of the Austrian Federal State. The Constitutional Court established in a ruling (VfSlg 2674/1954) that "*the orderly and forward-looking planning of a specific area with respect to land development, especially for housing and industrial purposes, on the one hand, and to the preservation of mostly unbuilt areas, on the other ('land use planning' - 'spatial planning')* […] *is the responsibility of the federated states [Länder] from a legislative and an executive perspectives*" (Mauerhofer, 2006: 9). However, the Federal State has an influence over the spatial organisation of the country because of its sectoral planning powers (federal roads law, railway law, forest law, water law, agricultural law, etc.) (Gruber et al. 2018: 62-63). The Federal government is also a key stakeholder in the Austrian Conference on Spatial Planning (*Österreichische Raumordnungskonferenz - ÖROK*). This institution brings together representatives of federal departments, state governments, local governments, as well as business associations and civil society associations, with the aim of coordinating spatially relevant policies across the whole country and between the various planning levels. It is also responsible for the preparation of the Austrian Spatial Development Concept (*Österreichisches Raumentwicklungskonzept - ÖREK*). This strategic document contributes to coherence between regional planning policies conducted by the different regional states.

Each of the nine federated states has its own constitution and legislative power in various areas of competence. Most federated states adopted a spatial planning law in the 1950s and 1960s. Nearly all of these legal approaches were comprehensively revised in the 1990s, as the country was integrating into the European Union (Schindegger, 1999: 74). Some federated states have once again revised their spatial planning law in the past ten years: Land of Salzburg (2009), Styria (2010), Lower Austria (2014), Tyrol (2016). In 2018, Styria promulgated a Land and Regional Development Act (*Landes- und Regionalentwicklungsgesetz*), thus defining, for the first time in Austria, the tasks of regional development in a separate law (Gruber et al. 2018: 56). Differences can be found in the organisation of the spatial planning systems in the various federated states. In all states except Vorarlberg, spatial development is framed by State Development Concepts (*Landeswentwicklungsprogramm - LEP / Landesraumordnungsprogramm - LROP*) and eventually by sectoral schemes. In addition, Regional Development Concepts (*Regionale Raumordnungs- und/oder Entwicklungskonzepte*) are developed in many states, either for the whole state or for specific areas. These documents are prepared either by state authorities or by regional planning authorities, depending on the state, and can be quite different in their nature.

Municipalities have significant planning powers, with some variations between the different state contexts. Municipalities have to develop self-binding Local Development Concepts (*Örtliche Raumentwicklungskonzepte - ÖROKO*) in which spatial planning objectives and perspectives for the next ten to twenty years are set out. Permissible land uses are specified in the Land-Use Plans (*Flächenwidmungspläne*). Finally, Land Development Plans (*Bebauungspläne*) determine how land parcels may be built up and used (Gruber et al. 2018: 11).

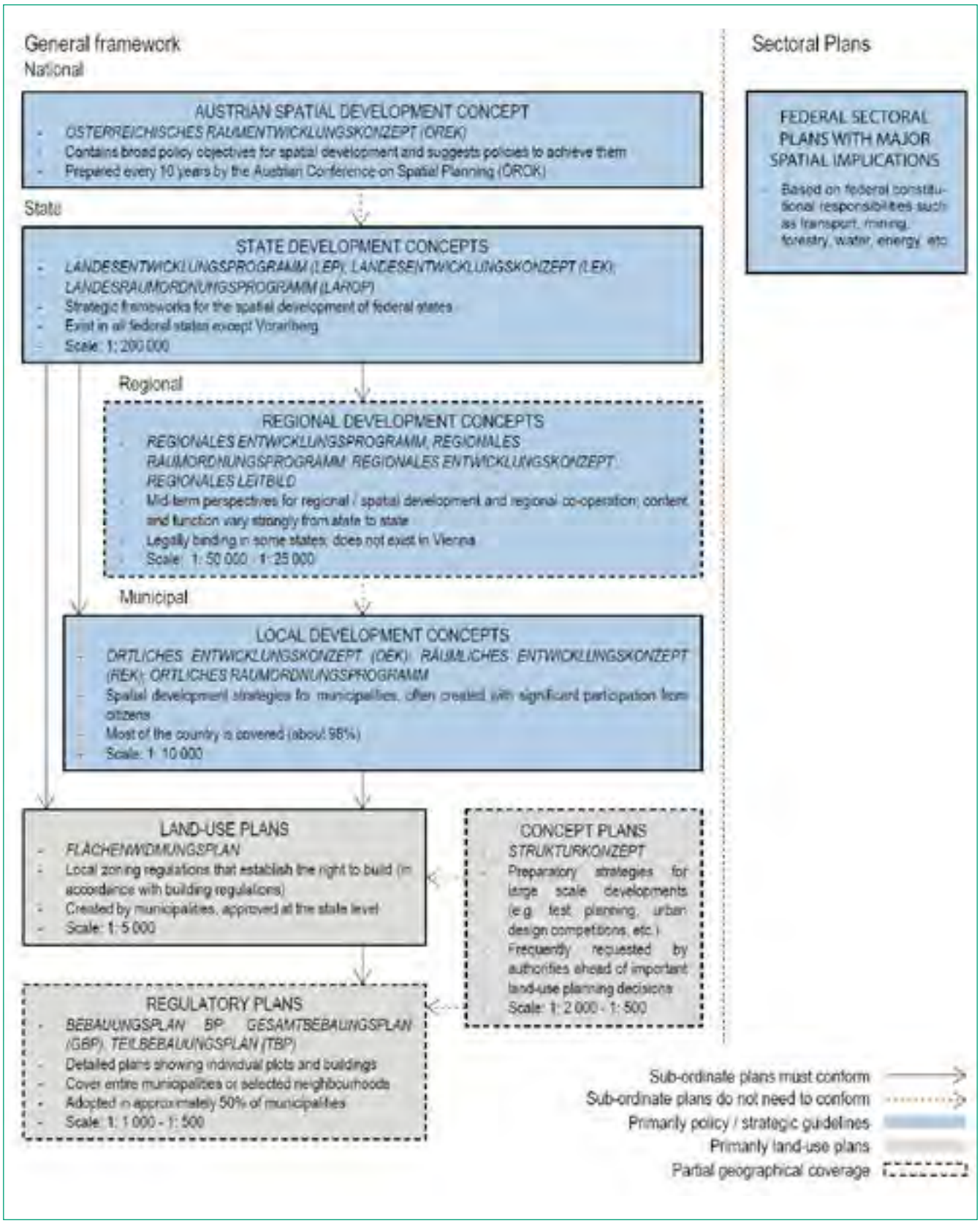

Fig. 01: The Austrian Spatial Planning System (Source: OCDE, 2017)

Considerations for ecological connectivity/networks

There is no legal obligation to address the issue of ecological connectivity or to protect functional corridors in spatial planning processes under the existing federal laws, much to the disappointment of environmental organisations (Umweltdachverband, 2016). However, the Austrian Biodiversity Strategy 2020+ *(Biodiversitätsstrategie Österreich 2020+*, 2014) specifies the need to significantly improve the ecological passability of the main traffic routes by 2020 and to identify areas of ecological interest as components of the green infrastructure in spatial planning at local and supralocal levels by 2020+ under its Goal 11 "Biodiversity and ecosystem services have to be taken into account in the fields of spatial planning and transportation/mobility". An increased consideration for ecological connectivity is thus expected in the next version of the Austrian Spatial Development Concept (ÖREK), which is to be developed by 2021. The current version of the document (ÖROK, 2011) mentioned the loss of biodiversity as a negative consequence of transport developments and urban sprawl in some regions but did not specifically address the issue of ecological connectivity. However, this lack of attention to the issue within the federal legal framework did not prevent initiatives in favour of ecological connectivity at the various levels. These actions are generally aimed at identifying areas/corridors of ecological interest and even, in some cases, at protecting ecological networks through spatial planning (Finka and Huysza, 2011; Leitner et al., 2015; Leitner et al. 2016).

One example of consideration for ecological connectivity in a legally binding and spatially explicit manner comes from the State of Styria. In accordance with the State Development Programme (*Landesentwicklungsprogramm 2009*), the seven planning regions are required to identify in their Regional Development Programmes (*Regionale Entwicklungsprogramme*) green zones that fulfil functions in the ecological, recreational, water management and water protection domains. On the basis of an Interreg Project NATREG, a state-wide network of green zones has been identified. Because of their priority status, these have to be kept free from development or artificial land-use like commercial gardening, keeping of livestock, dumping and others. Soil sealing must be avoided. This green network is not specifically focused on the high ecological quality of the areas, but it is conceived as a supralocal network of grassland, arable land, and forest, as green zones that must be respected in local planning decisions.

By means of a 2002 amendment to the Salzburg Nature Conservation Act (*Salzburger Natuschutzgesetz*), the regional state has included a provision encouraging local authorities to develop measures aimed at improving the landscape conditions from an ecological perspective, with specific attention to the biotope network (*Biotopverbund*), by virtue of Article 10 of the Habitats Directive. In addition, the Act has established obligations for the nature conservation authorities in terms of habitat area mapping and of environmental information diffusion. In the 2013 Regional Programme (*Regionalprogramm*) for Pinzgau, located in Salzburg State, supraregional and regional green corridors were mapped. Spatial planning projects at the local level have to keep these green corridors free from uses that could affect their functionality. Land uses and developments within the green corridors can be allowed, under the condition that the permeability to wildlife is not altered or that its degradation is ecologically compensated.

In other states, many documents and information have been made available for experts (e.g. kagis for Carinthia, doris for Upper Austria), but these have no legally binding force. Based on the Upper Austrian experience aimed at identifying a network of habitat-corridors, a map that specifies the most important large-scale corridors was then prepared for the whole of Austria. GIS-based modelling combined with interpretation and refinement efforts by experts have made it possible to prioritise wildlife migration routes according to a common standard. There are actually activities and discussions supporting a country-wide concept and a common strategy for all states in order to improve the recognition of ecological networks in regional and local planning (see: www.lebensraumvernetzung.at).

2.1.2. France

Spatial planning system

The French spatial planning system has historically been shaped by a unitary tradition. Legislations and in particular spatial/urban planning laws are passed at the national level. An initial legal framework for urban planning and building control was established in the first part of the 20th century with the adoption of the 1919 Cornudet Act (*Loi Cornudet*) and the 1943 Urban Planning Act (*Loi d'Urbanisme*). In a context of rapid urban growth, the 1967 Framework Act on Land (*Loi d'Orientation Foncière - LOF*) provided, for the first time, a strategic planning instrument for supramunicipal areas. In the same period, the central administration developed strong programming and operational capacities in terms of spatial planning and development, especially with the creation of the Delegation for Territorial Development and Regional Action (*Délégation à l'Aménagement du Territoire et à l'Action Régionale - DATAR*) in 1963 (Bodiguel, 2006). Large projects were launched, notably in order to develop specific regions economically and to pursue a balanced organisation of the national territory. However, the central administration has progressively lost a significant portion of its operational means and powers in the field. Pivotally, the 1982 Decentralisation Acts (*Lois de Décentralisation -also known as Lois Defferre*) marked a turning point in the administrative organisation of the country. At that point, regions were established as governing authorities. From that date, regions have been established as governing authorities. Municipalities have been granted more powers and in particular the responsibility for urban planning. Nevertheless, the national state still has some capacity to force regional and local authorities to change or revise their planning documents via the establishment of a Project of General Interest (*Projet d'Intérêt general - PIG*) in order to ensure proper implementation. Furthermore, the state has regained an indirect influence on planning practices at the regional and local levels during the last 10 years via the adoption of various environmental laws (Bétaille, 2007) and, more particularly, the Programming Act for the Implementation of the Grenelle Environnement Agreements (2009) and the National Commitment to Environment Act (2010) also known respectively as the Grenelle I and Grenelle II Acts.

In 2015, the number of regions in the metropolitan territory was reduced from 22 to 13, making them larger and more influential. The 2015 Act on the New Territorial Organisation of the Republic (*Loi portant Nouvelle Organisation Territoriale de la République - NOTRe*) has tasked the regions - except the Parisian, Corsican and Overseas regions that are already covered by specific documents - with the responsibility of preparing a Regional Planning, Sustainable Development and Equality Scheme (*Schéma Régional d'Aménagement, de Développement Durable et d'Egalité des Territoires - SRADDET*). This strategic, forward-looking and integrative document sets medium and long-term objectives aimed at ensuring a balanced regional organisation, the development of infrastructures of regional interest, the opening up of rural areas, an adequate housing supply, a careful use of land resources and environmental sustainability. It merges various pre-existing sectoral schemes, such as the Regional Scheme for Ecological Coherence (SRCE), the Regional Scheme for Climate, Air and Energy (SRCAE), and the Regional Scheme for Infrastructures and Transportation (SRIT). Urban planning documents developed at the supralocal and local levels shall consider the goals and comply with the rules set in the SRADDET.

Despite the national territory being integrally covered by 104 counties (*département*) or bodies with similar competences, no planning powers are defined at this traditional administrative level. Several laws have been passed since the mid-1990s, with the aim of establishing new functional regions, also known as project areas (*territoires de projet*), meant to be more adapted and reactive to spatial dynamics. Particularly, the 2000 Urban Solidarity and Renewal Act (*Loi de Solidarité et de Renouvellement Urbains - SRU*) introduced the Territorial Coherence Scheme (*Schéma de Cohérence Territoriale - SCoT*) to replace the pre-existing Master Scheme (*Schéma Directeur - SD*). The new strategic document has become a key component in the spatial planning system (Desjardins, 2007; Demazière and Desjardins, 2016). The *SCoT* is considered as an integrative document because its territorial project is intended to ensure the coherence between various sector-specific policies (urban planning, housing, transport, business development areas, economic development, landscape and environment, natural hazards and risk, energy and climate, etc.) and to integrate a wide range of upper-level legal and regulatory norms. The urban planning documents adop-

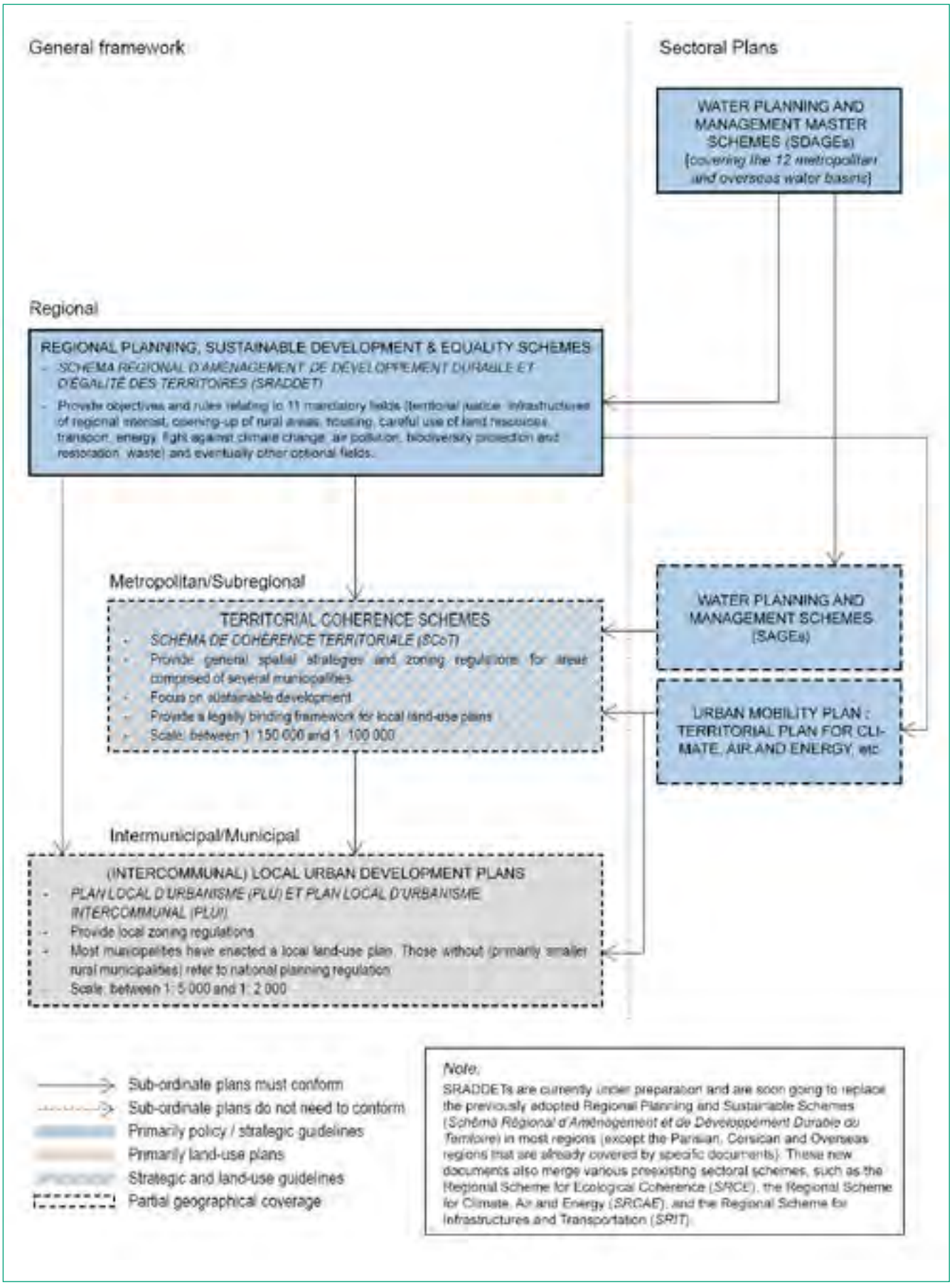

Fig. 02: The French Spatial Planning System (Source: OCDE, 2017, with updates by Perrin)

ted at the local level have to be legally consistent with the planning guidelines and maps provided in the *SCoT* that are currently in force.

There are about 35 000 municipalities (*commune*) in the country. These have significant powers despite their low average number of inhabitants as compared to the European standards. Municipal authorities are responsible for preparing a Local Urban Development Plan (Plan Local d'Urbanisme - PLU), which is a strategic and land-use planning document covering the whole municipal or supramunicipal area. Indeed, this planning responsibility has been transferred, except in specific cases, to supramunicipal bodies (community of municipalities, agglomeration community, etc.) by the 2014 Act for Access to Housing and Renovated Urban Planning (*Loi pour l'Accès au Logement et un Urbanisme Rénové - ALUR*). However, the issuing of building permits remains the responsibility of the municipal authority, including where the request processing has been centralised at the supramunicipal level.

Considerations for ecological connectivity/networks

The concept of an ecological network progressively gained legal force in the last 20 years. A first recognition took place with the adoption of the 1999 Framework Act for the Planning and Sustainable Development of Territories (*Loi d'Orientation pour l'Aménagement et le Développement Durable des Territoires - LOADDT*). Its article 23 stipulates that a Scheme of Community Services for Natural and Rural areas (*Schéma de Services Collectifs des Espaces Naturels et Ruraux - SSC-ENR*) shall specify the "principles for a balanced management" and, among other things, map "the ecological networks, connections and extensions of protected areas that need to be organised This document was adopted in 2002, drawn up on the basis of regional contributions prepared in collaboration between the regional services of the central state and regional authorities. The scheme provides for the development of a national ecological network over a 20-year timeframe. It should ensure connectivity between all sites of major ecological interest, via corridors "serving as links between core areas, with the final aim of providing the biota with sufficient possibilities of dispersion, migration and genetic exchange". This operational ecological network is stated in the document as an essential aim for the biodiversity conservation policy (Bonnin, 2003 and 2008; Bonnin et al., 2007).

The first National Biodiversity Strategy (MEDD, 2004) identified the need to design an ecological network at the national scale, as a priority action, in order to provide a minimal framework as soon as possible. This attention to ecological connectivity was renewed in 2007 in the context of the Grenelle Environnement Round Table, which brought together representatives of national and local governments, environmental organisations, industry associations, labour unions, etc. The 73rd of the 237 commitments approved by consensus on this occasion introduced the concept of green and blue infrastructure (*trame verte et bleue*) as a spatial planning instrument supposed to ensure ecological connectivity at the national, regional and local levels. The text also provided some founding principles underlying the concept and a timeframe for its implementation. In the aftermath of this noteworthy event, legislators enshrined the concepts of ecological continuum (*continuités écologiques*) and green and blue infrastructure (*trame verte et bleue*) in French law via the adoption of the Programming Act for the Implementation of the Grenelle Environnement Agreements (2009) and the National Commitment to Environment Act (2010) also known respectively as the Grenelle I and Grenelle II Acts. The latter has more particularly specified the ways in which the issue of ecological connectivity has to be addressed in the spatial planning system and thus clarified the roles and responsibilities of the various administrative authorities in implementing the green and blue infrastructure at the national, regional and local levels. It is designed as a multiscalar and top-down concept. Practically speaking, this multiscalar and spatial coherence remains a difficult objective to achieve in many instances (Chaurand, 2017).

To comply with this legal framework, all regions have adopted a Regional Scheme for Ecological Coherence (*Schéma Régional de Cohérence Ecologique - SRCE*) between 2013 and 2015. These documents have been prepared by dedicated regional committees composed of representatives from regional and local authorities, from the national state and public bodies, from socio-professional organisations and nature users, from environmental associations and protected areas' staffs, as well as scientists and experts (Vanpeene et al., 2018). These schemes contain, among other things, a map of the regional green and blue infrastructure that have to be considered in the supralocal and local planning documents. Variation is noticeable between the methods adopted for identifying and deli-

neating the habitat areas and ecological corridors in each region, because there were no specific pre-existing guidelines (Amsallem et al, 2010; Vanpeene et al., 2018). Afterwards, an overall map was produced at the country scale by combining and harmonising the results of these regional schemes (Billon et al., 2017). This document has no legal status. The 2015 Act on the New Territorial Organisation of the Republic *(Loi portant Nouvelle Organisation Territoriale de la République - NOTRe*) states that the Regional Scheme for Ecological Coherence shall be merged into the future Regional Planning, Sustainable Development and Equality Scheme (*Schéma Régional d'Aménagement, de Développement Durable et d'Egalité des Territoires - SRADDET*), which is a combination of several sectoral documents and schemes.

At the supralocal and local levels, spatial planning documents have to pursue an objective of preservation and restoration of the ecological continuum, in particular by considering the content included in the aforementioned regional schemes. However, significant latitude has been deliberately given to the stakeholders involved in the regional and local planning processes for dealing with the issue in their own way (Amelot et al., 2015). Consequently, the attention paid to ecological connectivity as well as the design methods and regulatory provisions adopted for developing and implementing the green and blue infrastructure differ between planning areas (Cormier et al., 2010; Consalès et al., 2015; Cormerais-Thomin and Bertrand, 2013; Debray, 2016). More recently, the 2016 Biodiversity, Nature and Landscapes Recovery Act (*Loi pour la Reconquête de la Biodiversité, de la Nature et des Paysage*) allowed for the classification of parts of the green and blue infrastructure as areas contributing to the ecological continuum (*espaces de continuités écologiques*) in the land-use maps contained in Local Urban Development Plans (*plans locaux d'urbanisme*), with the aim of reinforcing their legal protection. Previously, planners were quite well-equipped for preventing land conversions affecting connectivity but tended to consider themselves powerless when it came to protecting the ecological functionality of specific landscape components (Couillens, 2016).

2.1.3. Germany

Spatial planning system

By virtue of the Federal Act on Spatial Planning (*Bundesraumordnungsgesetz*), the Federal State (*Bund*) has been assigned the task of preparing a comprehensive framework for spatial development encompassing the entire country, taking into consideration the goals of the European spatial development policy. The Federal Ministry of Transport and Digital Infrastructure (*Bundesministerium für Verkehr und digitale Infrastruktur - BMVI*), under its various successive denominations, was responsible for spatial planning at the federal level over the last 20 years. However, a change in the distribution of competences occurred in 2018. Spatial planning, as well as flood protection, European spatial development policy, territorial cohesion, and demographic change, are now the responsibility of the Federal Ministry of the Interior, Building and Community (*Bundesministerium des Innern, für Bau und Heimat - BMI*).

No legally binding planning instruments are produced at the federal level, with the exception of the spatial plan for the German exclusive maritime economic zone prepared by the BMVI. Otherwise, federal authorities are essentially limited to formulating planning principles and spatial visions. In spite of this restricted power, a trend can be observed towards enhanced recognition of planning at the federal level to ensure large scale coherence and cover matters that transcend federated state boundaries in the successive revisions of the Federal Act on Spatial Planning since its original introduction in 1965.

New concepts and strategies for spatial development in Germany were adopted in 2016 by the Ministerial Conference for Spatial Planning (*Ministerkonferenz für Raumordnung - MKRO*) during which representatives of the Federal and Federated State ministries responsible for spatial planning discussed and agreed on shared principles. Four challenges are put to the fore in the document: enhancing competitiveness, ensuring the provision of public services, developing a sustainable land-use policy, adapting the space to climate change and integrating renewable powers in the energy system (MKRO, 2016).

In pursuance of the Federal Act on Spatial Planning and their own spatial planning legislation, each of the 16 federated states (*Länder*) produces a spatial development plan for its whole territory. Except in the three city-states of Berlin, Hamburg and Bremen as well as in Saarland, regional plans have to be drawn up, with the aim of transposing the planning principles and goals established at federated state level by including more textual and graphical details. This regional planning activity may be conducted in a variety of ways, (Schmidt, 2009) the task being either state-oriented (e.g. regional sub-offices of the federated state administration), municipality-oriented (e.g. regional

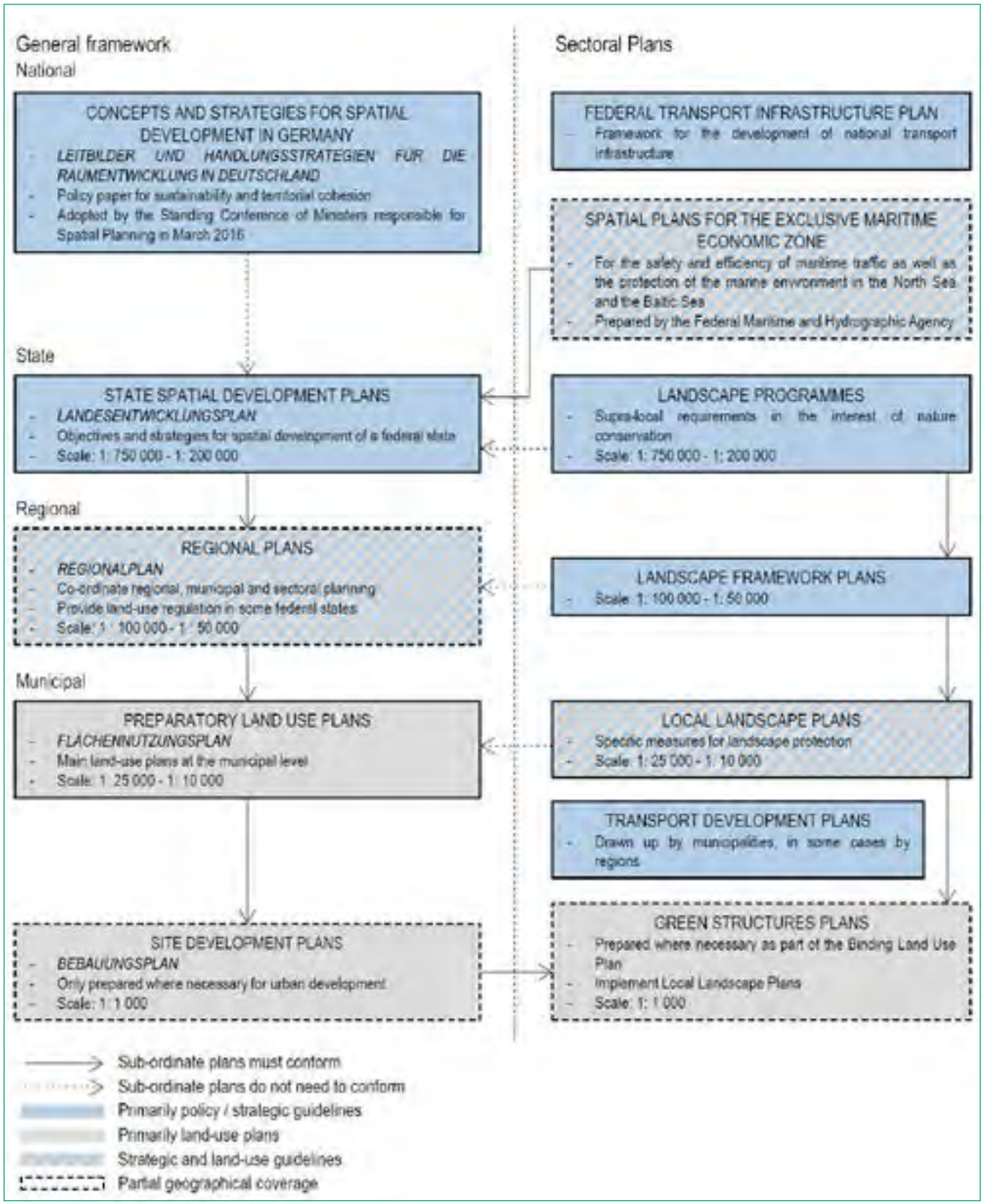

Fig. 03: The German Spatial Planning System (Source: OCDE, 2017, with modifications by Perrin)

planning associations), or mixed, depending on the federated state. Planning documents are also named differently in the federated states but are linked by the same mutual feedback principle (*Gegenstromprinzip*) throughout the entire country (Pahl-Weber and Henckel, 2008: 215). The overall coherence is thus ensured by a combined top-down and bottom-up approach. In other words, any plan must conform to the goals and/or take into account the principles set up in the documents at higher levels and, inversely, must be taken into consideration by the plans made at these higher levels.

The planning guidelines included in the spatial planning law as well as the content of the spatial development plan produced at the federated state level may be more or less constraining for regional and local planning authorities. However, municipalities have been granted significant land-use planning powers by the federal constitution. They essentially rely on two instruments, both established in the Urban Building Code (*Baugesetzbuch*). The Land-Use Plan (*Flächennutzungsplan*) determines the types of land use over the whole municipal area and provides legally binding guidelines for the preparation of the Site Development Plan (*Bebauungsplan*) that stipulates for landowners which developments (land conversion or construction) are permitted on the parcels. This second document is not mandatory and generally covers only some part of the municipal area.

Finally, the existence of sectoral plans and landscape plans should be highlighted. Being key instruments for nature conservation and landscape management, landscape planning instruments mirror spatial plans at every level of the planning system: Landscape Programmes (*Landschaftsprogramm*) at the federated state level, Landscape Framework Plans (*Landschaftsrahmenpläne*) at the regional level, Local Landscape Plans (*örtliche Landschaftspläne*) at the lower level, and Green Structure Plans (*Grünordnungspläne*) at the level of development area level. The important role assigned to landscape planning results from a long tradition in the country and, in particular, the adoption of the Federal Nature Conservation Act (*Bundesnaturschutzgesetzes*) in 1976 (Von Haaren and Galler, 2012). The law was revised in 2010, reformulating the goals regarding nature conservation and landscape management around three main aspects: "*conserving biological diversity; enhancing productivity and functionality of the ecosystem; and safeguarding variety, singularity, beauty and recreational value of nature and landscapes.*"

Considerations for ecological connectivity/networks

The issue of ecological connectivity was initially addressed legally in 2002, when legislators amended the Federal Environmental Law. On this occasion, they introduced the obligation for federated states to develop a cross-state "network of interlinked habitats" (*Netz verbundener Biotope*), also mentioned as an "biotope network" (*Biotopverbund*), covering at least 10% of the land surface of the country (von Haaren and Reich, 2006). The National Biodiversity Strategy (BMUB, 2007) confirmed this objective and listed specific measures and contributions, including for state and municipal authorities, environmental non-governmental organisations and private stakeholders, for this purpose. In 2009, a new amendment modified the previous provision, specifying that at least 10% of the land surface of every federated state should be covered by the cross-state ecological network (Jedicke, 2015). In recent drafts, the Federal Ministry for Environment (BMUB) proposed to additionally specify that the ecological network should be established by the end of 2027 (Bannas et al., 2017; Deutscher Bundestag, 2017). This provision was eventually removed from the amendment of the Federal Nature Protection Act approved in September 2017. As a result, there is no deadline for the implementation of this cross-state ecological network at the moment.

However, concerns for ecological connectivity gained force in spatial planning well before the issue was enshrined in federal law. As early as 1992, a resolution, adopted by a body of federal and federated state ministers in charge of spatial planning in the context of the Conference of Ministers for Spatial Planning (*Ministerkonferenz für Raumordnung - MKRO)*, called for the establishment of an ecological network in spatial planning, which was supposed to be functionally coherent and to cover about 15% of the whole undeveloped area of the country. Spatial planning was deemed the necessary field because of the need for a comprehensive approach making it possible to consider this ecological network at least at the regional and state scales and in regards to other land-use related issues. In 1993, the Spatial Planning Orientation Framework (*Bundesministerium für Raumordnung, Bauwesen und Städtebau*) identified the need to create a large-scale network made of habitats and open spaces as a contribution to the preservation

and development of environmental quality. As it was not legally binding, the resolution adopted in the context of the 1992 MKRO was followed by the federated states to a varying degree. While some of them introduced ambitious provisions into their federated state and regional plans, others did not develop any ecological network concept (Mayr-Bednarz, 2009; Leibenath, 2011; Hänel, 2015).

The Building Code was modified in 2004 in order, among other things, to include biodiversity as one of the environmental issues to be considered in the land-use plans. As a result of an amendment of the Environmental Impact Assessment Act approved in 2005, biodiversity has been defined as a legally protected good to take into account in the environmental compliance audits for all projects subject to mandatory audits (environmental impact assessments) as well as programmes/plans (strategic environmental assessments) (Koch, 2013). The Spatial Planning Act, as revised in 2008, stipulated that deteriorations to the ecological balance have to be compensated for and requirements regarding ecological networks have to be considered in each spatial plan. In 2009, the Act for Restructuring the Nature Conservation and Landscape Management Legislation (*Gesetz zur Neuregelung des Rechts des Naturschutzes und der Landschaftspflege*) stated that the landscape planning documents required by law (i.e. landscape strategy, landscape masterplans, landscape plans, green open space structure plans) shall "*contain information regarding the requirements and measures necessary for pursuing the concrete objectives in terms of nature conservation and landscape management, in particular* [...] *for the establishment and protection of an ecological network, of the ecological connectivity and of the "Natura 2000" network*".

The federated states have planned or are planning ecological networks, either in specific schemes or as parts of landscape plans, or more exceptionally in spatial plans. While some federated states (e.g. Bavaria, Rhineland-Palatinate, Saxony-Anhalt) have implemented this strategy for a long time-sometimes before the 2000s and thus before the adoption of legal constraints at federal level- others have launched this work more recently (Bannas et al., 2017). Significant differences can be observed in terms of content and planning scales between these ecological networks. Furthermore, some federated states provide a stronger degree of legal obligation and/or implementation measures to be considered in the land-use policy at lower planning levels (i.e. Baden-Württemberg, Saxony-Anhalt) (Bannas et al., 2017).

In the German planning system, landscape planning has a central role. Among other things, it is intended to ensure proper attention to issues of nature conservation and landscape management as well as to provide the information to be then taken into account in spatial/urban planning and other sectoral processes (Walz and al, 2013). The landscape plans developed at supralocal and local levels have thus to specify the requirements and measures needed for achieving a precautionary action from an environmental perspective (Schumacher and Schumacher, 2016). However, there is no duty to revise landscape plans at regular intervals, and hence to thereby update the development of an ecological networks concept. As a consequence, spatial planning guidelines may be determined in some cases on the basis of, among other things, 20-year-old landscape plans containing outdated environmental information (Leibenath, 2011).

2.1.4. Italy

Spatial planning system

Historically, spatial planning in Italy was regulated at the national level through the Urban Development Law (*Legge Urbanistica*) approved in 1942 and then revised in 1967 (Rega, 2013). However, planning and many other competences were increasingly transferred to regions by the decentralisation reform initiated in the 1970s and intensified in the 1990s. Consequently, the Italian state now has only a few decision-making powers in the spatial planning field. The national government and the parliament provide general guidelines for territorial development in the country. Central institutions also keep a handle on some sectoral issues, such as the protection of heritage sites and the natural landscape, as well as the construction and management of infrastructures of national importance (Prenger-Berninghoff, 2016). Another important change occurred in the Italian spatial planning approach with the constitu-

tional reform of 2001, which introduced a modification in the denomination of the planning field with a reference to Territorial Government (*Governo del Territorio*) instead of Urban Planning (*Urbanistica*). This shift was implemented with the intent of "*includ*[ing] *spatial planning inside a process of general reorganisation of public action and administration*" (Fedeli, 2016: 188). The change also "indicates a wider approach being taken to the spatial dynamics and dismisses an expression related to a mainly urban focus" (Lingua and Servillo, 2014: 128), since the Italian planning tradition having been particularly influenced by the world of architecture and urban design.

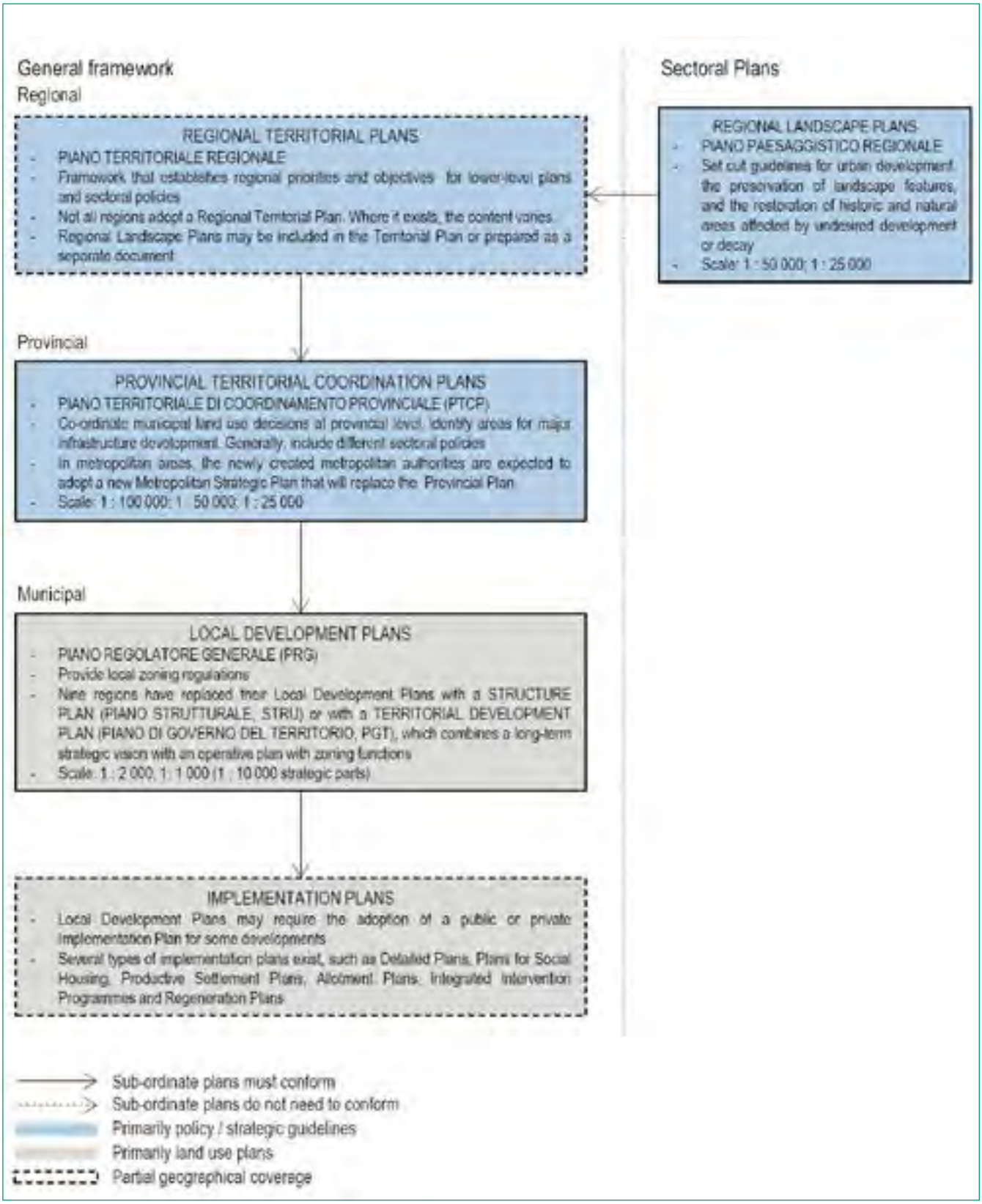

Fig. 04: The Italian Spatial Planning System (Source: OCDE, 2017)

The 20 regions enact their own spatial planning acts and are now the main source of legal provisions for planning structures and processes at regional and lower levels. They produce a Regional Territorial Plan (*Piano Territoriale Regionale*) through which general and specific objectives are established for the whole territory as well as offering guiding principles and rules to be taken into consideration in the lower-level plans and sectoral policies. In addition, by virtue of the federal Galasso Law of 1985, each regional administration is committed to prepare a Regional Landscape Plan (*Piano Paesaggistico Regionale*) in collaboration with the National Ministry for Cultural Heritage and Activities (*Ministero per i beni e le attività culturali*) (De Montis and Farina, 2012: 383). A 2004 legislative decree, named Cultural Goods and Landscape Code (*Codice dei Beni Culturali e del Paesaggio*), "entrusted the landscape with a new function: to be the engine for managing territorial transformations" (Colavitti et al., 2013: 174). The Regional Landscape Plan has actually become the key instrument for ensuring coherence between all the plans. It provides strategies for preserving the landscape, in particular its areas with high environmental value, and sets out guidelines or restrictions for urban development. The Regional Landscape Plan may be conceived separately or as part of the Regional Territorial Plan.

The provinces draw up Provincial Territorial Coordination Plans (*Piano Territoriale di Coordinamento Provinciale - PTCP*) with the aim of coordinating municipal land-use policies and planning major infrastructure projects on the basis of the regional guidelines. These plans provide the municipal authorities with planning prescriptions, directives or recommendations (Rega, 2013). In addition, Metropolitan Cities (*Città Metropolitane*), legally established in 2014 as alternative governing bodies at the provincial level, have recently adopted or are still producing a Metropolitan Area Plan (*Piano Strategico Metropolitano - PSM*). Fourteen metropolitan areas (e.g. Bari, Bologna, Cagliari, Catania, Firenze, Genova, Messina, Milano, Napoli, Palermo, Reggio Calabria, Roma, Torino, Venezia) were given this specific status so far.

The municipalities are responsible for the strategic and operational urban planning. The Municipal Regulatory Plan (*Piano Regolatore Generale Comunale - PRGC*) rules the land use over the whole municipal area. Executive and implementation plans – such as detailed plans (*Piani Particolareggiati*) and allotment plans (*Piani di Lottizzazione*) – provide additional development rules and guidelines for specific areas. Following the 2001 constitutional reform, several regions introduced a model that combines a Strategic Structure Plan with an Operative Plan (Collaviti et al., 2013). It is also possible to produce a Supramunicipal Regulatory Plan (*Piano Regolatore Generale Intercomunale - PRGI*) in order to collaboratively project future infrastructures, public services or facilities of public interest, as well as new development areas for residential industrial, artisanal, commercial or touristic use.

Considerations for ecological connectivity/networks

There is no legal obligation to address the issue of ecological connectivity in spatial planning processes under the existing national laws. This integration thus falls within the responsibility of regional legislators. However, the Italian State has contributed to a better consideration of the issue through various measures.

In 1998, the Interdepartmental Committee for Economic Programming (*Comitato Interministeriale per la Programmazione Economica - CIPE*) took advantage of the Structural Funds Programme for the 2000-2006 period to support the development of a coherent national ecological network, understood as a "*network of national and regional parks as well as other protected areas*". This concept was defined as the strategic reference tool for the enhancement of natural, environmental and cultural resources. In 1999, the Nature Conservation Service of the Ministry of the Environment published an Interim Report of the Sectoral Working Group "National Ecological Network". In this document, the concept of ecological network is defined as a "*natural and environmental framework that aims at developing the linkage and interconnection between spatial entities on the basis of, among other things, a greater presence of nature and a higher degree of embeddedness of local communities into natural processes*". The report identifies the following actions as useful contributions to the development of this national ecological network: technical support and monitoring of actions, enhancement of the mountainous space, environmental rehabilitation in urban and seaside contexts, enhancement and rehabilitation of minor islands (Ministero dell'Ambiente, 1999; Todaro, 2010). In the wake of this report, a national ecological network has been mapped on

the basis of scientific work that investigated whether existing protected areas were sufficient for the conservation of the vertebrate species, and what measures should be considered in order to address the deficiencies (Boitani et al., 2003). This task highlighted the importance of mountainous areas, especially in the Alps and the Apennines, as core areas for vertebrate species.

In the same period (1998-2000), the former Italian Ministry of University and Scientific Research founded the PLANECO (*Planning in Ecological Network*) project, with the aims of investigating the role of spatial planning in identifying ecological networks in specific contexts, guiding the land use within protected areas considered as core components of ecological networks, and developing new urban configurations supposed to increase the ecological functionality of suburban areas. In 2010, Italy adopted a National Biodiversity Strategy for Biodiversity (*Strategia Nazionale per la Biodiversità*). Various priority actions have been set out in order to meet the objectives to be achieved by 2020, including biodiversity aspects to be considered in planning instruments from large to local scale. The first listed measure consists of promoting revision of the national legislation regarding the territorial use, transformation and protection, in line with the scientific and cultural developments in terms of assessment, programming, planning and integration of biodiversity aspects. The second listed action aims at promoting the use of ecological network design methodologies in large areas, as a fundamental and prescriptive part of spatial planning processes as well as for the preparation of specific guidelines (MATTM, 2010).

The issue of ecological connectivity has gained momentum in regional legal frameworks since the late 1990s. However, the attention given to the issue, the promptness of its consideration, as well as its enshrinement in legislation have varied widely between regions (Todaro, 2010: 124-131; Todaro, 2017: 42-45). Some were quicker than others to integrate the concepts of interconnected systems of habitats or ecological networks into their legislation, sometimes because of favourable legislative timing or based on a particular sensitivity to the environment and landscape (Guccione and Schilleci, 2010: 13). References to these concepts have been included in the regional legislation either on the environment, protected areas, or spatial planning, depending on regions. Above all, differences could be observed between regions that have legally assigned ecological networks a structural function in their spatial organisation (e.g. Campania, Basilicata, Emilia Romagna, Umbria) and others that have given them a systemic function to be recognised and protected in spatial and urban planning instruments (e.g. Lombardy, Puglia, Veneto) (Guccione and Schilleci, 2010: 14-15; Todaro, 2010: 125-127; Todaro, 2017: 45).

For instance, Lombardy Region introduced a first reference to ecological network in its legislation with a regional law (L.R. 86/1983) governing the institution and management of the Lombard parks. It defines the Regional Ecological Network (*Rete Ecologica Regionale - RER*), which has to be identified in the Regional Territorial Plan (*Piano Territoriale Regionale - PTR*), as a combination of statutory areas (e.g. regionally protected areas and Natura 2000 sites) and any external areas that have by "*their linear and continuous structure a role of ecological connection* [and] *are functional for the geographical distribution, the genetic exchange of plant and animal species and the conservation of vital populations."* A new law in the field (L.R. 28/2016) aims at *"promoting the completion of the regional ecological and green network*", encouraging voluntary unification between existing parks. The 2010 Regional Territorial Plan explicitly considers the establishment of a RER and recognises it as a priority infrastructure in the field of biodiversity and ecosystem services, together with the Regional Green Network (*Rete Verde Regionale - RVR*) set in the Regional Landscape Plan (*Piano Paesistico Regionale - PPR*). The RER was approved in 2009 with regional deliberation that specifies its composition and provides local authorities with indications for its implementation at provincial and municipal levels. It is composed of parks, primary regional corridors and, in particular, "passages" (*varchi*) located in urbanised contexts, where specific actions are necessary to maintain or restore the ecological connections.

As another example, Friuli Venezia Giulia region did not include specific reference to ecological networks in its main spatial planning law. However, a Regional Ecological Network has been defined in the 2013 Regional Territorial Plan (*Piano del Governo del Territorio - PGT*) and the 2018 Regional Landscape Plan (*Piano Paesaggistico Regionale - PPR*). The ecological network foreseen in the Regional Landscape Plan is a strategic element formed by interconnected core areas, buffer zones and stepping-stones, structured in the Regional Ecological Network (REN) and the Local Ecological Networks (LEN). Indeed, local planning processes must take into account the contents of these regional

plans as legal references in terms of criteria and methodologies, in order to enhance, protect and implement the regional natural resources and values.

According to the latest status report (ISPRA, 2017), references to connectivity and eco-functional connections could be found in all regions, either in their regional landscape plans, or regional documents considered effective as landscape plans or supposed to include landscape-related considerations. However, "*it should also be noted that each plan approaches the topic of ecological connectivity in a different qualitative and quantitative way. The statements and references that can be found are often uneven and can range from very general and concise statements to detailed descriptions of actions and implementation projects*" (ISPRA, 2017: 63). Furthermore, various initiatives can be observed at the provincial and local levels. In 2012, explicit references to ecological networks could be found in 95 Provincial Territorial Coordination Plans (*Piano Territoriale di Coordinamento Provinciale)* out of the 107 provinces of the country (the 4 Provinces of the Friuli-Venezia Giulia Autonomous Region, that were abolished in 2016, were not legally bound to develop such a plan) (ISPRA, 2014: 63-65).

2.1.5. Slovenia

Spatial planning system

The first spatial planning laws date back to the socialist period (late 1960s, 1970s and early 1980s). The 1984 Planning Act (*Zakon o urejanju prostora - ZUreP*) introduced an integrated development concept aimed at addressing spatial, social and economic considerations simultaneously. However, this societal planning approach was officially abandoned in 1991 for a more strictly spatial planning approach that did not really gain traction in a changing political, economic and social context (Peterlin and McKenzie, 2007: 456). After a transition period following national independence in 1991, marked by limited changes, Slovenia has progressively renewed its spatial planning system with the adoption of the 2002 Spatial Management Act (*Zakon o urejanju prostora - ZUreP-1*), which was never fully implemented, and above all the 2007 Spatial Planning Act (*Zakon o prostorskem načrtovanju - ZPNačrt*). In 2017, a new set of laws comprised of a Construction Act, an Architectural and Engineering Activities Act and a Spatial Management Act (*Zakon o urejanju prostora - ZUreP-2*), was adopted. These successive reforms have partly contributed to the decentralization of spatial planning powers, which were traditionally mostly in the hands of the central state. However, the central state still has a very significant influence.

The 2004 Spatial Development Strategy of Slovenia (*Strategija prostoskega razvoja Slovenije - SPRS*) provides a long-term strategic vision for spatial development in the whole country and is to be implemented through the other sectoral and spatial plans adopted at the different levels. A new Spatial Development Strategy 2050 is under preparation by the Ministry of the Environment and Spatial Planning (*Ministrstvo za Okolje in Prostor - MOP*) and is expected to be voted on later by the Parliament. In addition, the national government can adopt National Spatial Plans (*Državni prostorski načrt - DPN*), which are physical plans that cover areas targeted for development projects of national importance. This planning instrument can override existing municipal land-use plans and thus provides the State with the ability to develop and modernise infrastructure relatively rapidly (OCDE, 2017). Moreover, the 2017 legislative reform introduced new tools for the State administration – namely the decree on the most suitable variant/alternative (*Uredba o najustreznejši varianti*), the comprehensive permit (*Celovito dovoljenje*), and the decree on area protection (*Uredba o varovanem območju*) – to facilitate the development of linear infrastructures (e.g. highways, power lines, etc.). Another big influence of the State on spatial planning at lower levels lies in the terms of many sectoral acts (nature conservation, environmental protection, water, forest, agriculture, etc.) and protection/management status (regional and national nature parks). In addition, the State administration is in charge of ensuring the compliance of regional and municipal planning documents with regulatory provisions.

There is no regional administrative level in the country. However, a regional level has been considered in the successive legal reforms (2002, 2007, 2017) aimed at reorganising the spatial planning system. Without knowing what the real impacts of the last reform will be, planning instruments established at the regional level have generally not

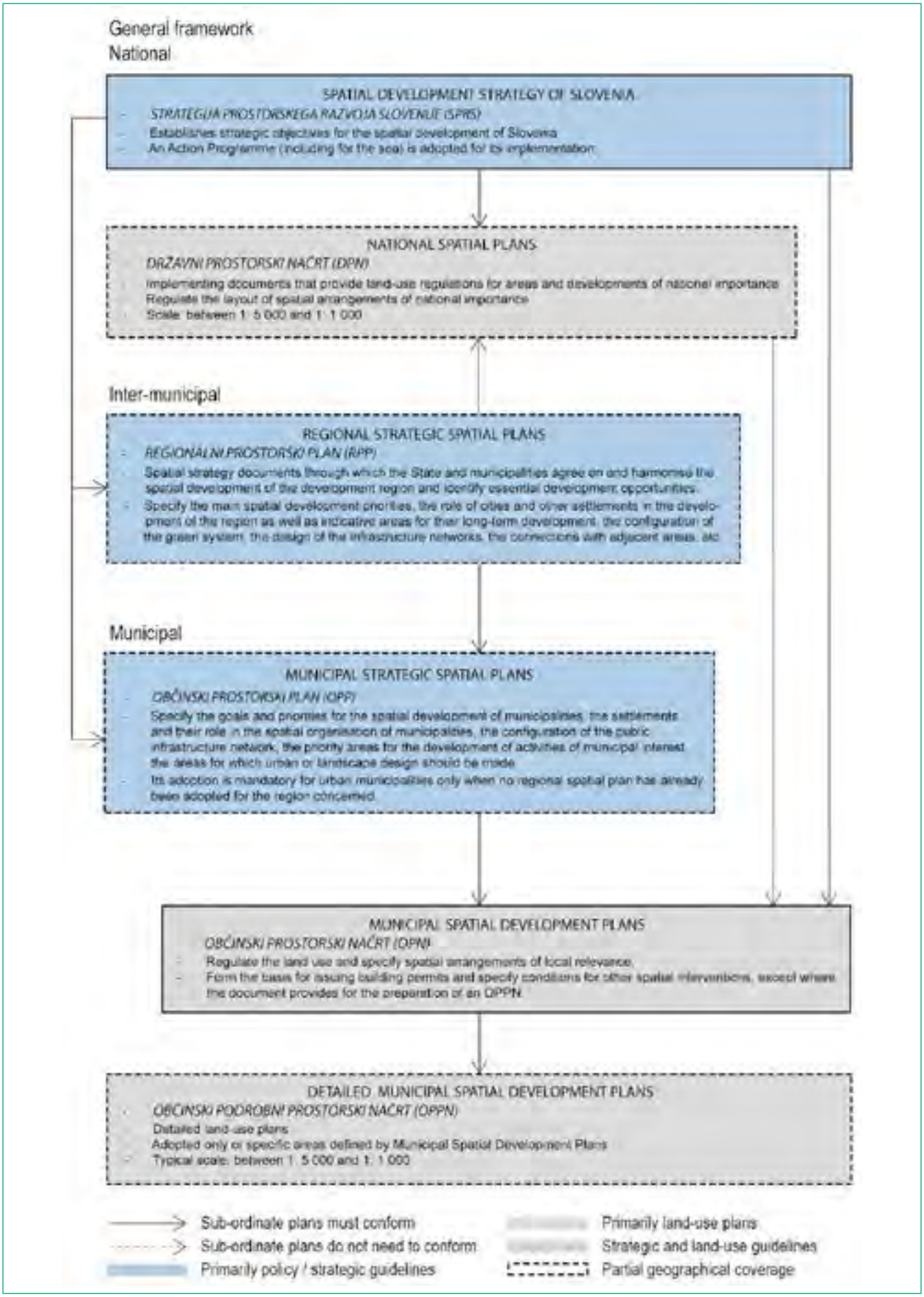

Fig. 05: The Slovenian Spatial Planning System (Source: OCDE, 2017, with updates by Perrin)

been taken full advantage of so far. The new legislation provides for the adoption of a Regional Strategic Spatial Plan (*Regionalni prostorski plan - RPP*), conceived as a strategic document through which the State and the concerned municipalities coordinate the spatial development of each region. The document has to specify objectives, priorities and guidelines for the spatial development of the whole region, in particular regarding the development of settlements and infrastructures as well as the regulation of landscape. This strategic instrument also provides the regions with a framework for planning developments of local interest that may concern several municipalities or impact other municipalities.

The municipalities, which were essentially the arms of central government during the socialist period (Elliott and Udovc, 2005), have been granted more decision-making powers during the devolution process implemented after the national independence. The municipalities are responsible for the preparation of the Municipal Strategic Spatial Plan (*Občinski prostorski plan - OPP*), which determines the strategic objectives, priorities and guidelines for spatial development in the whole municipal area. This document is mandatory for urban municipalities located in areas not already covered by an in-force or under-development Regional Spatial Plan. The Municipal Spatial Development Plan (*Občinski prostorski načrt - OPN*) is a mandatory document, containing a land-use map and zoning regulations for the whole municipal area. Furthermore, Detailed Municipal Spatial Development Plans (*Občinski podrobni prostorski načrt - OPPN*) may introduce additional land-use regulations and specify permitted uses for specific areas (OCDE, 2017). However, it must be noted that municipalities are generally hindered by limited resources. In addition, planning processes are lengthy. Consequently, the in-force municipal plans are outdated in many cases.

Considerations for ecological connectivity/networks

Slovenia included the ecological network concept in its national legislation in 1999 with the adoption of the Nature Conservation Act (*Zakon o Ohranjanju Narave*) (Harfst et al., 2010). This text, largely focused on the issue of biodiversity conservation, defines the ecological network as "*a system of interconnected ecologically important areas or areas close to one another that through an even biogeographical distribution significantly contribute to the maintenance of natural balance and consequently biodiversity conservation.*" It also states that "*the orientations, bases and conditions for biodiversity conservation and the protection of valuable natural features which are laid down in the regulations and documents issued pursuant to this Act and which have to be taken into account in spatial planning* [...] *shall be indicated in the nature protection guidelines.*"

Surprisingly, no explicit references to ecological connectivity, ecological networks or biodiversity corridors can be found in the first Slovenian Biodiversity Conservation Strategy adopted in 2001 (Slovenian Ministry of the Environment and Spatial Planning, 2002: 12). An updated Biodiversity Conservation Strategy and Action Plan 2015-2025 is expected to be adopted in the coming years (Bolješić and Groznik Zeiler, 2015). One measure listed in the proposed targets for the updated Biodiversity Conservation Strategy aims "*to preserve the mosaic nature of the landscape and identify landscape elements contributing to biodiversity within spatial planning and land use.*" (Bolješić and Groznik Zeiler, 2015: 55) Furthermore, one measure proposed for inclusion in the Action Plan aims "*to identify and maintain and, where necessary, re-establish ecological connections that enable genetic exchange between populations.*" *This measure:* "*covers all species recognised as endangered (red-listed) in Slovenia, and there are also several measures that contribute to ecological connectivity indirectly (for example preserving traditional landscape, encouraging the traditional use of natural resources, restoring abandoned agricultural land and more)*" (Plassmann et al., 2016: 61).

In 2004, Slovenia adopted a Spatial Development Strategy (*Strategija prostorskega razvoja Slovenije*) specifying that the conservation of biodiversity and natural values as well as the interconnection and interrelation of ecological networks shall be enabled by spatial development policies. Another paragraph recommends an integrated consideration of natural ecosystems in border areas in order to enable their interconnection and integration into international ecological networks and protected areas (Slovenian Ministry of the Environment and Spatial Planning, 2004). A new version of this document is currently under development.

Information related to ecological connectivity is not explicitly shown in municipal spatial plans or in the detailed plans that regulate specific spatial arrangements of national importance. However, the plans shall be prepared considering the general and detailed guidelines from national offices responsible for specific fields: nature conservation, water protection and use, agriculture, forestry, etc. In addition, municipal authorities shall execute a strategic environmental assessment if requested in the initial phase of plan preparation by the SEA office, which is a body of the Ministry for the Environment and Spatial Planning. Considerations for ecological connectivity may also be found in the guidelines provided by the Slovenian Forest Service (related to forests and forested landscapes) and the Fisheries Research Institute of Slovenia (related to riparian habitats) which collaborate in the spatial planning processes. The negotiation/reconciliation process during spatial planning often results in the adaptation of draft plans due to demands regarding ecological connectivity. The manner depends on the type of spatial plan. In the case of a detailed plan of national importance (i.e. for a highway), a spatial plan is prepared only for the alternative that has been selected upon evaluation of four aspects: economic, protective (including biodiversity and ecological connectivity), spatial and technical aspects. If such alternative still has some short-comings from an ecological-connectivity perspective, the detailed spatial plan shall include adequate spatial measures to address the issue, such as, for example, a green bridge. In the case of a municipal land-use plan, the reconciliation process can be concluded by minimising the land use that would hinder ecological connectivity.

2.1.6. Switzerland

Spatial planning system

Switzerland, officially the Swiss Confederation, is a federal republic of 26 member states called cantons (*Kanton / Canton / Cantone*). On the basis of an article introduced into the Constitution in 1969, the Confederation has been entrusted with the charge of establishing regulating principles for spatial planning. These have been set out in the Federal Act on Spatial Planning (SPA) (*Bundesgesetz über die Raumplanung - RPG*)[11] approved in 1979. In addition, the Swiss Federal Council adopted an Ordinance on Spatial Planning (*Raumplanungsverordnung - RPV*)[12] whose main purpose is to specify the principles and instruments established by the Federal Act on Spatial Planning. One of the main goals for spatial planning, as stated in the Constitution and the 1979 Spatial Planning Act, is a careful use of land resources. The legislation has, nevertheless, been renewed by referendum in 2013 in order to concentrate on future development and renewal operations within existing cities as well as urban areas in order to reduce uncontrolled urban sprawl. A new revision of the Spatial Planning Act is currently projected, in particular in order to introduce new building rules outside development areas.

In addition to its legislative responsibility, the Confederation shall support and coordinate the efforts of the cantons, considering that spatial planning activity is mainly their responsibility. To this end, the Confederation took part in the production of the first Swiss Territorial Project (*Raumkonzept Schweiz*)[13] in collaboration with representatives of the cantons, cities and municipalities. This strategic and non-binding document, issued in 2012, provides a policy framework and guidance for coordinating planning in the whole country on the basis of 12 supraregional areas (Conseil fédéral Suisse et al., 2012). Another significant influence of the Confederation lies in the adoption of sectoral legislations as well as sectoral plans (transport, high-potential agricultural areas, electric transmission lines, defence) and concepts (landscape, wind power, etc.), particularly given that spatial planning has been empowered by the federal legislation to coordinate sectoral policies (landscape and environment, agriculture, tourism, etc.) from an horizontal (between federal departments) and vertical (with the cantons) perspectives.

Cantons have to adopt an implementing legislation that regulates spatial planning and building, in compliance with the Federal Act on Spatial Planning. Additionally, they have to prepare a Cantonal Structure Plan (*Kantonaler*

11 *Loi fédérale sur l'aménagement du territoire - LAT / Legge federale sulla pianificazione del territorio - LPT*
12 *Ordonnance sur l'aménagement du territoire - OAT / Ordinanza sulla pianificazione del territorio - OPT*
13 *Projet de territoire Suisse / Progetto territoriale Svizzera*

Richtplan)[14]. This instrument provides a comprehensive planning strategy as well as measures aimed at coordinating spatially relevant policies. It also includes process instructions to be followed by the concerned bodies, especially by the municipal authorities, to progress towards the desired spatial development for the 20-25 years to come. The document has to be approved by the Confederation. Furthermore, some cantons delegate a part of their planning power to regional planning associations. These public bodies may produce studies, regional masterplans and support spatial planning at a supramunicipal level, depending on the canton (VLP-ASPAN, 2012). Another entity is gaining force in the Swiss planning context with the Agglomeration Policy (*Agglomerationspolitik*)[15] launched by the Confederation in 2001. It aims at fostering metropolitan collaboration, cooperation and governance within functio-

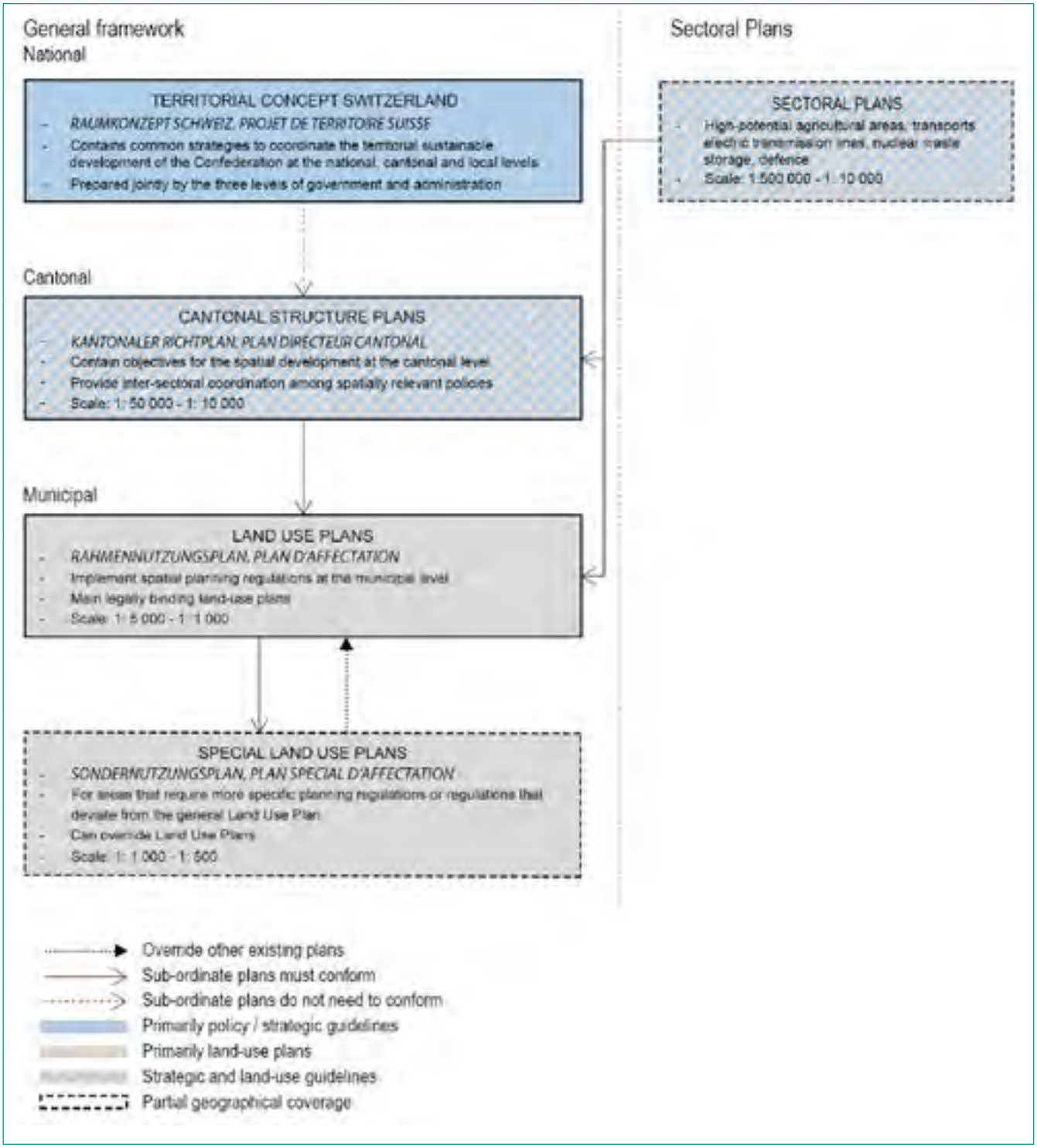

Fig. 06: The Swiss Spatial Planning System (Source: OCDE, 2017, with modifications by Perrin)

14 *Plan directeur cantonal / Piano direttore cantonale*
15 *Politique des agglomérations / Politica degli agglomerati*

nal urban areas that may override national and cantonal boundaries. Federal funds are allocated to the implementation of agglomeration programmes drafted beforehand by the concerned cantonal and local partners as well as for the development of new infrastructures and innovative projects. One of the main focuses was initially (and still is) the funding of the transportation system, but other issues have been progressively considered.

Cantons are free to determine in their legislation whether they or the municipalities are in charge of preparing Land Use Plans (*Rahmennutzungsplan*)[16]. Except in the cantons of Geneva and Basel-Stadt, the task is assigned to municipal authorities. These documents shall specify the building zones and the various land-uses authorised at the plot level. In addition, Special Land Use Plans (*Sondernutzungsplan*)[17] may complement the provisions included in the Land Use Plan or introduce rules that override it. These may include detailed requirements regarding neighbourhood layouts, architectural and aesthetic standards, or setback distances for specific building projects in a limited area or for specific planning issues. Both documents are binding on authorities and landowners (Kaiser et al., 2016).

Considerations for ecological connectivity/networks

In 1992, Switzerland laid the groundwork for the development of an ecological network at the federal level by launching the preparatory work on its Swiss Landscape Concept (*Landschaftskonzept Schweiz*) (BUWAL et al., 1998). This document was elaborated by the Federal Office for the Environment, Forests and Landscape (*Bundesamt für Umwelt, Wald und Landschaft - BUWAL*) in collaboration with other federal and cantonal administrations. It was approved in 1997 by the Federal Council in accordance with the Spatial Planning Act (Raumplanungsgesetz - RPG) stating that the Confederation has to develop the concepts and sectoral plans required for planning the national territory. The Swiss Landscape Concept provides the country with a programme aimed at restoring and revitalising ecological networks at the federal level. It also has specified objectives aimed at minimising the fragmenting effects of present and future transport infrastructures as well as developing/restoring water and riverside connectivity, which are binding to the federal authorities and recommended to be considered by the cantonal authorities. In addition, the document has promoted the networking of biotopes by introducing biological corridors and relay biotopes at regional or local levels, more especially by means of hydrographical networks (Bonnin et al., 2007). The 20-year-old Swiss Landscape Concept is currently being updated. In 2004, the BUWAL published a first version of a national ecological network (*Nationales ökologisches Netzwerk*, Réseau Ecologique National, *Rete Ecologica Nazionale - REN*), thus setting out an ecology-based vision of the landscape built on existing data and modelling processes (Berthoud et al., 2004). Local experts and the concerned cantonal administration were involved in the verification and completion of the dataset. The results are presented on maps on 1:100 000 and 1:500 000 scales.

In 2012, the Confederation, cantons, cities and municipalities committed "*to foster biodiversity by protecting and connecting areas and landscapes of high ecological value*" through one of the resolutions listed in the Swiss Territorial Project, aimed at providing strategic and non-binding guidance for spatial planning in the country (Conseil fédéral Suisse et al., 2012: 50). In the same year, the Federal Council adopted a Swiss Biodiversity Strategy including 10 strategic objectives to be achieved by 2020 (Conseil fédéral, 2012). The second consists of the development of an ecological infrastructure made of protected and connecting areas. In addition, the document contains a specific development regarding the responsibility of spatial planning regarding biodiversity. It must be highlighted that spatial planning instruments were considered until recently as inappropriate for pursuing sustainable development, given their observed incapacity to curb urban sprawl, landscape fragmentation, and other pressures on areas of ecological interest (Conseil fédéral, 2012: 35). The revised Federal Act on Spatial Planning may partly rectify this state of affairs by limiting the possibility for new developments outside cities or urban areas.

An Action Plan for the Swiss Biodiversity Strategy was adopted by the Federal Council in 2017 (Conseil fédéral, 2017). The, "*establishment, development and maintenance of an ecological infrastructure throughout the country*" is recognised as a cornerstone for the direct development of biodiversity in the long-term, which is one of the three main action fields identified in the document. To this end, it points out the need to "*improve the biological quality of*

16 *Plan d'affectation / Piano d'utilizzazione*
17 *Plan d'affectation spécial / Piano di utilizzazione speciale*

existing protected areas and ensure spatial and functional connectivity between natural areas worthy of protection" (Conseil Fédéral, 2017: 10). Particularly, two tasks are identified amongst the measures to be achieved in the first phase (2017-2023) of the Action Plan: to elaborate the ecological infrastructure in the whole country (4.2.1) and to plan, at a regional level, the connection of natural areas of high ecological value between them (4.3.1).

Given the federal organisation of the country and the wide latitude given to cantons, the Confederation has limited capacity to influence the spatial planning guidelines at lower levels, especially regarding the implementation of ecological networks (Lebeau and Righetti, 2008). However, the Confederation has a more indirect ability to influence the cantonal policies, in particular through financial incentives. The Confederation and cantons specify, in a 4-year programme agreement, a set of tasks to be achieved by cantonal authorities and the federal funds to be allocated in return. This financial lever is explicitly pointed out in the Action Plan for the Swiss Biodiversity Strategy for the implementation of the ecological infrastructure at the cantonal level.

In 1996, the Federal Office for Spatial Development introduced the following point in the technical guidelines provided to cantons for the preparation of their cantonal structure plans: "*Large near-natural landscapes are usually found only in the high mountains today; in populated landscapes, the habitats of existing plant communities and animal populations are confined and these are often threatened with extinction or already extinct. Often only small isolated biotope areas remain. The preservation and restoration of near-natural cultural landscapes require supporting environmentally friendly management in agriculture and spatially connecting particularly valuable flora and fauna habitats.*" (Bundesamt für Raumplanung, 1996: 39-40) However, in spite of this statement and of the large amount of habitat/species data made available, relatively low attention had been paid to ecological connectivity and ecological networks in the cantonal structure plans until recently. In some cases, an ecological network has been mapped for some parts of the cantonal area, but no concrete measures were adopted for ensuring its preservation or implementation (e.g. Cantonal Ecological Network for the Valaisan Rhone Valley, 2005). The situation is progressively changing. More concrete measures for preserving and restoring ecological connectivity can be found in the numerous documents recently adopted or under preparation (e.g. cantonal structure plan of Geneva, cantonal structure plan of Vaud, cantonal structure plan of Valais, cantonal structure plan of Jura, cantonal structure plan of Bern, cantonal structure plan of Basel-Stadt), given that cantons had to revise their spatial planning legislation and Cantonal Structure Plan by 30th April 2019, in order to make them compliant with the last version of the Federal Act on Spatial Planning.

2.2. Comparative overview at the Alpine scale

This comparative overview at the Alpine scale aims to depict the consideration of ecological connectivity in spatial planning in the different countries on the basis of the material collected in the different contexts (legislative, technical and academic literature as well as interviews). This picture (**see figure 07**) has been produced considering four main criteria: historical considerations for ecological connectivity and ecological networks in spatial planning; degree of legal obligation to address ecological connectivity and/or to develop ecological networks in spatial plans; degree of multilevel governance; degree of ecological knowledge considered. More details regarding the selection and the understanding of these criteria can be found below (**see figure 08, p. 46**). Each classification has inherent limits. The colour attribution may differ according to which subcriteria are given prominence in the class distinction. Another complication may lie in the weight assigned to national/federal and state/regional levels respectively, when the situation may differ significantly between both levels or even between regions. In particular, this comparative overview does not allow a detailed understanding of the pioneering role, and thus of the potential influence of specific regions/states in addressing ecological connectivity through spatial planning within the different countries.

The selected criteria can be seen as factors that generally contribute to a better consideration for ecological connectivity in the different spatial planning systems. However, a higher attention to the issue in the spatial planning system does not guarantee a careful consideration for ecological connectivity in practice. Planning authorities are generally afforded, because of the very nature of the policy field, some latitude in interpreting and implementing the legal norms and planning guidelines. Consequently, much relies on the willingness and available means to address ecological connectivity at the regional and local levels. Conversely, a lower degree of consideration for the issue in the spatial planning system does not necessarily imply more fragmented landscapes and more threats to ecological connectivity. The development of specific land-use and sectoral policies or instruments can have significantly beneficial effects on ecological connectivity, even without having been specifically designed for this pur-

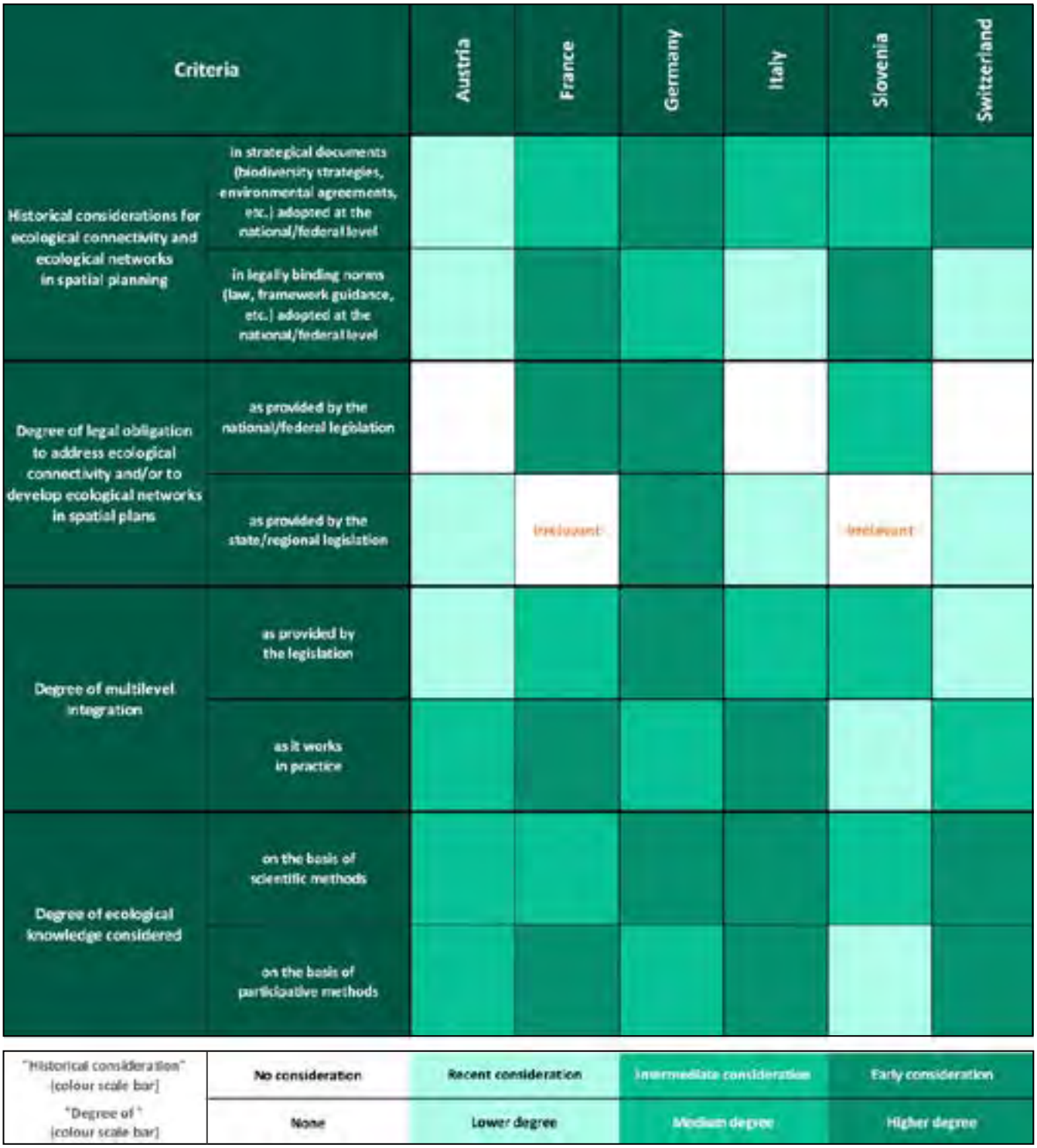

Fig. 07: A comparative overview of the way ecological connectivity is addressed in the different Alpine countries

pose. This is all the more the case when such policies and instruments were implemented a long time ago and thus effectively played a preventive role in reducing landscape fragmentation.

The first finding to be emphasised is the large diversity of ways the issue of ecological connectivity/networks in spatial planning has been put on the agenda and then been addressed in the different countries. It is indeed difficult to establish a typology of countries based on the selected criteria. Below are some lessons that can be learned from the different comparative perspectives:

Historical considerations for ecological connectivity/networks in spatial planning

Despite a general trend towards more references, commitments and obligations regarding ecological connectivity and networks in spatial planning within strategic documents and legally binding norms, different timelines can be observed between the countries. It should be noted that there is not a strong temporal relationship between the period from which the issue/objective has been mentioned in strategic documents to the time it has been, or could be in the future, included in legally binding norms. In one case, considerations and commitments in favour of ecological connectivity in spatial planning have been enshrined in strategic documents well before strict legal provisions have been adopted in the field (i.e. Germany). In other cases, commitments have been made at the federal/national level, but discretion has been given thus far to federated states or regions to establish their own legal framework on the matter (i.e. Austria, Italy, and Switzerland). In two countries, norms had first been enshrined in environmental and/or planning legislations before further commitments were made within strategies (i.e. France and Slovenia).

Degree of legal obligation to address ecological connectivity and develop ecological networks in plans

There is no clear legal obligation in dealing with ecological connectivity or developing ecological networks at the national/federal level in every country. Explicit obligations can be found in only three countries (i.e. France, Germany, and Slovenia). It should be highlighted that clear quantified targets have been legally enshrined in only one case (i.e. Germany) by means of a ratio of the land surface to be covered in each federated state by the ecological network. This exception emphasises the difficulty in establishing pertinent indicators for assessing and monitoring the relevance of the efforts and choices made from an ecological perspective. In absence of obligations at the national/federal level (i.e. Austria, Italy, and Switzerland), significant variations may be observed between regions in terms of legal constraints regarding ecological connectivity/networks in spatial planning.

Degree of multilevel integration in planning ecological networks

This criterion tends to reflect both the overall degree of vertical integration in the planning system and the degree of homogeneity in terms of consideration for the issue at the various levels. Various kinds of provisions can be found in the different planning systems in order to ensure a certain degree of multilevel coherence. One country (i.e. Germany) has organised its planning system around a mutual feedback principle that entails carrying out planning in a mixed top-down and bottom-up way. This implies taking into consideration the planning orientations adopted at higher and lower levels. Other countries have introduced mechanisms intended to foster collaboration between different planning authorities and/or administrations: co-planning or reconciliation processes involving institutions at different levels in the decision-making, programme agreements enabling federal/national states to pursue a comprehensive policy by funding specific measures at lower levels, etc. (e.g. Italy, Slovenia, Switzerland). However, these different principles and mechanisms do not always ensure a proper multilevel integration in practice. Conversely, informal exchanges and assistances can be observed in some contexts, thus contributing to more vertical integration in the planning of ecological networks.

Degree of ecological knowledge considered for the production of ecological networks

The more frequent use of scientific methods in the production of ecological knowledge tends to reflect a certain academic and professional tradition in landscape ecology (i.e. Germany, Switzerland) or even a certain representation of the role of the central/federal state in supporting the overall implementation of ecological networks despite relatively limited planning responsibilities (i.e. Italy, Switzerland). It may also indicate, in some cases, the voluntarism of federated states or regions in developing specific skills or in taking advantage of local competences in the field. Model-based methods are more frequently used at the national level and sometimes at the regional levels to produce reference maps and identify threats or opportunities in terms of ecological connectivity. On the other hand, some countries have deliberately adopted approaches that largely rely on the expertise and contribution of various partners, such as protected areas' staff, nature conservation organisations, hunting/fishing federations, etc. (e.g. France, Austria). It must be noted that these approaches are not necessarily exclusive.

Comparative criteria	Clarifications
Historical consideration for ecological connectivity and ecological networks in spatial planning	Countries of the Alpine Convention Area were not, strictly speaking, pioneers in addressing ecological connectivity through spatial planning in the European context. Their attention to the issue largely arose simultaneously with or in the wake of initiatives launched and texts adopted at the European level, such as EEcoNET (European Ecological Network, 1991 & 1993), the Habitats Directive (1992), the PEBLDS (Pan-European Biological and Landscape Diversity Strategy, 1995) and the European Community Biodiversity Strategy (1998). The increase in consideration for ecological connectivity/networks in the different national contexts can be pinpointed in time on the basis of the following elements: the date from which ecological connectivity/network was enshrined in strategic documents (biodiversity strategies, landscape strategies, etc.); the date from which ecological connectivity/network was enshrined in legally binding norms.
Degree of legal obligation to address ecological connectivity and/or to develop ecological networks in spatial planning	The obligation to address the issue of ecological connectivity in spatial plans can be introduced in the legislation, at the federal/national and/or state/regional levels, in different ways. There frequently exists a direct requirement to address the issue of ecological connectivity and to develop an ecological network in spatial/urban plans. In addition, some laws provide an obligation to consider binding schemes/plans or orientations in the planning process, thus leading practitioners to comply with guidelines specifically aimed at protecting/restoring ecological connectivity. In some contexts, targets – for example in terms of minimum area to be dedicated to ecological connectivity – can be introduced into the legislation. It has to be noted that a strict legal obligation to address ecological connectivity in spatial planning does not necessarily imply an ambitious/careful consideration of the issue in the practice and consequently in the documents. There generally exists a relatively broad margin of discretion in the way planning authorities are allowed to consider an issue, especially when there are no clear performance obligations.
Degree of multilevel integration in planning ecological networks	The ecological network concept should ideally be addressed on a multi-scalar and even a trans-scalar basis, given the cross-border nature of ecological mechanisms and the variety of ecological functions potentially fulfilled by a same area at different spatial scales (Poiani et al, 2000; Huber et al., 2010). Competences in environmental planning and spatial planning are generally distributed between different management and/or administrative levels. Two obstacles may thus hamper the planning and development of a consistent ecological network. A very decentralised/federal organisation may engender a lack of coherence at upper scales. A very nationally/regionally centralised organisation may involve an insufficient/unrefined implementation at lower levels as well as deficits in terms of feedbacks. A multilevel governance should therefore be favoured. Such interconnectedness between different law-making and/or planning levels can be pursued by means of formal dispositions (e.g. legal duty to consider higher/lower norms) and informal dispositions (e.g. collaborative methods and information sharing).
Degree of ecological knowledge considered in the preparation of ecological networks	The interest in ecological networks initially relies on a scientific basis and particularly, on developments achieved over the last decades in the fields of island biogeography and metapopulations; although some researchers in ecology expressed concerns regarding the use of this concept in spatial planning practices (Boitani et al., 2007; Battisti, 2013; Gippoliti and Battisti, 2017). The ways of designing ecological networks to be considered in spatial plans/schemes vary considerably with the context. While some authorities opted for a relatively scientific approach, others prioritised a more participative way of designing ecological networks. On the one hand, a stronger scientific involvement may contribute to a more accurate identification of the existing challenges in terms of ecological connectivity and make the adopted ecological network harder to challenge before the courts in some respects. On the other hand, a participative approach may contribute to a more rapid diffusion of the ecological network concept and a better understanding of the process by stakeholders and populations. These approaches are not necessarily mutually exclusive. However, scientific methods are more frequently considered at the national and regional levels (colour attribution here made on the basis of these two spatial levels), and participative methods tend to be open to a broader range of stakeholders at supra-local and local levels. The degree of scientificity considered in the processes can be assessed on the basis of the following elements: nature of the promoted concept (scientific definition versus pragmatic definition); interest for ecological functionality (focus on indicators, tools, data, etc.) versus time/money-saving methods (focus on pre-established inventories and area listings, landscape analysis by means of photo-interpretation); quality of the stakeholders/institutions involved in the designing process (universities, research institutes, environmental engineering offices with recognised competences in ecology/biology, etc.). The degree of participation considered in the processes can be assessed on the basis of obligations or measures for involving specific stakeholders (in the production/collection of ecological data, in the designing of ecological networks, in the planning decision-making, etc.).

Fig. 08: Clarifications regarding the criteria used for the comparative overview made at the Alpine scale

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3 Consideration for Ecological Connectivity in Spatial Planning Practices

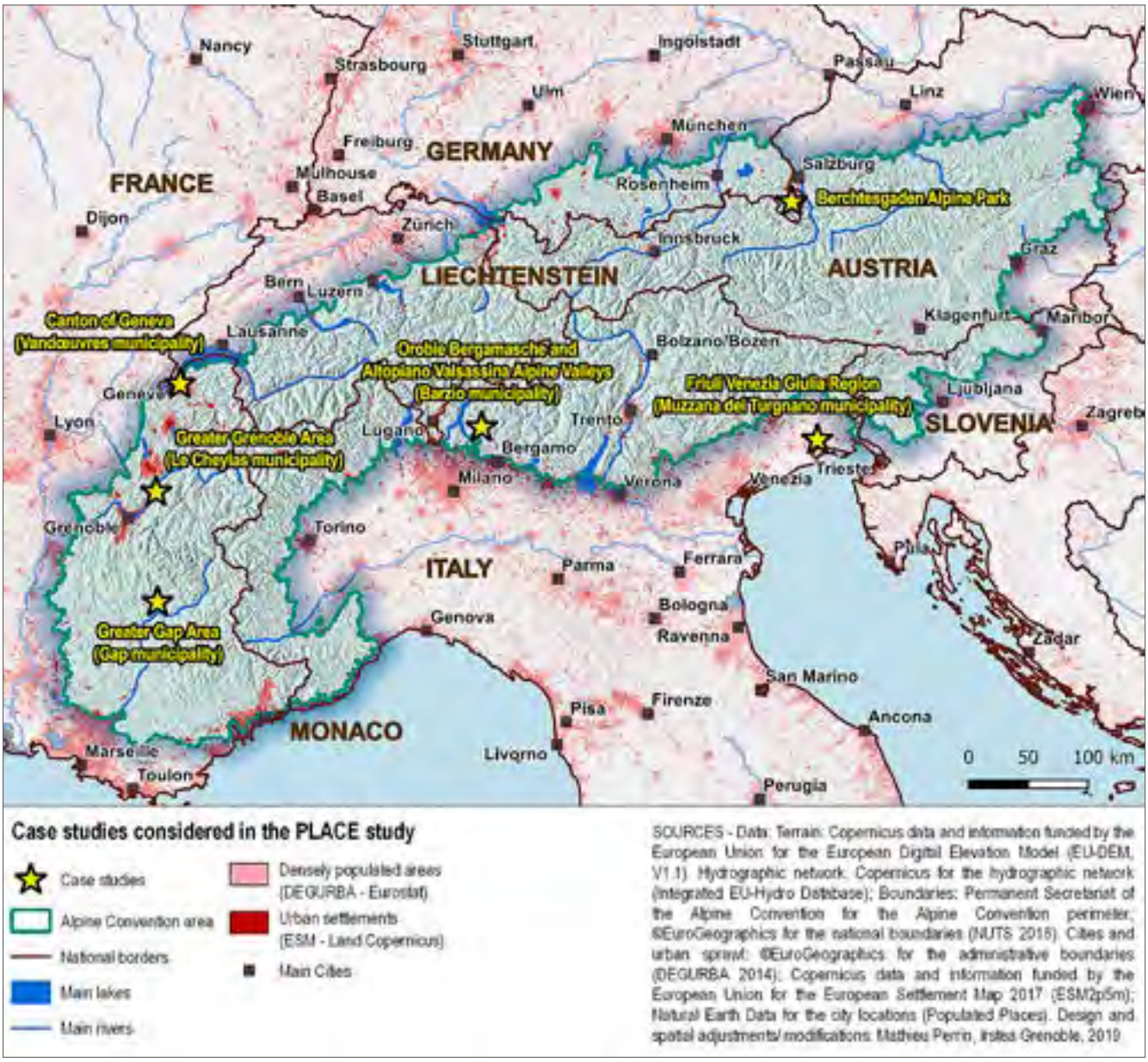
Introduction

The planning activity results both from legal and administrative fundamentals as well as informal institutions, ways and means. In other words, a same spatial planning system can lead to a wide variety of practices on the ground. This is all the more the case when professionals and stakeholders involved in planning enjoy a large flexibility. Processes are differently run. Concepts are unevenly understood. Instruments are diversely operated. In addition, a certain innovation and learning potential can be observed on the ground, contributing to the development/importation of new ways of proceedings. Local authorities and communities may also decide to deliberately deal, in planning processes, with issues for which there is no legal obligation or established framework.

Attention must therefore be paid in this part to the consideration given to ecological connectivity in the very planning processes and documents by means of a case study analysis. The latter was carried out on 6 different case-studies located in or around the Alpine Convention area. These were selected on the basis of location (geographical situation and spatial dynamics), planning (a quite recent planning activity) and ecological criteria (challenges and threats regarding ecological connectivity). The case studies are not intended to be representative of the whole diversity or even necessarily exemplary of the Alpine region. The selection aims more at giving a first glimpse at the diverse approaches and methods, as well as the common and distinct challenges faced in practice.

The way spatial planning addresses ecological connectivity differs from country to country and even from case to case. However, this issue is commonly addressed through a multistep, multiscale and sometimes incremental process. In order to give a more comprehensive picture, the case studies include a regional planning level (district, province, specific planning area, etc.) and a local planning level (usually the municipality) when both are relevant in the planning context.

In each case study, spatial/urban planning documents were collected and analysed. In addition, semi-directive interviews were conducted with planners (in city planning offices, private consulting firms, etc.), ecological experts (environmentalists, landscape planners, etc.) and elected representatives (mayors, deputy mayors, etc.) directly involved in the spatial planning processes. The questions focused mainly on the general attention given to the issue of biodiversity and ecological connectivity, the available knowledge and expertise regarding biological and ecological issues, the process of designing ecological networks/corridors, the concrete implications of the choices made in terms of ecological connectivity for the whole spatial project, and the public reception among local communities and stakeholders.



Case study regional planning area	**Focus** local planning area	**Country**
The Canton of Geneva *(Canton de Genève)*	Vandœuvres municipality *(Commune de Vandœuvres)*	CH
The Friuli Venezia Giulia Region *(Regione Autonoma Friuli Venezia Giulia)*	Muzzana del Turgnano municipality *(Comune di Muzzana del Turgnano)*	IT
The Greater Gap Area *(Aire Gapençaise)*	Gap municipality *(Ville de Gap)*	FR
The Greater Grenoble Area *(Grande Région Grenobloise)*	Le Cheylas municipality *(Commune du Cheylas)*	FR
Orobie Bergamasche and Altopiano Valsassina - Alpine Valleys *(Orobie Bergamasche e Altopiano Valsassina - Valli Alpine)*	Barzio municipality *(Comuni di Barzio)*	IT
The Berchtesgaden Alpine Park *(Alpenpark Berchtesgaden)*	–	DE

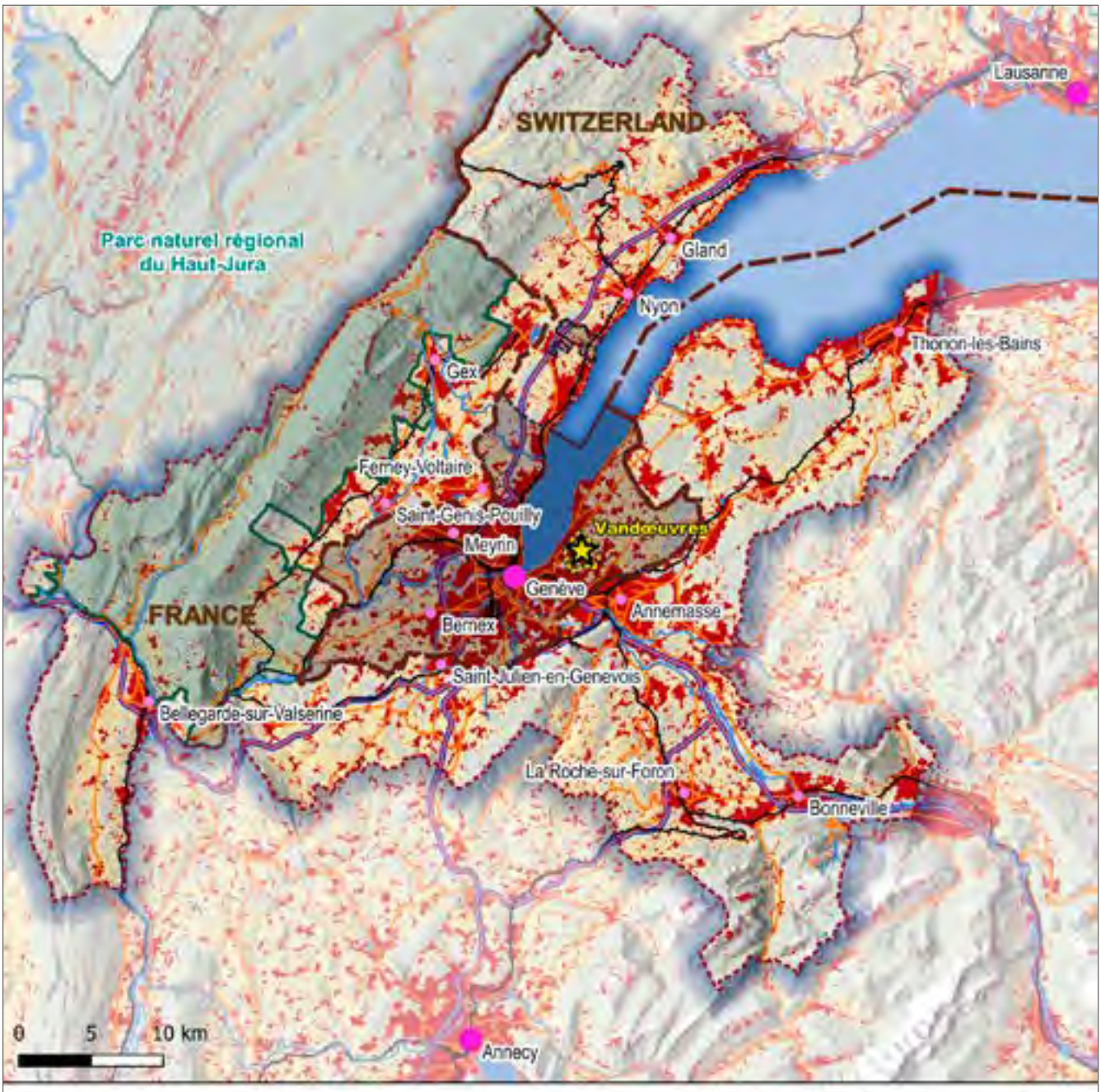
3.1. The Canton of Geneva and Vandœuvres municipality

Geographical context and spatial dynamics

The Canton of Geneva is located on the shores of Lake Geneva, in the far southwestern corner of Switzerland, close to the French border **(see map 01)**. The city of Geneva, the cantonal capital, is located at an altitude of 375 meters and is in a natural basin situated between the Alps and Jura mountains **(see photo 01)**. Geneva is the second most populated urban agglomeration in Switzerland, with more than 830 000 inhabitants and a density of over 500 inhab./km^2 in 2013 (Observatoire Statistique Transfrontalier, 2016). However, only two-thirds of the inhabitants live in the Swiss part, either in the Canton of Geneva or in the Canton of Vaud, with the remaining third residing in the French part. The population density is higher in the Canton of Geneva with about 495 000 people living in an area of 282 km^2, that is to say 1 753 inhab./km^2 (2017). On the other hand, during that same year, 83% of the 438 000 jobs accounted for in the urban agglomeration were located in the Swiss part. Not surprisingly, more than 80% of these jobs belong to the tertiary sector (Observatoire Statistique Transfrontalier, 2016). This unbalanced spatial distribution of housing and jobs results in a lot of commuting between Switzerland and France. From a larger-scale perspective, Geneva is a structuring part of this growing urban corridor - known as the *Sillon Alpin* - that stretches over nearly 250 km from Geneva to Valence. It must also be noted that the Geneva area is perceived in Switzerland as having a unique context, especially because of its very urban character when compared to other Helvetian cantons and its integration into international institutional and business networks. It was not until after 1945 that Geneva experienced this rapid urban growth and gained world influence.

Vandœuvres municipality is located relatively close to the city of Geneva and to the French border, in the eastern part of the Canton of Geneva. However, the area is quite sparsely built. The municipality has been classified within the 5th development zone, dedicated to the construction of villas and the installation of agricultural exploitations (although various open-air activities may also be found in these areas) according to a concentric zoning system established in 1929. As a result of this and other policies, almost 40% of the overall area was still dedicated to agricultural activities in the first decade of the 21th century. In addition, the population density appears to be relatively limited, taking into account the quite central localisation of the municipality in the Geneva urban agglomeration, with about 2 500 inhabitants living in a 4.41 km^2 wide area and consequently about 570 inhab./km^2 (Office Fédéral de la Statistique, 2017). Vandœuvres is also known to be a wealthy municipality, with one of the highest average net income per capita in the canton and in the country.

Photo 01: Geneva, on the shores of Lake Geneva, with the Prealps mountains in the background. Photo credit: © Schnäggli (Wikimedia Commons)



Greater Geneva area and Vandœuvres municipality

Administrative/Planning areas
- Greater Geneva area (Projet d'Agglomération)
- Canton Of Geneva (Plan Directeur Cantonal)
- Vandœuvres municipality (Plan Directeur Communal)
- Main nature parks and protected areas
- National borders

Land covers
- Urban areas
- Agricultural areas
- Forests and semi-natural areas

Cities and towns
- Main cities
- Secondary cities/towns

Transport infrastructures
- Motorways
- Secondary roads
- Railways

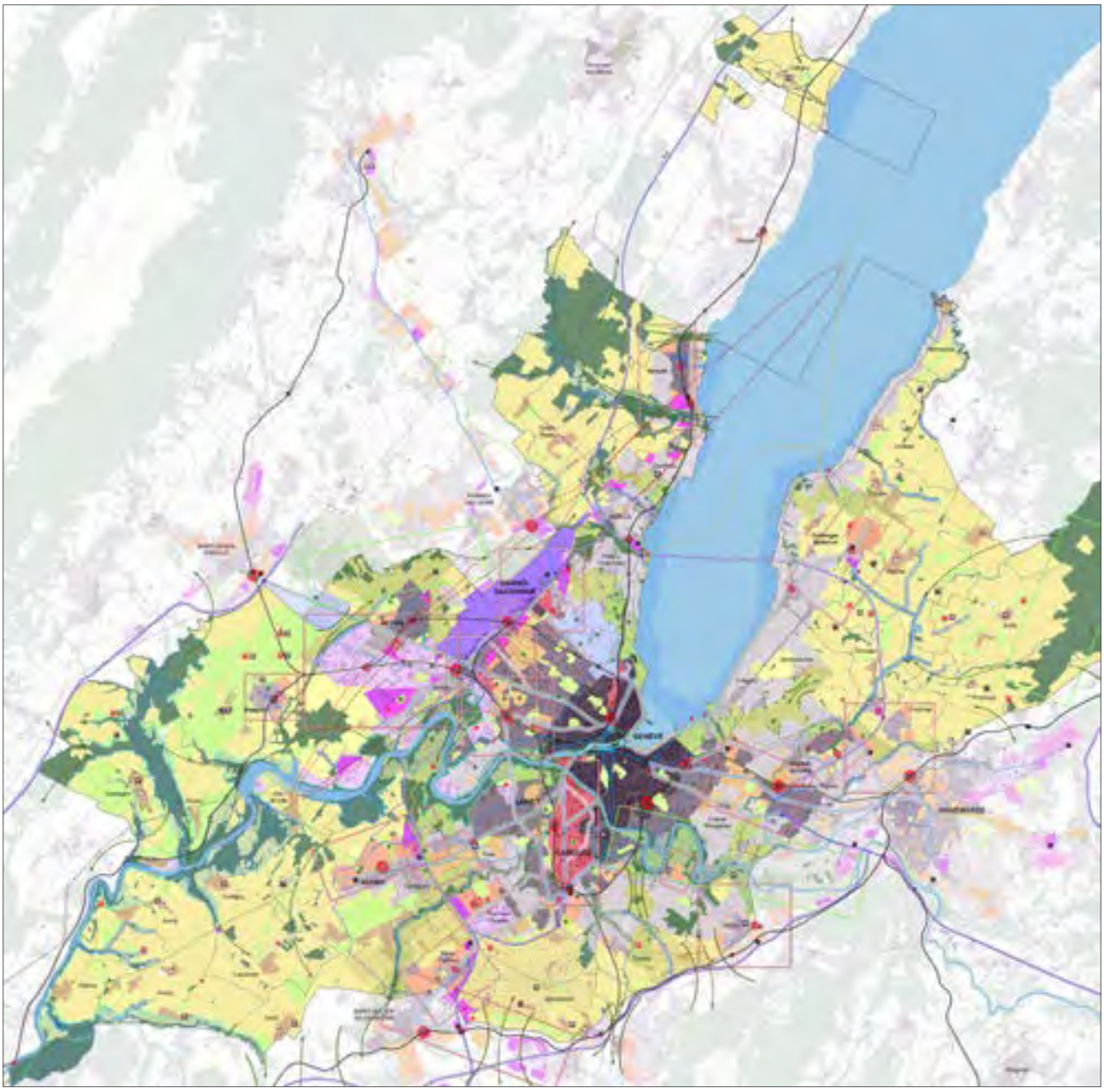
Hydrographic network
- Main lakes
- Main rivers

SOURCES - Data: Terrain: Copernicus data and information funded by the European Union for the European Digital Elevation Model (EU-DEM, V1.1); Copernicus data and information funded by the European Union for the land cover (Corine Land Cover, V2018). Hydrographic network: OpenStreetMap.org and MapCruzin.com for the hydrographic network. Transport networks: OpenStreetMap.org and MapCruzin.com for the road and railways networks. Boundaries: ©EuroGeographics for the national boundaries (NUTS 2016); GeoBasis-DE/BKG 2019, Opendata.swiss/BfS, Istat, IGN for the subnational administrative boundaries; European Environment Agency - European Environment Information and Observation Network for the protected areas (CDDA, V17, 2019). Cities and urban sprawl: Copernicus data and information funded by the European Union for the European Settlement Map 2017 (ESM2p5m). Design and spatial adjustments/ modifications: Mathieu Perrin, Instea Grenoble, 2019.

Map 01: The Canton of Geneva (dark-shaded area) is the heart of the Greater Geneva Area that sits astride to the Swiss-French border and between Lake Geneva (northeast), the French Alps (southeast) and the Jura mountains (northwest). Vandœuvres municipality is located 5 km away from the city of Geneva.

Planning context, areas and documents

The Genevan context can be seen as being particular in Switzerland since municipal authorities have no spatial planning powers of their own there. Consequently, the cantonal authority of Geneva has extensive powers in the field compared to what is generally seen in the country. The State of Geneva is responsible for the development of a Cantonal Structure Plan (*Plan Directeur Cantonal - PDCn*), which is legally binding for the cantonal and 45 municipal authorities. The 2030 *PDCn* was developed by the Cantonal Planning Office and adopted by the Parliament (*Grand Conseil de la République et Canton de Genève*) in 2013 and then approved, with some reservations, by the Swiss Federal Council in 2015 **(see map 02)**. The document is currently being updated particularly with the objective to obtain the withdrawal of the reservations previously expressed by the Swiss Federal Council.



Map 02: Synthetic map (detail) included in the 2013 Cantonal Structure Plan (*PDCn*) developed by the State of Geneva. It specifies the land uses authorised, and in particular, the areas dedicated to urban densification, renewal, and extension *(respectively represented in dark/light grey, red and orange*) as well as the agricultural, winegrowing and forested areas (*respectively represented in yellow, light green and dark green*). The map also points out, among other aspects, the main projects (*red boxes*), the greenways and landscape/parks projects (*green hatched parts and light green boxes*) as well as the biological corridors (*thin green arrows, between green curves when threats are identified*) and finished/current watercourse-rewilding projects (blue hatched parts).

In order to face the challenges associated with the cross-border spatial dynamics, and in particular, to meet transport infrastructure needs between the Swiss and the French parts, an additional planning level has been developed at the city-region scale. The Greater Geneva Area (*Grand Genève*) is a result of 45 years of dialogue between the Swiss and French governing bodies. This collaborative initiative has especially gained more impetus in 2001 with the adoption of the Swiss Confederation's Metropolitan Policy (*Agglomerationspolitik / Politique des Agglomérations*). This legal provision qualifies the Greater Geneva Area for targeted funding under certain conditions, such as the development of cross-border transport infrastructures. In 2007, a first spatial scheme was adopted for this city-region. A second one was approved in 2012 and a third one in 2016, in accordance with the pace set by the allocation of funds under the Swiss Confederation's Metropolitan Policy. On the French side, the Greater Geneva project has been supported by national funding and region Rhône-Alpes contractual policy for territorial and agricultural development. The Greater Geneva Area is home to more than 1 million people. With a surface area of about 2 000 km^2, it currently covers 209 municipalities that belong to the two Swiss Cantons of Geneva and Vaud as well as to the two French Ain and Haute-Savoie Departments. This large planning area can be seen as a soft space, acting as a shared but not compulsory reference for planners at supramunicipal and municipal levels. In other words, the Greater Geneva Spatial Scheme is supposed to guide the planning orientations at the lower levels and to strengthen the overall and cross-border spatial coherence.

Despite their lack of planning power and the usual absence of internal planning skills, the municipal authorities within the Canton of Geneva have to develop a Municipal Structure Plan (*Plan Directeur Communal - PDCom*). Vandœuvres approved its in-force *PDCom* in 2007. However, this document will expire soon. Consequently, a new version is under development. The municipality has commissioned an urban planning consultancy firm named Urbaplan to prepare this new Structure Plan. It will have to consider the spatial guidelines and prescriptions established in the last version of the *PDCn*, particularly in terms of urban densification.

Background and challenges regarding biodiversity and ecological connectivity

The particular geographical location of the Canton of Geneva undoubtedly calls for addressing the issue of ecological connectivity through a larger-scale vision. In this respect, the Greater Geneva Area is a very strategic place because of its localisation between the Alps and Jura mountains. However, the area is nowadays under pressure due to the galloping urban dynamics. A specific provision in the Swiss legislation has made it possible to secure a certain proportion of agricultural land in the Canton of Geneva. However, it tends to induce a spillover effect with increased urban sprawl in the more distant outskirts, especially on the French side. At the same time, most wildlife corridors cross the Swiss-French border to connect lowland areas with the surrounding mountain ranges. The issue of ecological connectivity thus requires cross-border coordination to ensure wildlife moves at intermediary and large scales.

The Greater Geneva Area provides the whole region with a shared vision that addresses the issue of ecological connectivity among others. A landscape project considering the landscape connections and eventually the ecological infrastructure was developed in this context. It has had a positive effect on the reception and the rating of the 2007 and 2012 metropolitan projects by the Swiss Confederation, and has consequently determined the granting of subsequent co-funding. In addition, it must be noted that the Greater Geneva Area largely contributed to the diffusion of the Corridor Contract (*Contrat Corridor*) measure on the Swiss side, which was originally established by the French Rhone-Alpes region. This instrument is an operational programme that combines actions carried out by public authorities, organisations and private partners, with the aim of protecting or restoring habitats and ecological connections as well as raising awareness about the threats for biodiversity among the population. The package of measures is co-funded by territorial authorities (e.g. cantons, regions, departments), sector-based bodies (e.g. water agency) and the project leaders (e.g. supramunicipal bodies, organisations, syndicates). In the Greater Geneva Area, preliminary studies were conducted between 2009 and 2010 in order to set up Corridor Contracts on eight priority areas. This task has contributed to enrich the already quite substantial ecological knowledge over the region. Additionally, various mapping efforts had previously been made, as seen through the maps of the corridors for large fauna in the Geneva basin and of a Genevan ecological network, respectively made public by the

Cantonal Administration of Geneva in 2003 and 2004." The Canton of Geneva is known in Switzerland to be one of the most monitored, thus providing much data to environmental and planning practitioners. However, reflections are underway to give them more accurate and refreshed information through time (see comment 01).

By definition, [t]he Cantonal Structure Plan provides a picture [of ecological connectivity] at a given time and on a larger scale. This overview should ideally be complemented operationally by a dynamic and interactive tool, such as a geographical information system where we could directly access online the updated map, which considers the ecological network evolutions, new urban developments, new species data, etc. Technology can really help us to get in touch with reality and avoid working with still images."

Com. 01: Aline Blaser, Head of the Ecological Corridors Programme at the Office de l'Agriculture et de la Nature du Département du Territoire du Canton de Genève (Office of Agriculture and Nature of the Genevan Department of the Territory), involved in the development of the *PDCn* of Geneva, 2018.

Despite being located in the near vicinity of the city of Geneva, Vandœuvres municipality still comprises a large amount of unbuilt land. The place is also known for the landscape and biological value of its oak grove that can be found between and within the low-density residential areas (see comment 02). However, the municipal authority fears a rapid urban densification resulting from a recent modification in the cantonal legislation that allows for the derogatory construction of real estate complexes in lands traditionally devoted in the zoning plan to the development of villas. The Vandœuvres municipality expresses concerns about loss of landscape quality, negative impacts on the local environment, and more indirectly deteriorations in the quality of life. Due to its strategic location for ecological connectivity, the Vandœuvres municipality is directly concerned by one of the corridors identified in the Greater Geneva Area and to be protected/restored by means of a Corridor Contract. This one was signed at the end of 2012. Two measures explicitly commit the authorities concerned to specify in the *PDCom* of Vandœuvres and in the *PDCn* of the Canton of Geneva an interstitial area made of agricultural lands to be kept free from development, as well as an interstitial greenery area to be kept permeable to fauna and flora.

"In order to support the choices from an ecological perspective and to highlight, for example, the importance of the oak grove, we can argue that it is one of the areas where we find the highest densities of common redstarts (small passerine birds) in the Canton of Geneva, and even in Switzerland [...] In some places, we have 20 or 30 couples per square kilometer. These are very significant densities. Common redstarts are a species that can be found on the red list or priority species in Switzerland. So, there are endangered species, known to be of importance, on site."

Com. 02: Christian Meisser, Environmentalist and Director of Viridis Environnement, involved in the development of the *PDCom* of Vandœuvres, 2018.

Considerations for ecological connectivity in the planning processes and documents

Since the first half of the 20th century, radial greenways have been repeatedly considered as a means to shape the city and guide urban development in the successive plans approved for the Canton of Geneva. Not surprisingly, greenways can be found in the spatial planning strategy of the *2013 PDCn*, with the aim of connecting from a landscape perspective the central districts with the countryside. However, the ecological value of such areas, notably in terms of connectivity for fauna and flora, has not always been as well recognised in the past. The *2013 PDCn* includes an operational roadmap, with one of the sheets being dedicated to the preservation and restoration of the biological continuum. It specifies the implementation measures (mapping of obstacles to wildlife movements, fulfilment of objectives established at the metropolitan level, support to agro-environmental measures, adoption of planning decisions, fund and build wildlife crossing structures, etc.) and the planning mandates for cantonal and municipal authorities (contribution to the development of a cross-border network of natural areas, transposition of the ecological continuum in municipal structure plans, development of a municipal policy for protecting/restoring the ecological continuum, etc.) (see comment 03). In addition, a map of biological corridors is attached to this

2013 PDCn **(see map 03)**. However, the various provisions aimed at protecting/strengthening ecological connectivity in the document do not constitute a highly restrictive source of bindingness for planners at the municipal level **(see comment 04)**.

"The basis is the 2013 PDCn, with the delineation of this greenway. We can see that a wildlife corridor under threat is specified in Vandœuvres and its surroundings [...] In 2015, the Canton carried out a general study on these greenways. It sets out a framework, with principles or priorities for each type of greenways. I partly based my work on this material at the beginning to then go into a little more detail [and map the key-components from a biological and ecological perspective.]"

Com. 03: Gaël Maridat, Environmentalist at Viridis Environnement, involved in the development of the *PDCom* of Vandœuvres, 2018.

"The zoning plan specifies what can and can't be done there. You are allowed for launching new developments in areas classified as buildable in the zoning plan. [...] Greenways do not have the same status. These are delineated in the 2013 PDCn, but they do not have the same legally binding force, I would say. The legal protection attached to greenways is not comparable to what the zoning plan offers. It is a kind of grey area. For sure, greenways are recognised and specified in the 2013 PDCn. However, if some buildable areas are located in the greenway, we will probably have to do the best we can to keep as much as possible the qualities of the greenway. In other words, it does not mean that we are in position to say: "sorry, you can't build.""

Com. 04: Christian Meisser, Environmentalist and Director of Viridis Environnement, involved in the development of the *PDCom* of Vandœuvres, 2018.

Map 03: map included in the 2013 Cantonal Structure Plan developed by the State of Geneva and specifying the landscape continuums (green and yellow parts), the reservoirs of biodiversity (hatched parts), the biological corridors (thin black arrows, between black curves when threats are identified), the local pressures on connectivity (red points), as well as the corridor contracts (green curved and dotted lines).

As previously mentioned, the Vandœuvres municipal authority fears a rapid urban densification of its lands covered by villas and large estates as a consequence of a recent modification in the cantonal legislation. In this context, the *PDCom* under development is expected to include a kind of rationale aimed at advocating the views of the municipal administration and at strengthening its potential to oppose development projects **(see comment 05)**. The document seeks to stress the importance of these large estates in terms of biological connectivity and soft mobility as well as their complementarity with the neighbouring agricultural areas **(see map 04 and comment 06)**. *Viridis Environnement*, an environmental consulting firm, was in charge of carrying out the environmental assessment in the planning process. This input contributed to the delineation at the local scale of the local greenways as well as the corridors.

"According to their criteria, the different cantonal departments state whether they will or not take into account the Municipal Structure Plan for this or that reason. Afterwards, we are free to introduce changes. It is a kind of concertation. They can also state that our proposal is good and therefore decide to change their criteria concerning our municipality [...] In the negotiation phase with the Canton, we did not come by saying "we will not build here, we will build there..." We had the Canton admit that our municipality has a particular character and that it was not just a matter of zoning. There are large estates we want to protect, specific parcels in the wildlife corridor we also want to protect, groves and forests too. That's it. It is a more comprehensive vision of the municipality. It isn't just about zoning."

Com. 05: Hervé Despland, Deputy Mayor of Vandœuvres in charge of environment, landscape and energy, involved in the development of the *PDCom* of Vandœuvres, 2018.

"In 2013, there was a legal change that allows for higher densities in the areas historically dedicated in the zoning plan to villas. It is nevertheless a derogating provision. Indeed, the law specifies that [ignoring the building density regulations laid down in the zoning plan is authorised only] where circumstances warrant and on condition of compatibility with the neighbourhood character, harmony and layout. It is all very vague. Municipalities have been mandated by the Canton, within the context of the establishment of the 2013 PDCn, to set the guidelines for the development of these areas historically dedicated in the zoning plan to villas and rural activities. With the PDCom, we have sought to specify - and the Vandœuvres municipality was the first to do it with such level of accuracy - what are the conditions for the granting of derogations by the cantonal administration. In these conditions, heritage and ecological issues have been integrated in a predominant way, I would say, with the following idea in mind: if the municipality wants to limit the building density, [the strategy] has to advocate for the public interest. And what is in the public interest? This is all the work we've done with the municipality, with the aim of having criteria that are not arbitrary."

Com. 06: Marcos Weil, Spatial and Landscape Planner, Associate Director of Urbaplan, involved in the development of the *PDCom* of Vandœuvres, 2018.

Map 04: synthetic map (detail) annexed to the under-development PDCom of Vandœuvres. It presents the municipal strategy advocated for the 5th development zone (also known as the villa zone), with a specification of lands to be kept free from development as well as the interstitial greenery areas to be kept permeable to fauna and flora.

3.2. The Friuli Venezia Giulia Region & Muzzana del Turgnano

Geographical context and spatial dynamics

Located in northeastern Italy, the Friuli Venezia Giulia Region is an autonomous region with special statute. It borders Austria to the north and Slovenia to the east; to the south, it faces the Adriatic Sea and the western border is in the Veneto Region. The total regional territory is subdivided into a 42.5% mountainous Alpine terrain in the north, 19.3% is hilly (mostly to the southeast) and the remaining 38.2% comprises the central and coastal plain **(see map 01)**. The regional population is about 1 200 000 inhabitants (2017): 59.3% of them live in the plain areas, 35.5% in the hilly areas and only 5.2% live in the mountain areas. The region has a density of respectively 241 inhab./km^2 in the plain areas, 284.8 inhab./km^2 in the hilly areas and 18.9 inhab./km^2 in the mountain areas (FVG, 2017. Friuli Venezia Giulia in cifre).

The regional territorial structure results from a concentric organisation around the main urban areas (Trieste, Udine, Pordenone and Monfalcone), and a network of small towns structured along road and railway infrastructure or close to the watercourse system. In flat and hilly contexts, the presence of widespread but fragmented agricultural areas as well as the absence of large industrial districts, has contributed to create a territorial and landscape homogeneity and to reduce the dichotomies between city-countryside and agriculture-industry, well known in other Italian territories. Conversely, the mountain area is characterised by a wide variety of landscapes and habitats.

The Muzzana del Turgnano municipality is located in the Bassa Friulana plain, between the Tagliamento and Isonzo rivers in the southern part of the Region. The municipality has a population of about 2 527 inhabitants (2017) and an area of 24.29 km^2. The main town, Muzzana del Turgnano, is along the National road 14 "della Venezia Giulia", that link Venezia to the Italian-Slovenian border. The territory is characterised by a flat (maxim altitude 6m above sea level) and fragmented agricultural area (especially cropping) with two protected ancient lowland forests of ecological interest (*Boschi di Muzzana*).

Planning context, areas and documents

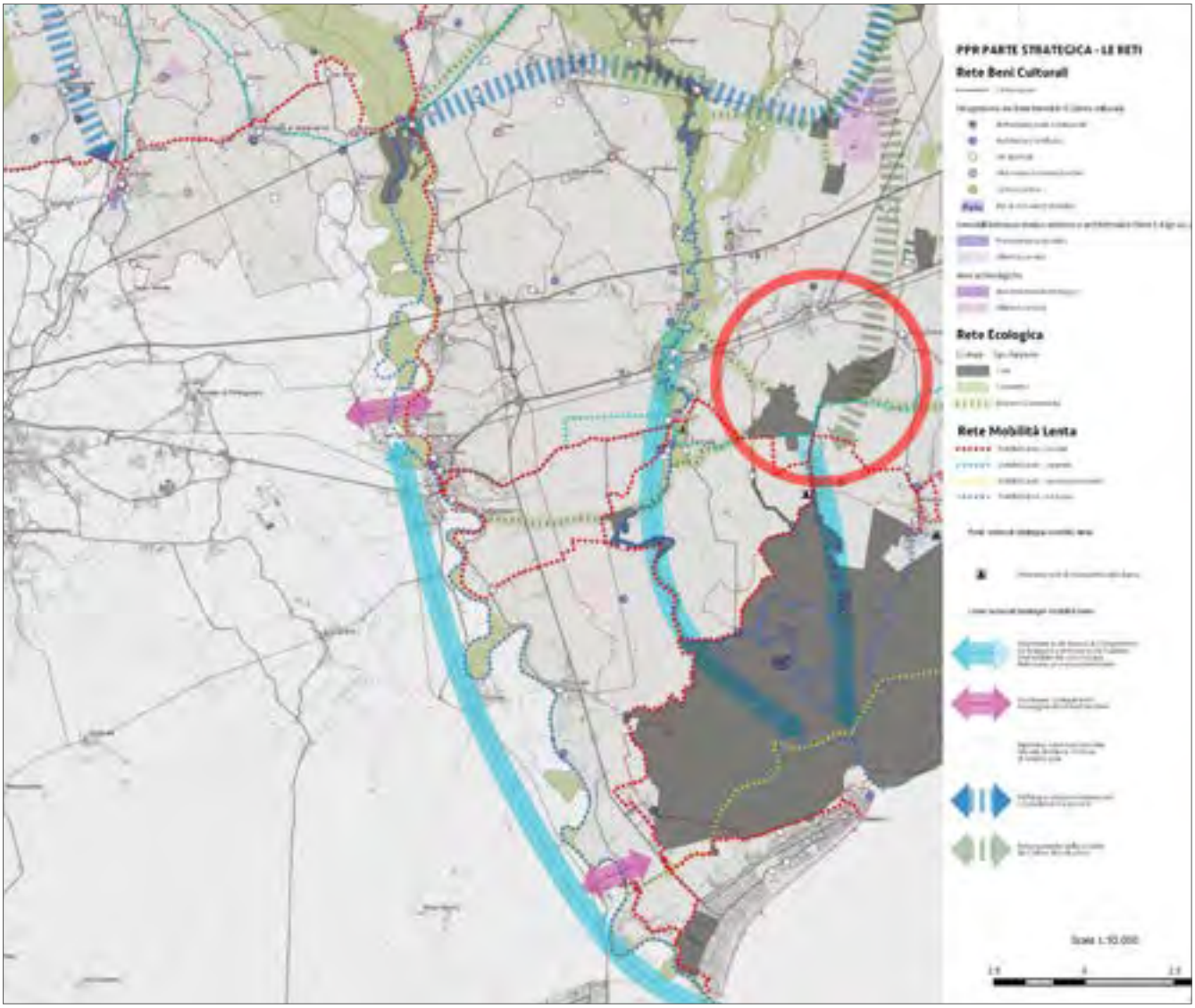
The Regional Territorial Spatial Plan and the Regional Landscape Plan (RLP), both in force, are the main planning references at the regional level. In both of them, the Regional Ecological Network (REN) is defined as one of the main strategic frameworks to organise and manage the territorial planning activities. The local level (municipalities) is underlined as strategic to implement the indications provided by the regional plans. In the RLP, particular attention has been given to the efficient applicability and the easy transposition of regional rules into territorial and urban planning as well as to the concrete inputs that arise from the local stakeholders.

The RLP is based on the principles of sustainable development, conscious land use, lower land consumption and preservation of landscape characteristics. The plan aims, therefore, at stopping and reversing the process of territorial fragmentation and homogenisation and thereby restoring the regional ecological connectivity, in application of the provisions of Habitat (92/43/EC) and Birds (2009/147/EC) Directives. The adopted approach has the objective, among others, of tackling simultaneously the loss of biodiversity and ecosystem services.

Map 01: The Friuli Venezia Giulia Region is made of a large northern mountainous area, with highest peaks exceeding 2 700 m above sea level, and of a southern hilly and plain area. The latter hosts the vast majority of the population, settlements and activities.

The RLP planning process is based on a bottom-up approach, in order to avoid and manage administrative and social conflicts. It included an intense sharing and collaborative *informative and formative* process with local stakeholders. This effort has allowed for the collection of local information as needs, actions and expectations already available and useful for the preparation of the RLP planning document **(see map 02)** and its implementation in the municipal planning tools, as provided by the law in force. The consultation process, described above, has deeply characterized the formation of the RLP collection of local information and the municipal plan's contents and land uses as in the case of revised version n.10 of the municipality of Muzzana del Turgnano. All this data has supplied the process of defining the Regional Ecological Network (REN): it has been verified and validated by the scientific team and, in some cases, also integrated with information concerning others areas in order to guarantee the ecological coherence of the network from the regional level to the local scale.

The RLP is organised into two main parts, namely a statutory one and a strategic one. While the former contains the legally required material, the latter defines a system of three networks (ecological, cultural heritage and soft mobility) in combination with a system of landscape areas (coastal and lagoon, mountainous, and rural areas). This approach allows ensuring the spatial continuity of the functional systems. Furthermore, management tools aimed at



Map 02: Landscape Plan of Friuli Venezia Giulia region (detail) - *The Strategic framework: the system of networks*. The map gathers the information relevant to the 3 networks: cultural heritage network (*Rete dei beni culturali*); ecological network (*Rete ecologica*); soft mobility network (*Rete della mobilità lenta*). The big arrows define different strategies for soft mobility. The red circle identifies the Muzzana del Turgnano territory.

implementing, monitoring and integrating the strategic guidelines can be found in a third part of the RLP. Particularly, tools such as river contracts, area treaty, integrated landscape projects and incentives measures are considered, thus involving different sectors and stakeholders in the process. Additional support has been given from landscapes requalification projects or pilot initiatives in relation to other actions foreseen by the Plan, including those in relation to the other networks or specific local activities.

Muzzana del Turgnano administration developed its Municipal Regulatory Plan (*Piano Regolatore Generale Comunale - PRGC*) in 2000 without any consideration for ecological connectivity/networks. From that, 11 revised versions have been approved in order to update the plan to regulatory advances, territorial needs and changes as well as to make it coherent with the contents of the above-ordinated plans. The version n.10 was prepared in 2015 **(see map 03)**, simultaneously with the start of the RLP consultation process, in particular to introduce new provisions aimed at safeguarding and enhancing the environmental specificities of the area. The indications contained in the version n.10 in terms of social and ecological needs have been considered in the drafting process of the three regional networks system **(see comment 01)**.

"The RLP acknowledges the local requests and information of the municipality of Muzzana acquired during the participatory process that accompanied the formation of the Plan."

Com. 01: **Paola Cigalotto**, urban planner involved in the preparation of the revised version n.10 of the Municipal Regulatory Plan of Muzzana del Turgano).

Map 03: Variante n.10 of Municipal Regulatory Plan of Muzzana del Turgnano. On dark green the core areas (the protected ancient lowland forests); on light yellow the areas with low connectivity (agricultural areas); the blue areas are areas for public activities.

Background and challenges regarding biodiversity and ecological connectivity

The RLP of Friuli Venezia Giulia deals with the territorial degradation process and the increasing impoverishment of biological and landscape diversity, observed in the region. The preservation of regional landscape characteristics is thus considered to be of strategic importance. The lower Friuli plain, in which the Muzzana del Turgnano municipality is located, is characterised by a widespread urbanisation and land consumption. In addition, intensive agricultural practices impoverish the landscapes and largely impact the areas of high natural value. Therefore, the main ecological challenges identified for this sector in the RLP are the high territorial fragmentation, the isolation of natural and semi-natural habitats as well as their proximity to fields of intensive agriculture, the lack of buffer strips around the ancient lowland forests and connecting corridors, and finally, the reduced surfaces and elongated conformation of plain and riparian woods. This last factor induces a lack of typical species in the concerned areas. It should be noticed that these problems are viewed in the RLP not only as threats to biodiversity but also to ecosystems, to their resilience and their capacity in supplying services.

The revised version n.10 of the Municipal Regulatory Plan of Muzzana del Turgnano has introduced new provisions that can be seen as a contribution to the ecological, slow mobility and cultural heritage networks that form the regional multifunctional system established in the RLP. In particular, specific attention has been given to relict ancient lowland forest habitats,

threatened by territorial development. These two woods **(see photo 01)**, although separated and surrounded by great extensions of agricultural crops, are what remain of the ancient forests (*selva lupanica*) that, according to the Roman age testimonies, covered the entire Po Valley. The version n.10 plans to consolidate these protected lowland wooded areas and to improve their use and accessibility, specifically by including them as an extension of the cycle network that connects different regional landscapes (source: SEA documentation of the revised version n.10 of the Municipal Regulatory Plan of Muzzana del Turgnano).

Photo 01: The territory of Muzzana del Turgnano municipality, characterized by a flat and fragmented agricultural area as well as two protected ancient lowland forests in the southern part.

Considerations for ecological connectivity in the planning processes and documents

Taking into account that the preservation of protected areas alone cannot achieve the conservation of biodiversity, the RLP places the construction and the maintenance of a large-scale ecological network as a priority strategy **(see comments 02 and 03)**. In the document, the ecological network is understood as an interconnected system of landscapes aimed at safeguarding biodiversity that takes form through regional (REN) and local (LEN) ecological networks.

The REN has been designed on the basis of a structural landscape analysis, a functional landscape analysis and project proposals. The structural analysis has contributed to identifying landscape components of ecological interest, mapping linear infrastructures with fragmentation effects, and highlighting the state of isolation of some natural and semi-natural areas. This task has been carried out on the basis of the Land-Use Database adapted to wildlife purposes and drawn up for the 2013 version of the Regional Wildlife and Hunting Plan, in association with information available in other databases (e.g. natural grasslands and forest typologies). The functional analysis has allowed for the identification of elementary spatial units, named ecotopes, with homogeneous functional characteristics: core areas; connectivity sections on hydrographic network; connectivity areas of agricultural nature, connectivity areas of forest nature, areas of discontinuous connectivity; low connectivity areas; barriers; and crossings (FVG, 2018: All.70-14). The assignation of connectivity functions has been realised on the basis of animal species of community interests and considered as the most suitable to represent and explain ecological connectivity. Finally, the project drafting has consisted in assigning each ecotope a specific direction (to be preserved, strengthened or restored - with a specific focus on their fringes by means of buffer zones - given their existing/potential contribution to ecological connectivity) and in highlighting areas of regional interest to be restored. In addition, the document identifies main connectivity paths, which can be seen as optimal landscape configurations responding to the minimum cost path criterion between two core areas and thus minimising the energy cost of dispersal for animal species **(see map 04)**.

A vademecum, containing guidelines and identification criteria (priority for nodes and corridors relevant to more species, historical presence, multifunctional landscapes, etc.), has been inserted in the RLP, thus providing local administrators and technicians with a methodology for identifying and designing local ecological networks (LEN).

In parallel with the preparation of the RLP, the Muzzana del Turgnano municipality has resolved to maintain and consolidate the two protected lowland wooded areas of high ecological value by adopting the version n.10 of its Municipal Regulatory Plan. This provides for a zoning change and the insertion of a new ecological connection between the two lowland forest areas and thus the constitution of an essential node for the establishment of a regional ecological network **(see map 05)**. This proposal (designed by E. Siardi) expressly feeds into the RLP and has been included and networked with the soft mobility system. The realisation of this ecological corridor is ongoing and achieved thanks to the regional funding provided for the Landscape Implementation Projects of RLP.

"The attention given to the issue of ecological connectivity is very high and the whole regional ecological network has been evaluated in the Landscape Regional Plan, in order to provide directives for implementing ecological connections. The problem of habitat fragmentation and consequent loss of biodiversity has never been challenged before in the regional planning process. For the first time, the RLP takes into consideration ecological connectivity not only inside or in proximity to protected areas, but at a regional scale behind administrative borders."

Com. 02: Chiara Bertolini, Director of the Office for Landscape and Biodiversity of the Friuli Venezia Giulia Region)

"In the past years, the problem has been hugely underestimated, considering biodiversity conservation a problem related only to the protection of wilderness areas and underestimating the fundamental traditional role of farmlands in ecological connectivity. Too often this topic is still considered of minor importance and subordinate to economic interests and employment expectations; generically, targets of conserving biodiversity and increasing ecological connectivity are well accepted only if they do not collide with development goals".

Com. 03: Giuliana Renzi, Ecology Expert at the Office for Landscape and Biodiversity of the Friuli Venezia Giulia Region

Map 04: The regional ecological network map (detail) from the Landscape Plan of Friuli Venezia Giulia region identifies main connectivity paths (*light green lines*); core areas (*grey areas*); connectivity sections on hydrographic network (*blue dotted areas*); connectivity areas of forest nature (red dotted areas); connectivity areas of agricultural nature (*light green areas*); and areas of discontinuous connectivity (*light yellow areas*). Regarding the buffer strips around core areas, three types can be distinguished in the map: strips to be confirmed (*blue contours*), strips to be strengthened (*yellow contours*) and strips to be realised (*red contours*). The red circle identifies the Muzzana del Turgnano municipality.

Map 05: Zoning change introduced by the revised version n.10 of Municipal Regulatory Plan of Muzzana del Turgnano (detail), with the insertion of a new zone of eco-biological connection (*labelled F2# and represented with cross-hatched yellow lines*) between the two ancient lowland forests, both already covered by zones of environmental protection (*labelled F2 and represented with cross-hatched yellow lines*). Additionally, the zone dedicated to the establishment of green areas, sport and leisure facilities (*labelled Sv and coloured in blue*) has been extended and subcategorised in order to ensure this connective function. Adjacent agricultural areas were already covered by zones of environmental protection (*labelled F4 and represented in green*).

3.3. The Greater Gap Area and Gap municipality

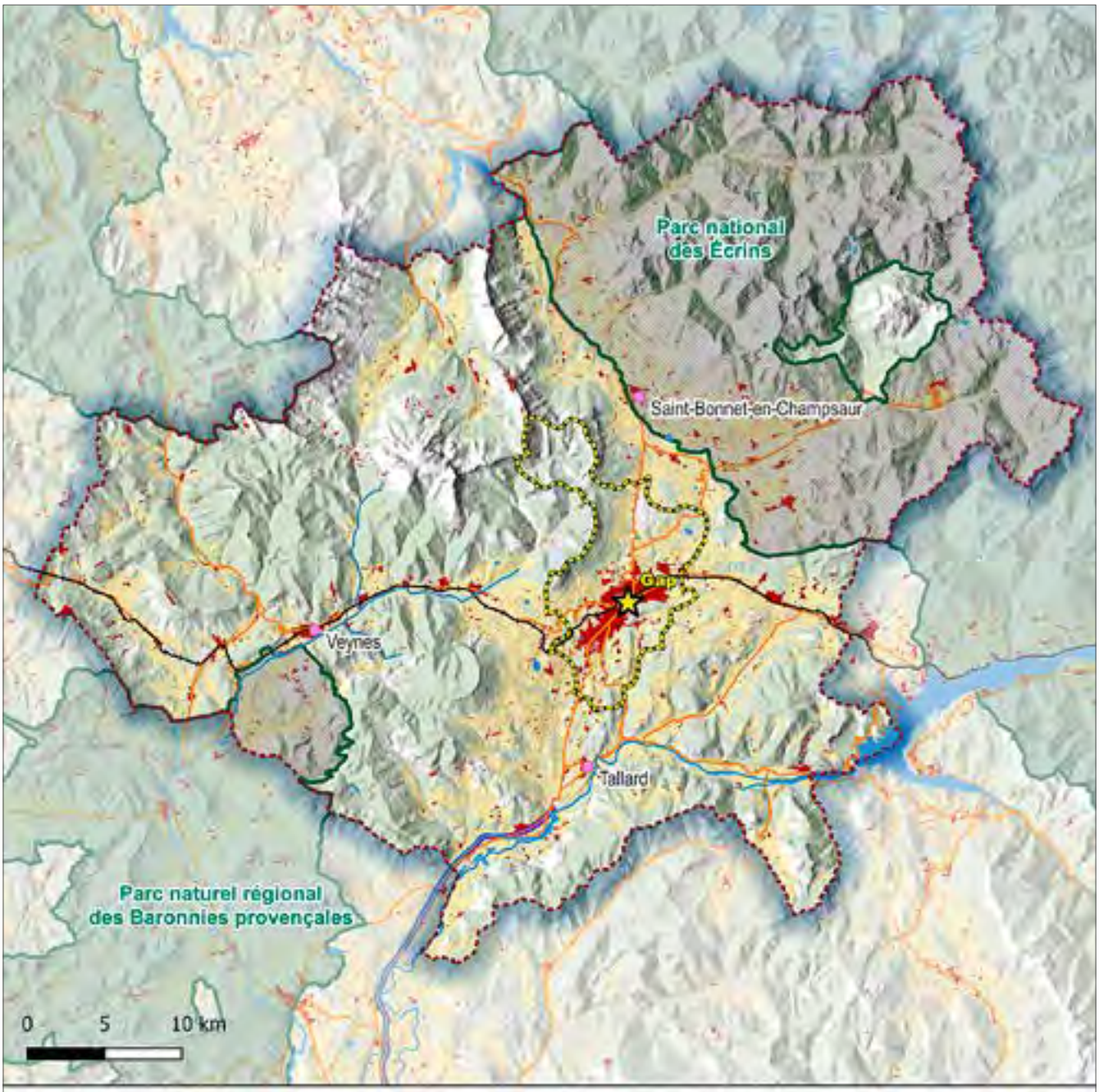
Geographical context and spatial dynamics

Located in the Southern French Alps, Gap is located at an altitude of 750 m in a relatively wide valley surrounded by mountains - named Ecrins, Dévoluy, Bochaine - culminating between 2 000 and 4 000 meters. The region is particularly rugged with a mean altitude of 1 450 m and a proportion of flat areas (average slope under 20%) inferior to 30% over the Greater Gap Area (ScoT de l'Aire Gapençaise, 2013: 40) **(see map 01 and photo 01)**. The city of Gap is crossed by the Luye River, which joins the Durance river about 10 kilometres downstream. Gap's population is about 40 800 inhabitants (2015) at the city level and about 63 500 inhabitants (2015) at the urban area level. The Gap municipality has an area of 110.4 km^2 (a very high figure when compared to the national standards) and the urban area covers 475.5 km^2, implying a density of 369 inhab./km^2 and 172 inhab./km^2 respectively.

The city of Gap has a strong importance in the spatial organisation of the Greater Gap Area. It must be noted that only three other municipalities have more than 2 000 inhabitants and that two-thirds of the municipalities have less than 400 inhabitants in the whole Greater Gap Area (2013). The demographic gains observed since 1999 are essentially concentrated in the Gap city and urban area. This has resulted in a strong urban sprawl, because of the predominance of individual households and the development of economic activity areas, located essentially in Gap and neighbouring municipalities. The mainweight of the core city in the spatial organisation can also be observed in the commuting and other rides to Gap (ScoT de l'Aire Gapençaise, 2013: 43-44).

The region relied essentially on two main economic fields. A large part of the land was and still is devoted to agriculture, in spite of a significant decline due to afforestation and urban development dynamics. The main productions are meat, milk and fruits. It must be noticed that about 90 farms are currently located in the Gap municipality, which is a very high figure for a central city. This particularity can be explained by the large municipal surface area and therefore, the large amount of land available for agricultural activities. However, the weight of this sector is not as important economically speaking as it used to be for the region in the middle of the last century. Besides, efforts are made to secure and develop tourism activities. Ski resorts were developed in the Dévoluy and Champsaur massifs in the second part of the 20th century. New forms of tourist activities – such as cultural, religious, nature and agritourism – are now promoted in a wider range of geographical sectors of the Greater Gap Area. More recently, authorities have developed a policy based on the attractiveness of the region to pensioners, generally seduced by the quality of life and the sunny climate, with the aim of benefiting from their presence and contributions to the local economy.

Photo 01: The Gap urban area and its surrounding mountains. Photo credit: © Focale Emotions - BISTON Marc (Wikimedia Commons)



Map 01: A very large part of human activities and settlements of the Greater Gap Area are located in the val-leys, more especially in and around Gap, with 92% of the population concentrating in about 30% of the whole area (SCoT, Rapport de Présentation, p. 40 and 164).

Planning context, areas and documents

The planning tradition at the supramunicipal level is quite recent in the context. Admittedly, a Regional and Urban Master Scheme (*Schéma Directeur d'Aménagement et d'Urbanisme - SDAU*) was approved in 1974. However, the general content mainly reflected the visions of the French State for the area and was therefore not so much the result of a shared development project elaborated by the local authorities (Fenestre, 2002). In 2001, a supramunicipal joint organisation was founded with the aim of developing a Territorial Coherence Scheme (*Schéma de Cohérence Territoriale - SCoT*) and ensuring the follow-up of the process. At this time, the established planning area was made up of only 26 municipalities. In 2007, when the plan's drafting process was officially launched, 66 municipalities were involved. When the planning document was approved in 2013, the Greater Gap Area covered a total of 77 municipalities and 1 900 km^2. It must also be pointed out that this developing cooperation at the supramunicipal level was strengthened by the creation of the Pays Gapençais in 2003. Established at the initiative of the municipal authorities to launch shared development projects, this status largely contributed to the structuring of a supramunicipal coordination. The spatial guidelines included in the 2013 SCoT of the Greater Gap Area were partly influenced by the content of the Sustainable Development Charter (*Charte de Développement Durable*), approved in 2004 for the Pays Gapençais. A small part of the Greater Gap Area is also covered by the Regional Nature Park of the Baronnies Provençales (*Parc Naturel Régional des Baronnies Provençales*) and a large part by the Écrins National Park (*Parc National des Écrins*) which provide the area with high-level skills in spatial and environmental engineering. In addition, the local authorities of the Greater Gap Area were able to draw up on the expertise of the *Agence d'Urbanisme de la Région Grenobloise* (AURG) to elaborate the *SCoT* document; an urban planning agency set up in 1967 under a nonprofit organisational status.

The Gap municipality adopted a Local Urban Development Plan (*Plan Local d'Urbanisme - PLU*) in 2018. It repealed and replaced the 1995 Land-Use Plan (*Plan d'Occupation des Sols - POS*), which was a planning document of the previous-generation that could no longer be revised. The internal Urban Planning Office of the Gap municipality developed this new Urban Development Plan with the contribution of a private environmental engineering firm, named Ecovia, for the environmental assessment study. It should be mentioned that the adoption of this new planning document was not a smooth process. At the end of 2017, the prefect, representing the French State, requested the withdrawal of the *PLU* (initially adopted) and the introduction of various amendments to ensure the legality of the document. The reservations concerned in particular the legal compatibility of the *PLU* with the *SCoT* with regards, among other things, to the excessive amount of land devoted to urban development and to the regulatory protection of ecological corridors.

Background and challenges regarding biodiversity and ecological connectivity

The region is quite rich and important from an ecological perspective, specifically due to its localisation at a climatic crossroad between Mediterranean, temperate and mountainous influences. The area therefore offers habitats to various fauna and flora species. In addition, the region may prove to be strategic in the context of climate change by allowing the wildlife to move towards coolers areas. In addition, it should be noted the ecological value of the traditional Bocage countryside; that is to say a mixed wood and pasture land framed by thick and continuous hedgerows. This landscape organisation can essentially be found at the bottom of the Champsaur valley, in the northern part of the planning area. Agricultural decline may be an important threat because of the subsequent afforestation of farmland parcels and thus the disappearance of the structuring hedgerows. Things may be different in other parts of the region. Although the Greater Gap Area remains largely rural to this day, the central parts have experienced a relatively fast urban sprawl over the last few decades. This spatial dynamic may have been boosted over the Gap municipality because of its wide surface area in comparison to French standards, and its still large proportion of undeveloped parcels to date. In addition, the strategy promoted by the city to capitalise on the attractiveness of the region to retirees and people seeking a higher quality of life tends to induce a relatively strong land-consuming development. Although the rural parts of the Greater Gap Area are not as impacted by urban sprawl, dwellings appear to be relatively scattered in the landscape.

In 2009, the Greater Gap Area had been selected by the Regional Authority in charge of Environment, Spatial Planning and Housing (*DREAL-PACA*) as a study area for a project aimed at providing a methodological basis in order to identify and develop ecological networks. This initiative could be seen as an exploratory work of the Regional Scheme for Ecological Coherence (*SRCE*). The study was carried out by the Urban Planning Agency of the Greater Grenoble Area (*Agence d'Urbanisme de la Région Grenobloise*), the Natural Areas Conservatory of the Provence-Alpes-Côte d'Azur region (*Conservatoire des Espaces Naturels de la Région PACA*) and the National Botanical Alpine Conservatory (*Conservatoire Botanique National Alpin*) between 2009 and 2010. In addition, the Écrins National Park (*Parc National des Écrins*) gathered habitat/species data over a large part of the Greater Gap Area.

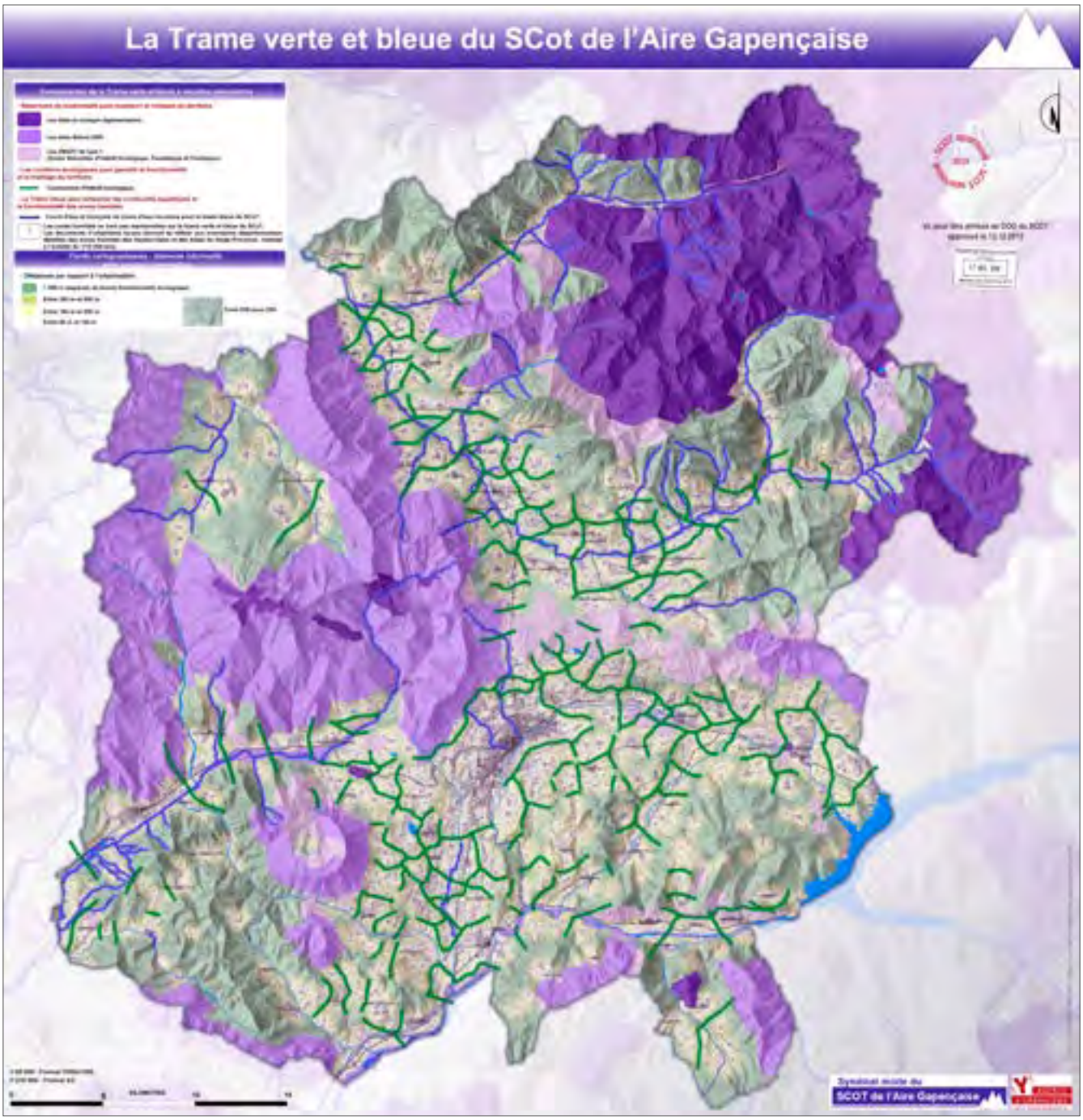
Considerations for ecological connectivity in the planning processes and documents

Various nature conservation organisations can be found in the Greater Gap Area. One of the main challenges was therefore to create the conditions for taking advantage of the local expertise on biodiversity in the spatial planning process. This task was fortuitously facilitated by the educational and professional background of the head manager of the joint association in charge of the *SCoT* development. Her training in urban planning, combined with a past experience as secretary general of the National Botanical Alpine Conservatory, gave her the opportunity to acquire a broad view of both fields. It must be noted that such profiles are particularly rare. She acted as a facilitator, making the exchanges between environmental and planning technicians easier and the habitats/species data more functional from a spatial planning perspective **(see comment 01)**. The green and blue infrastructure was elaborated on the basis of expert views, a map of natural habitats, a map of plant patches and faunal data. The latter was considered as less complete. An additional effort was therefore made to establish the potential presence of faunal species. To this end, 48 species were selected by the expert group in the list of species established at the national level by the National Museum of Natural History as well as a list of species identified locally. Finally, a map of human settlements was considered in the process with the aim of identifying the corridors to be protected from fragmentation.

"As I integrated the Botanical Conservatory, I thought: I worked for years as an urban developer without knowing the existence of the National Botanical Alpine Conservatory and of their work that could have provided us with accurate and precise information in response to all the questions we were facing. [...] On the other hand, I realized that the information was far too detailed compared to what is needed for an urban planning document. One of the main challenges lied in our capacity to take advantage of this information which is very rich and based on a highly developed nomenclature, to degrade the information [...] By degradation, I mean the reduction of the level of information detail."

Com 01: Myriam Reynaud-Banus, Planner and Head Manager of the Syndicat Mixte du SCoT de l'Aire Gapençaise (joint association in charge of the SCoT of the Greater Gap Area), involved in the preparation of the SCoT of the Greater Gap Area, 2018.

High attention was given in the *SCoT* to areas for which interests in terms of ecological functionality could be more surely established, and in particular, to those that contribute to the connection between mountainous massifs. It was decided to limit the number of ecological corridors to be included in the green and blue infrastructure **(see map 02)**, and then to secure them with rigorous planning requirements. Among other things, the *SCoT* states that municipal authorities have to reject projects that may impact the areas identified as biodiversity reservoirs. In addition, municipal authorities are bound to further specify the interest and nature of the areas covered by the ecological corridors identified at the *SCoT* level, or even to complement the green and blue infrastructure by including additional ecological corridors of local interest. On this basis, local planning documents shall classify the concerned lands as unbuildable, excepted for projects of general interest and for which alternative locations cannot be found given their nature or function (SCoT, DOO, p. 8-13).



Map 02: Map of the green and blue infrastructure planned for the 2013 *SCoT* of the Greater Gap Area. It maps the biodiversity reservoirs made of areas covered by regulatory protections (*dark violet patches*), Natura 2000 sites (*medium violet patches*) and areas covered by inventories of natural resources (*light violet patches*), as well as the connections of ecological interest (*green and blue links*). Distance to human settlements are also specified as an additional and non-binding information: > 500 m (*dark green patches*), 250-500 m (*light green patches*), 100-250 m (*pastel yellow patches*).

The adherence to the green and blue infrastructure planned in the *SCoT* varies widely between geographical sectors. Resistances can be observed, notably over the Gap municipality. Land-consuming development patterns spread locally over time. Consequently, elected representatives, developers, farmers and estate owners have become accustomed to this weakly regulated context. It is now difficult to curve and reverse the trend **(see com-**

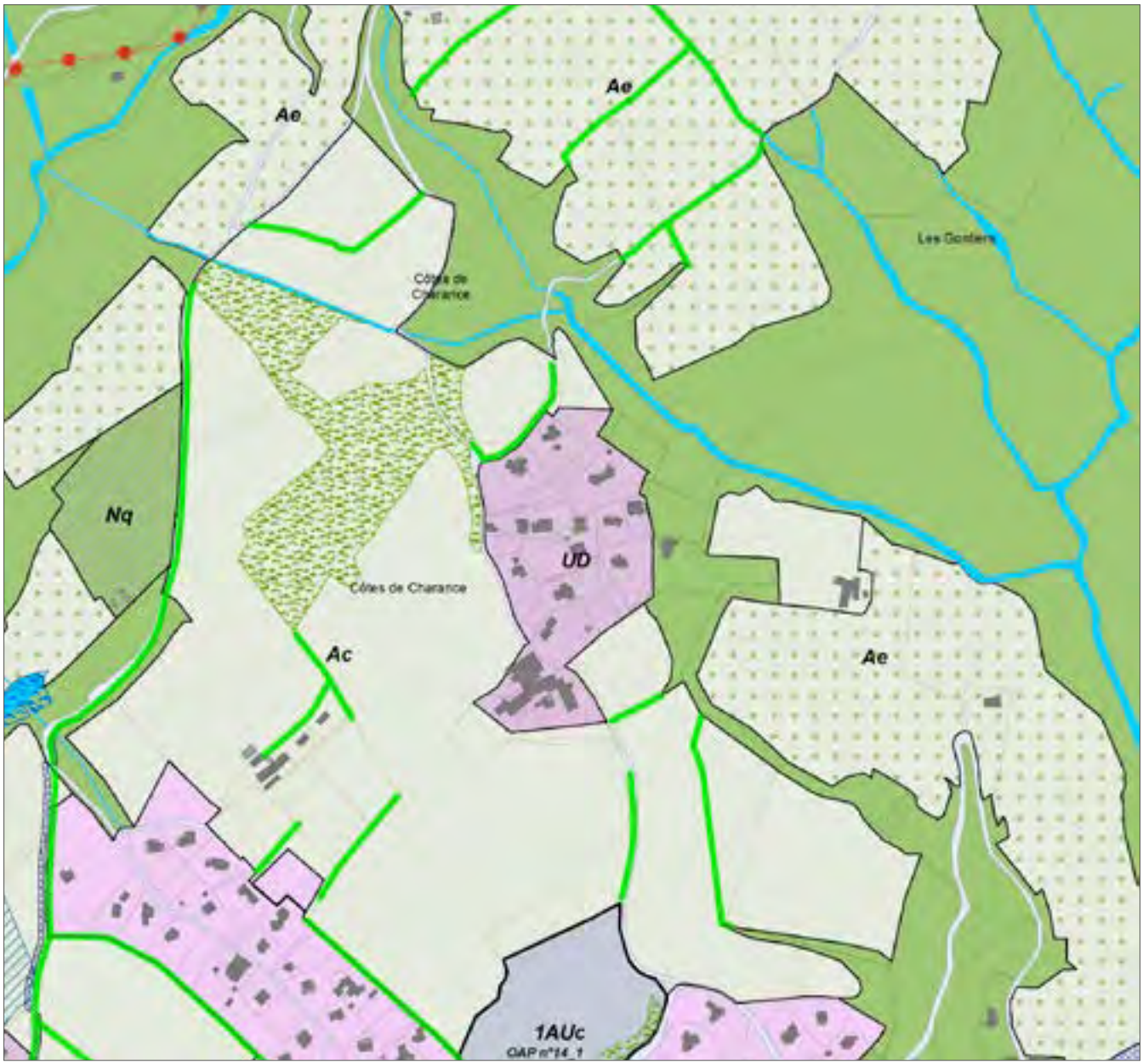
- "[Representatives of] the French State and of the supramunicipal joint organisation in charge of the SCoT may have wanted a higher density. In our sectors, it was a little bit difficult to move from a density of 18 to 35 [housings by hectare], because at one time we talked about that. We managed to keep it at 25. [...]"

Com 02: Maryvonne Grenier, Elected Assistant to the Urban Planning for the Gap Municipality, 2018.

ments 02 and 03). It was therefore a real challenge to produce a Local Urban Development Plan (*PLU*) that is required to be legally compatible with the *SCoT* document and adopted by the City Council. The temptation was strong to transpose the planning prescriptions provided in the *SCoT*, notably concerning the regulatory protection of ecological corridors, in a weakly constraining manner (see map 03).

- "[Representatives of] the French State and of the supramunicipal joint organisation in charge of the SCoT may have wanted a higher density. In our sectors, it was a little bit difficult to move from a density of 18 to 35 [housings by hectare], because at one time we talked about that. We managed to keep it at 25. [...]"

Com 03: **Deborah Belin**, Urban Planner and Director of the Urban Development Office of the Gap municipality, involved in the preparation of the PLU of the Gap municipality, 2018.



Map 03: Land-use zoning map (detail) included in the 2018 *PLU* of the Gap municipality. The green and blue infrastructure is transposed into the map on the basis of two different methods. First, elements are identified as corridors (*densely distributed green motifs*) and hedgerows (*bright green lines*). Buildings, developments and works carried out on the parcel or bordering land shall be designed in such a way as to preserve the functionality of these components. Second, some areas are classified as "Ae" – agricultural areas contributing to the functionality of biodiversity reservoirs and ecological corridors – (*green doted yellow patches*) and "Ape" – agricultural areas of landscape and ecological interest – (*not observable on the selected map*) in the land-use zoning map. Constructions are permitted in the "Ae" and "Ape" areas for farm facilities, collective equipment and public facilities only. It should be noticed that this second transposition method has been used over agricultural areas only. It provides additional information about the plots on which farmers are allowed to build and the land that is more strictly protected.

3.4. The Greater Grenoble Area and Le Cheylas municipality

Geographical context and spatial dynamics

Located in the Northern French Alps, Grenoble is located at the intersection of three valleys crossed by the Isère and Drac rivers. The urban area is surrounded by three massifs - named Belledonne, Chartreuse and Vercors - culminating between 2 000 and 3 000 meters **(see map 01 and photo 01)**. Grenoble's population is about 163 000 inhabitants (2017) at the city level and 687 000 inhabitants (2014) at the level of the urban area. The latter has a density of 263 inhab./km^2.

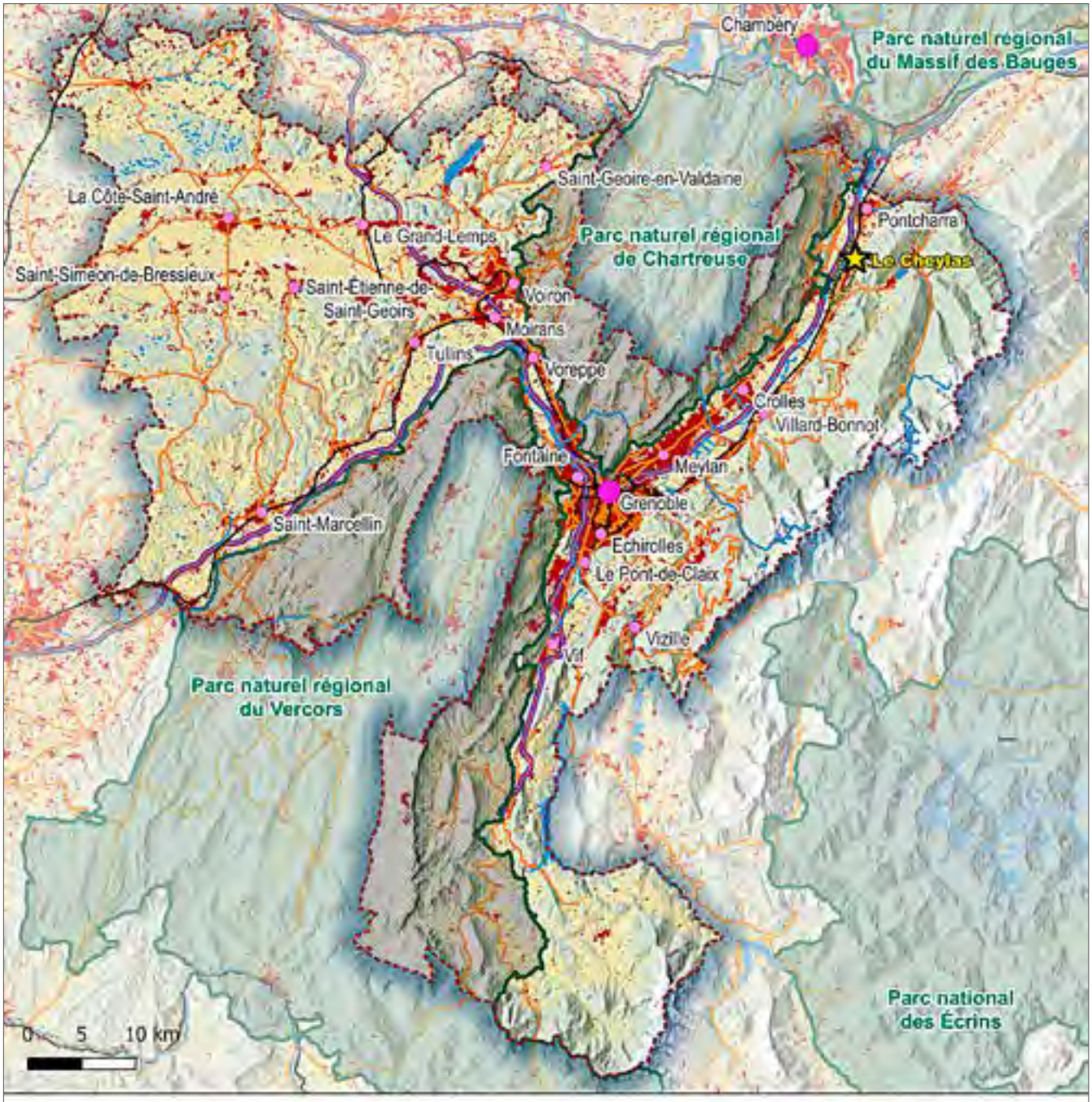
Grenoble's population increased at an accelerated pace over the 20th century. At first, this demographic boom essentially contributed to a certain densification of the historical centre and to a relatively continuous spatial extension of the city. From the late 20th century, the area experienced a larger and intense urban sprawl in the valleys. Grenoble's urban area is now considered as a structuring part of this growing urban corridor - known as the *Sillon Alpin* - that stretches from Geneva to Valence. This space is one of the most densified areas of the Auvergne-Rhône-Alpes region and is becoming less spatially discontinuous. The Grenoble urban area nevertheless lost a part of its economical attractiveness in the last few years.

Le Cheylas municipality is located in the Grésivaudan Valley, on the left shore of the Isère river, midway between the cities of Grenoble and Chambéry. With a population of about 2 650 inhabitants (2018) and an area of 8.44 km^2, the town is thus one of the many human settlements that can be found along the *Sillon Alpin*. The municipality experienced a significant industrial development during the second part of the 20th century, in particular with the establishment of electrometallurgy and hydropower plants. In addition, the town experienced a large urban development. Both of these dynamics progressively contributed to the conversion of local farmlands, whose surface area was more than halved between 1970 and 2010. It must also be noted that the agricultural activity has been largely abandoned on the slopes. Traditionally dedicated to orchards and vineyards, the remaining farmland is now largely dedicated to cropping.

Planning context, areas and documents

Contemporaneous spatial dynamics and pressing urban issues encouraged local authorities to collaboratively engage in a regional-scaled planning process and to approve a Territorial Coherence Scheme (*Schéma de Cohérence Territoriale - ScoT*) in 2012. The French legislators had also greatly encouraged - and more recently largely constrained - municipalities to adopt such a document by modifying the law and reframing the national planning system. However, a certain planning culture, acquired in particular during the drafting of the 1973 Urban Development

Photo 01: The Greater Grenoble Area and the Grésivaudan Valley, lying between the Chartreuse *(left)* and Belledonne (*right*) mountain ranges. The Vercors massif can be seen at the forefront (*left*). Photo credit: Agence d'Urbanisme de la Région Grenobloise.



Greater Grenoble area and Le Cheylas municipality

Administrative/Planning areas
- Greater Grenoble area (Schéma de Cohérence Territoriale)
- Le Cheylas municipality (Plan Local d'Urbanisme)
- Main nature parks and protected areas

Land covers
- Urban areas
- Agricultural areas
- Forests and semi-natural areas

Cities and towns
- Main cities
- Secondary cities/towns

Transport infrastructures
- Motorways
- Secondary roads
- Railways

Hydrographic network
- Main lakes
- Main rivers

SOURCES - Data: Terrain: Copernicus data and information funded by the European Union for the European Digital Elevation Model (EU-DEM, V1.1); Copernicus data and information funded by the European Union for the land cover (Corine Land Cover, V2018). Hydrographic network: OpenStreetMap.org and MapCruzin.com for the hydrographic network. Transport networks: OpenStreetMap.org and MapCruzin.com for the road and railways networks. Boundaries: ©EuroGeographics for the national boundaries (NUTS 2016); GeoBasis-DE/BKG 2019, Opendata.swiss/BfL, Istat, IGN for the subnational administrative boundaries; European Environment Agency - European Environment Information and Observation Network for the protected areas (CDDA, V17, 2019). Cities and urban sprawl: Copernicus data and information funded by the European Union for the European Settlement Map 2017 (ESM2p5m). Design and spatial adjustments/ modifications: Mathieu Perrin, Irstea Grenoble, 2019.

Map 01: The urban development of the Greater Grenoble Area has essentially concentrated at the bottom of valleys between three massifs - named Belledonne, Chartreuse and Vercors - culminating between 2 000 and 3 000 meters. Le Cheylas municipality is located in the northeastern part of the planning area, alongside the Isère river and the highway between the cities of Grenoble and Chambéry.

Master Plan (*Schéma Directeur d'Aménagement et d'Urbanisme - SDAU*) and the 2000 Master Scheme (Schéma Directeur - SD) for the Grenoble Region, made it possible to launch the planning process relatively early and to include a wide number of municipalities in the planning area. The latter, recently renamed Greater Grenoble Area (*Grande Région de Grenoble*), covers 268 municipalities and 3 746 km^2. However, it must be noted that the *SCoT* area does not really encroach upon the neighbouring mountainous sectors. This particularism can be explained by a certain apprehension amongst highland people about the possibly detrimental influence of urban areas as well as by the existence of regional nature parks (parcs naturels régionaux) that provide the massifs with high-level spatial and environmental engineering resources. For their part, the local authorities of the Greater Grenoble Area could draw on the expertise of *the Agence d'Urbanisme de la Région Grenobloise* (AURG), an urban planning agency set up in 1967. Another component of this regional planning culture lies in the historical consideration for agricultural issues and farmland conservation, even more in the western part of the planning area. This focus contributed to the development of a specific approach and a particular interest for open areas.

Le Cheylas municipality developed its Local Urban Development Plan (*Plan Local d'Urbanisme - PLU*) from 2010 and finally approved the document in 2014, thus repealing and replacing the previous and outdated Land-Use Plan (*Plan d'Occupation des Sols - POS*). Consequently, this *PLU* was largely developed simultaneously with the *SCoT* of the Greater Grenoble Area, the former having legally to comply with the latter. An urban planning consulting firm was contracted for the preparation of this *PLU*.

It must be also highlighted that both documents have been labelled as "Grenelle". This distinction aims to give prominence to the plans and schemes that implemented the provisions contained in the Grenelle Environnement Agreements (2009) and the National Commitment to Environment Act (2010) - also known respectively as the Grenelle I and Grenelle II Acts **(see comment 01)**.

"Our PLU has been labelled Grenelle. We pursued the implementation of the Grenelle I and Grenelle II laws. It was an important thing. It's a choice we made. As we were in the drafting phase and about to finish when the Grenelle laws and their implementing decrees were issued, we could have approved the document. But we made that choice. It took us longer. It took us nearly 6 more months [...] The urban planning consulting firm had made us aware of this possibility [...] There was no obligation to act this way."

Com. 01: M. Cohard, Mayor of Le Cheylas, 2017.

Background and challenges regarding biodiversity and ecological connectivity

The steep-sided configuration in which Grenoble developed has induced a significant land pressure in the valleys over the last decades as the demand for new developments grew. It has also implied a concentration of transport infrastructures (highways, railways, power lines, etc.) alongside the rivers, thus contributing to the landscape fragmentation and thereby to the hindrance of the inter-massif ecological connectivity. This particular vulnerability and, first and foremost, a real political voluntarism encouraged the Isère department authority to launch in 1999 a first mapping project (*Réseau Ecologique Départemental de l'Isère* - REDI) aimed at identifying, with the contribution of the local communities, the ecological continuum, corridors and conflict hotspots for wildlife movements over its whole area of jurisdiction. A first ecological network was thus published in 2001. Complementary studies were then carried out by the AURG in 2003 and 2004 over two critical areas of the Grésivaudan Valley, located upstream and downstream from Grenoble, in order to spot the vulnerable corridors and to determine the restoration measures to be considered. Another mapping project was launched at the regional level (*Réseau Ecologique de Rhône-Alpes* - RERA) in 2006 and then updated in 2009, in the same spirit as the REDI initiative. It must be noted that this material did not expressly feed the spatial and urban planning processes of the time, particularly because national law did not yet require any consideration for ecological connectivity/networks in planning documents and also because the previous generation plans/schemes were not well adapted to address such concerns. Nevertheless, these mapping efforts subsequently made it possible for the Isère department to obtain European funds to restore and protect

selected ecological corridors alongside the Grésivaudan Valley within the context of the 'Corridors of Life' (*Couloirs de Vie)* project. Le Cheylas municipality was directly concerned by one of them. In addition, an alluvial area of the Le Cheylas municipality has been labelled by departmental authorities as a sensitive natural area (*Espace Naturel Sensible*) in 2005. This status aims to provide sites of interest - recognised as such on the basis of their quality and/or their wildlife - with a specific protection by means of land acquisition or agreements with concerned landowners.

Considerations for ecological connectivity in the planning processes and documents

Previous habitat/species inventories and mapping initiatives provided the Greater Grenoble Area with a useful basis when the time came to develop the green and blue infrastructure for the *SCoT*. Environmental organisations, hunting/fishing federations and ecology experts were also invited in the context of a workshop held in 2009 and a dedicated working group active from 2009 to 2010, to discuss the methods adopted and so that they could contribute their local knowledge to the identification of additional biodiversity reservoirs as well as areas of functional interest. Two main outputs resulted from this process: the schematic map of the structuring natural continuum and the preparatory map of the green and blue infrastructure.

In addition, a big effort was also made by the staff of the urban planning agency in charge of drafting the planning document in order to raise awareness, to foster public acceptance and to avoid subsequent legal disputes. In particular, their planners and ecologist made a tour of the municipal authorities across the whole Greater Grenoble Region in order, among other aspects, to identify likely critical aspects and to defuse the tensions. This work was followed by a phase of negotiations during which the various representatives expressed their views about the green and blue infrastructure delineated in the preparatory map. As a result, various adjustments were made **(see map 02 and excerpt 01)**. It must also be noted that the whole methodology for delineating this green and blue infrastructure is quite exhaustively explained in one part of the *SCoT*. Such a level of explanation in the spatial planning documents is quite uncommon in the French context. The whole designing process was thought of with a pragmatic

"The green and blue infrastructure increased from a reference area of 13 427 hectares, at the beginning of the process, to 13 507 hectares. This net gain resulted from both an addition of 434 hectares and a removal (trimming or elimination) of 354 hectares."

EXC 01: 2012 SCoT of the Greater Grenoble Region - Presentation Report, p. 817.

Map 02: Preparatory map (detail) of the green and blue infrastructure of the 2012 SCoT of the Greater Grenoble Region. This specifies the primary biodiversity reservoirs to be included by law (*sea green patches*) and the supplementary biodiversity reservoirs identified on the basis of local expertise/inventories (*olive green patches*). It also maps the natural connections of ecological interest and/or under urban threats (*green links*) as well as those whose addition (*pink links*) and removal (*red links*) were asked by municipal/supramunicipal authorities.

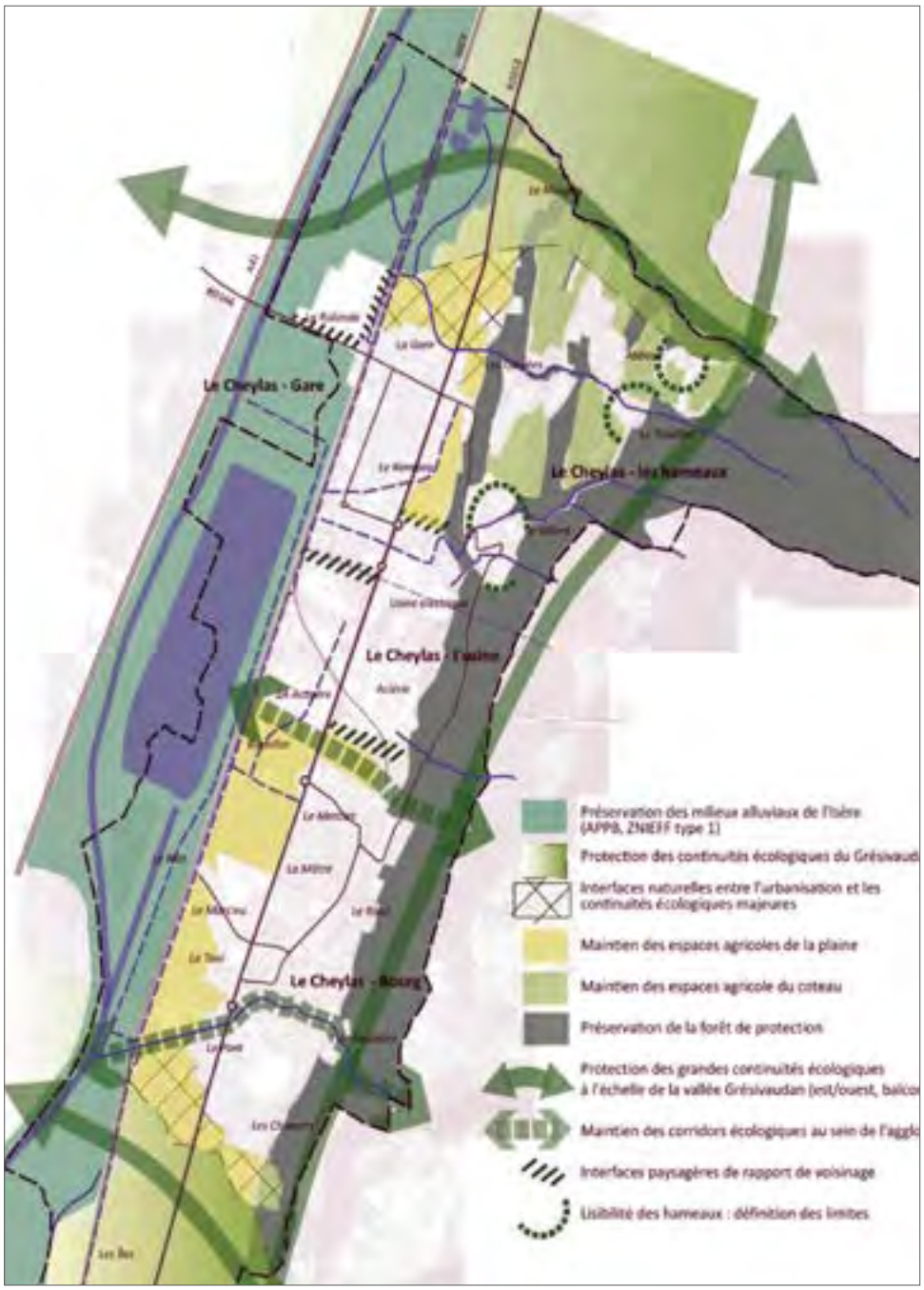
approach in mind and the desire to involve the local authorities and representatives in the development of the green and blue infrastructure. This was probably facilitated in some areas by the various initiatives on biodiversity conservation and ecological connectivity previously carried out. However, this social learning, based on the past experience and involvement of local stakeholders/representatives, may be very time-consuming and requires a long-term effort that does not always fit into the planning rhythmic **(see comment 02)**.

"This [awareness-raising] effort is still to be done and done again. It was done before the 2014 municipal election, [that is to say about 18 months after the adoption of the SCoT]. Have the new teams been made sensitive [to the issue of ecological connectivity] and trained again? In any case, at the Urban Planning Agency, we have no longer been involved in any other tour of the municipal authorities, as we called it... In addition, technicians change as well as their positions and functions in the administration... From what I can see from time to time, when I exchange words into the municipalities, there are many messages that are already no longer at all in the minds of elected officials and technicians. A lot should be explained again concerning the fundamentals."

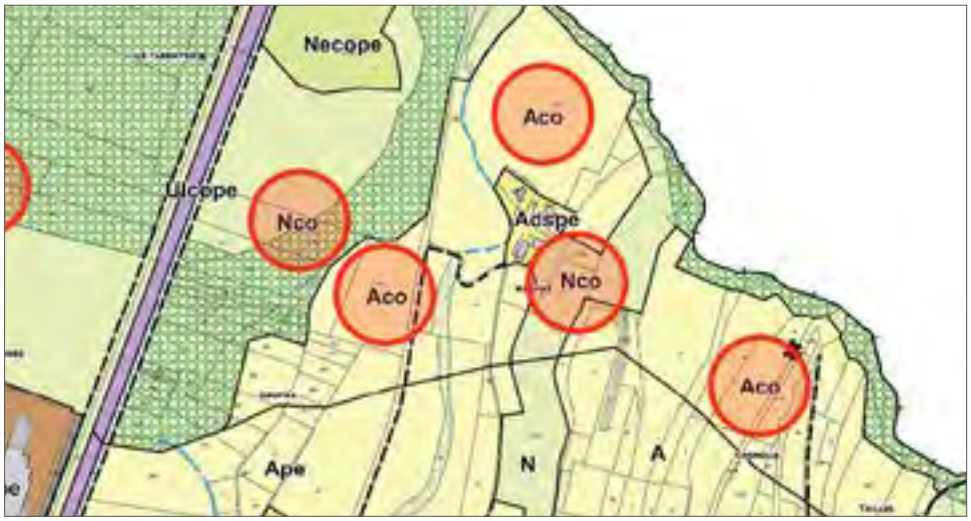
Com. 02: **Hugues Merle**, Ecologist at the Agence d'Urbanisme de la Région Grenobloise (Urban Planning Agency of the Greater Grenoble Area), involved in the development of the SCoT of the Greater Grenoble Area, 2017).

Regulatory requirements can be found in the *SCoT*. Among other things, municipal authorities are bound to delineate ecological corridors more accurately at the local planning scale through the means of a regulatory transposition of the preidentified ecological corridors into the rules and zoning maps of the local urban/town planning documents. Besides, municipal authorities have to map the existing or to-be-developed landscape components that are necessary for the maintenance, strengthening and/or restoration of the ecological functionality of the areas. In addition, local urban/town planning documents should address the ecological corridors located in agricultural areas with a specific attention. For instance, rules that combine considerations for ecological functionality with production purposes on the land dedicated to agricultural activity may be introduced in planning documents (SCoT, DOO, p. 32). However, it should be made clear that municipal authorities generally have significant leeway in determining how to transpose these upper-level regulations into their local planning documents. Other considerations as ecological functionality may thus influence the choices made.

In preparation for the *PLU* of Le Cheylas municipality, the environmental engineering consultant made quite a large effort in terms of their landscape analysis, with the aim of delineating the ecological corridors mapped in the *SCoT* more accurately and of identifying other components of interest for ecological connectivity at the local scale **(see map 03)**. In other words, the local contribution to the definition of the green and blue infrastructure relied much more on photointerpretation than on the analysis of habitat/species data, especially because of limited financial and human resources engaged to this end. The attention given to ecological connectivity is also noticeable in this context in the transposing of the ecological corridors into zoning regulations **(see map 04)** and in comprehensive development areas (*Orientations d'Aménagement et de Programmation*), which are more urban-design-oriented instruments.



Map 03: Map included in the 2014 *PLU* of Le Cheylas municipality and highlighting the main challenges in terms of ecological balances. This specifies the protected alluvial area (*sea green patch on the western parts*), the protection forest (*dark green patch on the eastern part*), the agricultural areas to be preserved in the plain (*yellow patches*) and over the hillside (*light green patches*). The map also identifies the ecological connections of municipal (*wide green dotted arrows*) and supra-municipal (*wide green continuous arrows*) interest as well as the buffer areas between urban areas and the main ecological connections (*green crosshatching*).



Map 04: Map (detail) included in the 2014 PLU of Le Cheylas municipality and showing the transposition of the northern wildlife corridor into zoning regulations: Aco (agricultural zone with wildlife corridor), Nco (natural zone with wildlife corridor), UIco (business zone with wildlife corridor) implying some specifications regarding building regulations, landscape compositions, wildlife-permeable fencing, etc.

3.5. The Lombard Alpine valleys and Barzio municipality

Geographical context and spatial dynamics

The area of interest is located in the heart of the Lombard mountains, in the foothills of the Orobie Bergamasche and the Valsassina Plateau, near the city of Lecco **(see map 01)**. This area is composed of three Alpine valleys (Valle Brembana, Valle Seriana and Valsassina), with a total surface of 901.60 km^2. It is an area characterised by a very high percentage of municipalities that have a very low population (total 47 100 inhabitants in 2011) and population density (50,47 inhabitants/km^2). Municipalities with a population of less than 1 000 inhabitants predominate.

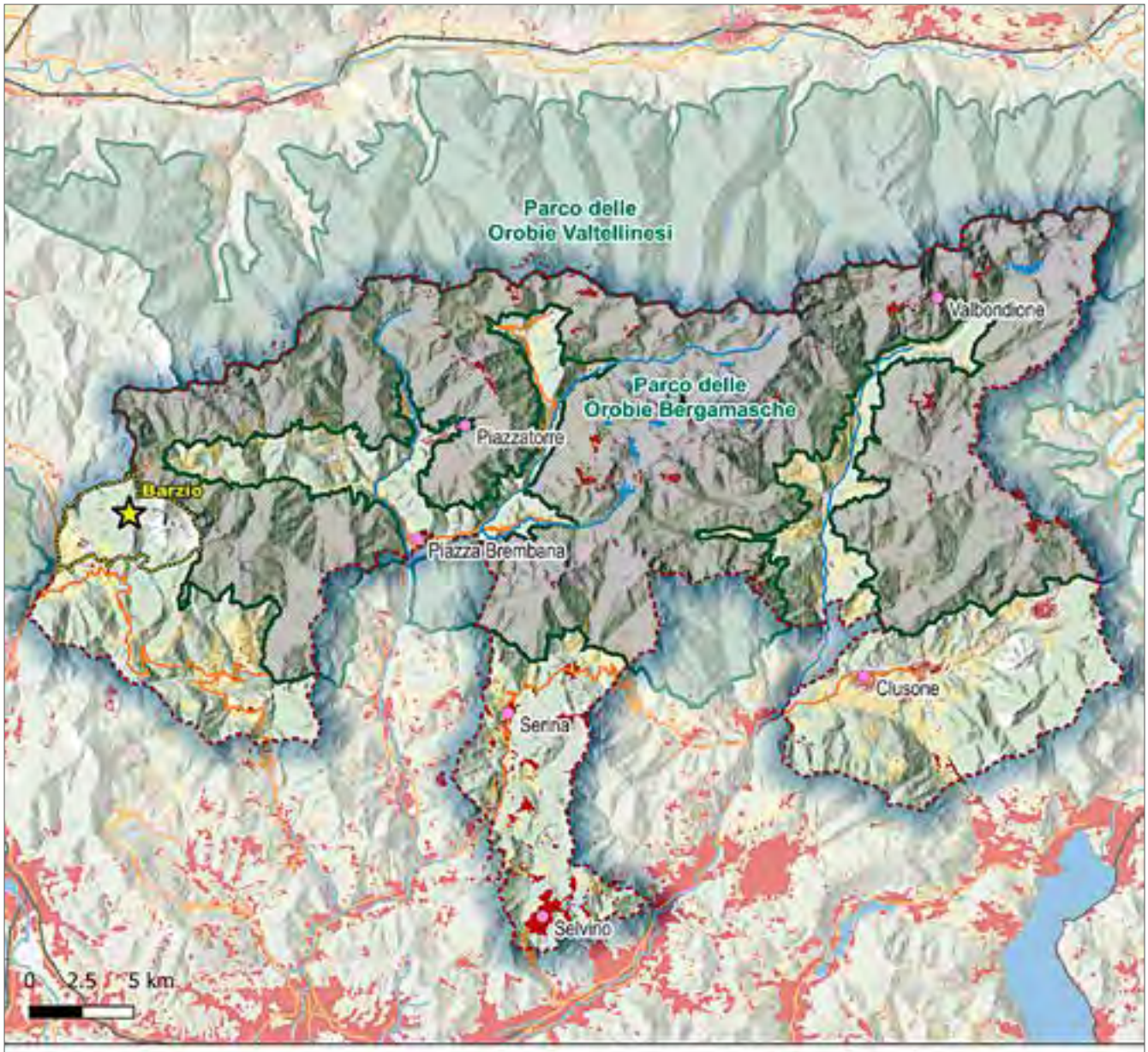
The territory is characterised by a high ecological-environmental value and is covered by many protection/management areas: the Orobie Bergamasche Regional Park, as well as Special Protection Areas (SPA) and Sites of Community Importance (SCIs) belonging to Natura 2000 Network. In addition, the area shows the presence of numerous cultural landscape elements (e.g. terraces, pastures, historical roads, etc.). While the territory benefits from the presence of large natural areas, the small size of the municipalities entails an economic and social disadvantage for the area.

The short distance from the cities of Milan and Bergamo has led, since the first post-war period, to the spread of intense residential tourist settlements in these valleys. The development of ski and summer tourism, especially in the economic boom years (mainly 1960s and 1970s), caused the spread of second homes, mostly owned by non-residents, who are characteristically occupied only for short periods of the year, causing negative and depressive effects on the entire resort.

The Barzio municipality, located in the Province of Lecco, had a population of 1 321 inhabitants in 2010, an area of 21.35 km^2 and a density of 61.9 inhabitants/km^2. The dwellings in 2001 amounted to 2 337. Barzio is the most famous of the localities of the Valsassina Plateau and rises at the foot of the Piani di Bobbio in a relatively central position in the frame of the Orobie and Grigne massifs **(see photo 01)**. The economic development is based on cattle breeding and cheese production, thanks to the numerous and rich pastures that still characterise the municipal territory. In addition, the Barzio municipality boasts an environmental system that has managed to resist urban pressures prior to the eighties. The natural and undeveloped land still covers more than 95% of the municipal area and

Photo 01: Grignetta (left) and Grigna (right) seen from the surroundings of Barzio. Photo credit: © Michele F. (Wikimedia Commons)

is mainly covered by woods, grasslands, meadows and pastures (Territorial Development Plan of the Barzio municipality, 2017).

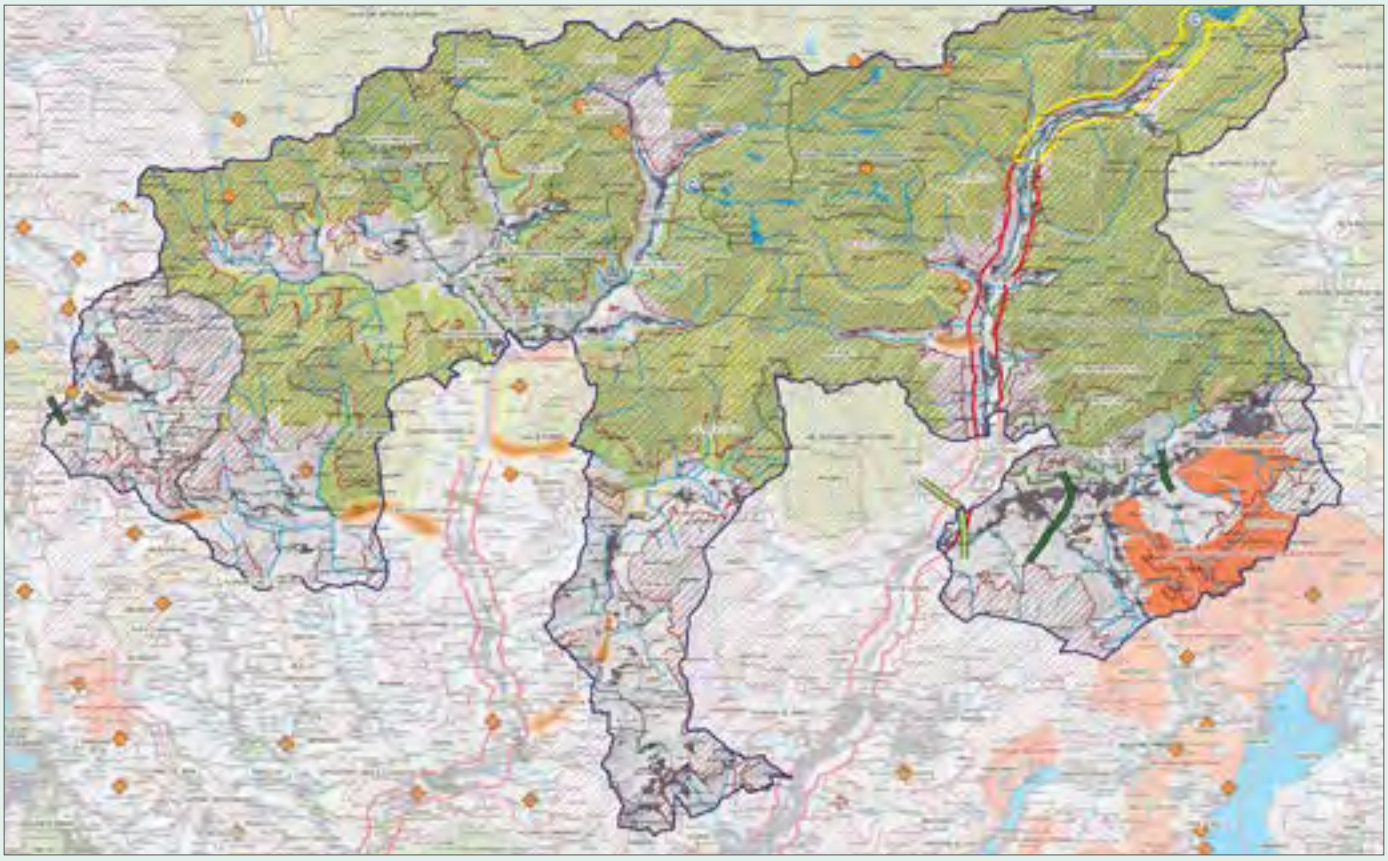


Map 01: The Orobie Bergamasche and the Valsassina Plateau are rugged and sparsely populated areas located in the vicinity of a high-density region, with Milan and Bergamo being situated a few tens kilometers away to the southwest and south respectively. Barzio municipality is located on the western part of this perimeter, on the Valsassina Plateau.

Planning context, areas and documents

The situation of economic and social disadvantage that characterises the area calls for an integrated approach, which could provide a multifunctional perspective of this Alpine Valley, while taking into account the demands of local stakeholders. The Regional Territorial Area Plan (RTAP) is a strategic planning tool identified in the Regional Territorial Plan (RTP) (L.R. 12/2005) aimed at regulating the governance of areas of significant size, affected by different types of "projects, interventions or land uses" (i.e. urbanization, infrastructures, etc.) of regional and supraregional significance. The main strategic objective of the RTAP is to promote sustainable economic development in accordance with the particular identities and characteristics of the mountain territories involved, in order to counterbalance their historical and ongoing depopulation and marginalisation.

The area concerned by the RTAP "Alpine Valleys: the Orobie Bergamasche and the Valsassina Plateau" has an articulated and complex territorial context, characterised by a particular geomorphological structure, significant settlements in the bottom of the valley, preserved natural ecological niches and different agricultural systems. The RTAP Alpine Valleys covers 45 municipalities belonging to two provinces (Lecco and Bergamo), a Regional Park (Orobie Bergamasche Regional Park) and three mountain communities (Valle Brembana, Valle Seriana, Valsassina-Valvarrone-Val D'Esino and Riviera). The RTAP Alpine Valleys was approved in 2015 as one of the five territorial area plans of the Lombardy Region.



Map 02: Map of the RTAP area which depicts the REN elements: protected areas (Or-obie Bergamasche Regional Park (*green area*) covers most of the RTAP territory) and the "passages" (*light and dark green lines*) in the valleys Val Seriana and Valsassina (source: Board 2a - Natural and environmental elements of RTAP Alpine Valleys)

This RTAP defines three main objectives for which target actions have been identified respectively. These have to be implemented on the territory through mandatory rules, strategic guidelines and implementation projects defined by the local authorities. Among others, the operational objective 1.3 of the RTAP (*Enhancement of landscape elements, examples of an integrated ecosystem, consisting of natural and cultural aspects, which represent the identity of the territory*) is the most important objective affecting the implementation of the Regional Ecological Network (REN) in the Alpine Valleys. This objective proposes three main concrete actions to enhance landscape, natural and cultural elements as representative of the identity of the territory of the RTAP Alpine Valleys: (1) the protection and enhancement of natural and environmental values; (2) the recognition and enhancement of the landscape heritage; (3) the development of the green infrastructures of the territory.

The RTAP Alpine Valleys transposes the design of the REN, identified by the RTP, and aims to safeguard in particular the "passages" **(see map 02)** as the most vulnerable elements of the REN, by promoting actions able to reduce the ecological fragmentation and encourage the consolidation and/or restoration of natural elements. A qualifying element of the RTAP lies in the design of a new green infrastructure **(see map 03)** both in view of a landscape requalification and for the improvement of biodiversity and eco-systemic coherence.

Map 03: Project (detail) of the green infrastructure (orange contour) that connects natural, environmental and landscape aspects highlighted with dotted oval forms: lakes system (*blue ovals*); karstic calcareous landscapes (*red ovals*); dolomitic landscapes (*brown ovals*). In addition, blue-lined ovals indicate areas with high natural value to be valued and protected as well. (source: Board 4s - Strategies for landscape attractiveness of PTRA Alpine Valleys)

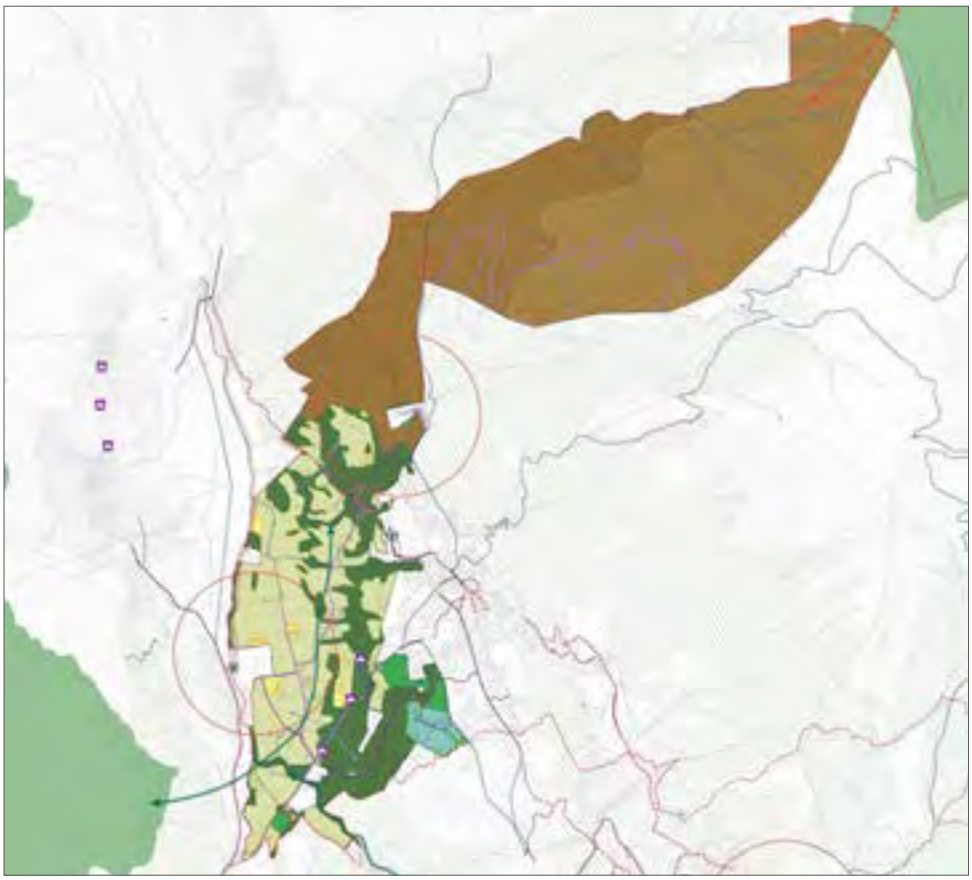
Background and challenges regarding biodiversity and ecological connectivity

The orientations contained in the RTAP Alpine Valleys must be reported and transposed by the provinces, municipalities and other concerned local authorities to their urban planning documents as these will be revised. Concerning the development of a new green infrastructure, some local projects have been considered as *functional to the naturalistic environmental enhancement of specific territorial realities with a view to continuity and integration also with the territories outside the RTAP*, among which the project "Local Park of Supramunicipal Interest (LPSI) Valsassina-Monterone Plateau".

By updating its Territorial Development Plan (PGT) in 2017, the Barzio Municipality introduced the establishment of the "LPSI of Barzio from the Valley bottom to the Orobie", in accordance with the orientations of the RTAP **(see map 04)**. This Park is an opportunity for the consolidation of the Municipal Ecological Network (MEN) and for the revitalisation of the mountain system. In addition, the perimeter of the LPSI of Barzio has also been transposed to the Territorial Coordination Plan (TCP) of Lecco Province (approved in 2014). The LPSI of Barzio has an area of 4.7 km^2, equal to about 22% of the entire municipal area, and is located entirely in the Barzio Municipality. The LPSI acts as an ecological corridor ensuring the connection between the Regional Park and the SPA Orobie Bergamasche to the east, and the SCI Northern and Southern Grigna to the west. In order to complete the LPSI's environmental system, the MEN transposed to the park's documents **(see map 05)** identifies "strategic agricultural areas" of particular relevance for the connection they provide to the ecological network and the protection they bring to adjacent rural areas from urban development trends.

It is fundamental to consider that the concerned territory owns a high ecological and environmental value, among which the Orobie Bergamasche Regional Park. The latter is part of the Natura 2000 Network for 86% of its surface. This specificity has encouraged the rethinking of the traditional Territorial Coordination Plan (TCP) of the Park (L.R. 86/83), although having been always intended as an instrument for mainly urban purposes, in favour of a higher naturalistic characterisation. In 2008, the Park formally launched the "Naturalistic Plan" project, whose aim is to experiment with innovative ways of drawing up the TCP, constituting a preliminary and functional document for the Municipal Development Plan relating to ecological aspects. The activities carried out during the last 10 years aimed at reducing the infrastructural gap with the bottom of the valley and valorising the touristic and cultural aspects of the area. Efforts have been made in identifying policies for countering the depopulation, safeguarding the environmental characteristics and enhancing mountain farming and typical local productions.

Map 04: Perimeter of the LPSI of Barzio (*red contour*) highlighted in a Board of the RTAP Alpine Valleys reported in the planning guidelines of the PTCP of Lecco Province. The map indicates the "passage" (*dark green strip*) of Valsassina and the "secondary" elements (*yellow areas*) of the REN around the village of Barzio; the "primary" ones are the protected areas (source: extract of the Board 2a - Natural and environmental elements - Regional Ecological Network).



Map 05: The Municipal Ecological Network (MEN), such as planned within the LPSI area of Barzio, includes "strategic agri-cultural areas" (light green and brown-dotted areas) as well as mountainside green areas (brown areas) in its design. The LPSI is intended to act as an ecological corridor between both regional parks, namely Grigne and Orobie Bergamasche (laurel green areas, respectively on the left and right parts of the map). (source: Board 2.11 - Map of the transposition of the municipal ecological network)

Map 05 bis: Besides the "strategic agricultural areas", the network considers as relevant also areas not subject to transformation (*dark green areas*), as well as green private (*light green areas*) and public areas (*laurel green hatch*) on the southeast of Barzio. With reference to the connection with Grigne Regional Park (left) relevant element of the LPSI's ecological network is also the "connectivity corridor" foreseen by PTCP of Lecco Province (*green dashed arrow*). In addition, an area dedicated to the soft mobility (*red dashed circle*) has been identified as functional for the landscape fruition and affects one of the park's entrances. (source: zoom of Board 2.11 - Map of the transposition of the municipal ecological network)

Considerations for ecological connectivity in the planning processes and documents

The first design of the Lombard Regional Ecological Network (REN), including the Alpine and Pre-Alpine areas, was approved in 2009 and identified the "Alpi Orobie - Grigne" as a priority area for biodiversity in the Lombard Alps and Pre-Alps (*WWF project "Priority areas for conservation in the Alps"*). The "passages" identified in the RTP as the most vulnerable elements of the regional ecological network are the main nodes around which the RTAP Alpine Valleys has been developed.

As a territorial multi-governance tool, the RTAP aims to ensure an effective synergy between the strategies for socio-economic and environmentally sustainable development concerning a certain territorial area. The RTAP is based on an integrated approach for the protection and enhancement of the environmental components and the landscape. The approach chosen is multidisciplinary and based on three general objectives closely integrated into a comprehensive vision including territorial, environmental, cultural, and societal considerations, as well as mountain-related economic and touristic dynamics.

The level of priority attributed to the issue of ecological connectivity in the planning strategy of RTAP is moderate. In RTAP Alpine Valleys, the concept of ecological connectivity is implied as a *"green infrastructure [...] aimed at connecting the natural, environmental, landscape and cultural aspects, representative of the identity of RTAP territory"* (Objective 1.3) **(see Comment 01)**.

"It is clear that the aim to contain the building development and programme it is complementary to the desire to build an effective green network. The main problem, for many years, was of a situation not under control, which obviously provoked landscape fragmentation and elements contributing to the detriment of the overall continuity. This situation expanded even in medium-high valley contexts, where we register the greatest presence of very large tourist homes. I answered «moderately» because, on the one hand, the plan was born rather on tourist homes that to make a strong characterisation of the green system. [On the other hand,] this aspect was taken into account naturally because a large part of the territory that falls within the Plan is Orobie Bergamasche Regional Park. In the working papers, we focused on the distinctive elements of the Management plans of Natura 2000 sites present in the area."

Com. 01: Fulvio Adobati, Spatial Planner - University of Bergamo, Vice-chancellor (Relations with institutional and local bodies), 2018

The Territorial Development Plan of Barzio perceives the concept rather as "ecological connections" with the intent to *"restore riparian vegetation along the peripheral areas, primarily in the state-owned areas and in those in which the landscape constraints or the protection requirements established in the Hydrogeological Plan prevent other uses, with the aim of consolidating the ecological connection capacity of these components"*.

The main qualifying element of the RTAP Alpine Valleys is the design of a new green infrastructure. The plan adopts and integrates the REN, promoting its implementation at local level through project proposals highlighted by local authorities. One of these projects implementing the RTAP affects the territory of the Barzio municipality. The establishment of the Local Park of Supra-municipal Interest (LPSI) of Barzio aimed at developing the project of the Municipal Ecological Network, where the proposal of the LPSI is an essential element for the protection of the values of connectivity and environmental continuity.

The LPSI of Barzio is, above all, conceived as a major corridor that connects two legally protected areas at a regional level. It is on one side, the Orobie Bergamasche Regional Park, located northeast of the LPSI and of the Barzio municipality and on the other side, the Grigna Settentrionale Regional Park, which is located towards the southwestern part of the LPSI, over the valley bottom of the Valsassina. This Park's purposes are in accordance with the orientations of the RTAP and the Territorial Coordination Plan (TCP) of the Province of Lecco. The benefits deriving from the establishment of the LPSI and the transposition of the MEN to the Park's documents, should positively reflect on two scales:

- Local scale: better exploitation by the local administrations;
- Supra-municipal scale: an additional zone in the Valsassina valley's system of protected areas would be introduced, ensuring adequate connection between the Grigne Settentrionale Regional Park, the LPSI of Alta Valsassina and the block of the Orobie Valtellinesi and Bergamasche Park.

"A proposal of LPSI in the reality of Valsassina, I seem to remember, it was very already mature in that context, which saw the arrival of the RTAP as an opportunity to consolidate and assert itself. The Area Plan did not arouse it. This is the reality of Barzio-Cremeno, a ski resort that is fairly regulated with a very significant heritage, and of Barzio's second homes without significant presence of Natura 2000 Network in those four municipalities."

Com. 02: Fulvio Adobati, Spatial Planner - University of Bergamo, Vice-chancellor (Relations with institutional and local bodies), 2018.

"The then councillor was very clear: there are no specific funds for the Plan, except for those to finance the construction of the Plan. However, if you come up with a project that contributes to the achievement of the objectives of the Plan, my door is open and we can look together for a way forward. The idea is therefore to encourage active planning [...] the arrival of a plan that activates projects capable of capturing resources.

Com. 03: Fulvio Adobati, Spatial Planner - University of Bergamo, Vice-chancellor (Relations with institutional and local bodies), 2018

3.6. The Berchtesgaden Alpine Park

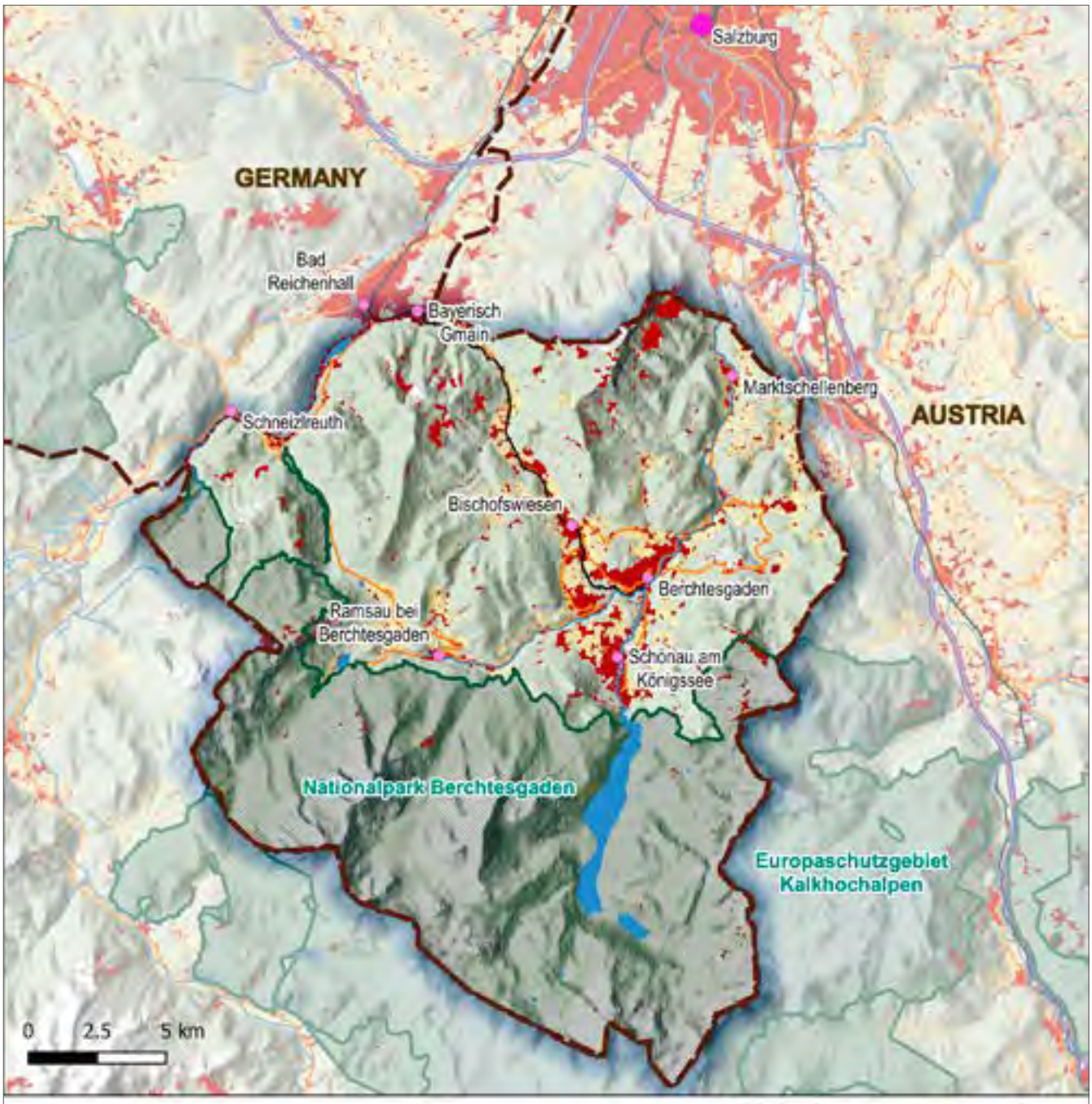
Geographical context and spatial dynamics

The concerned area of the Berchtesgaden Alpine Park is located in the southeast of Germany, in the Free-State of Bavaria. The area borders Austria. The Berchtesgaden Alpine Park comprises the Berchtesgaden National Park (20 800 hectares) and the National Park buffer zone (*Nationalpark-Vorfeld*) (25 927 hectares), which borders the National Park at its northern part. Both areas were established under the Bavarian Government's initiative in the 1970s that led to the creation of the Berchtesgaden National Park as a core zone on the basis of the pre-existing Königssee nature reserve and of the Berchtesgaden Alpine Park as a buffer zone.

The municipalities of Bischofswiesen, Ramsau, Schönau a. Königssee, Berchtesgaden and Marktschellenberg are located in this buffer zone. In the north of the buffer zone, smaller parts of the municipalities of Bad Reichenhall, Bayerisch Gmain and Schneizlreuth are also included in the National Park buffer zone **(see map 01)**. Since 1990 the Berchtesgaden Alpine Park is part of the Biosphere Region Berchtesgadener Land.

The area presents a very diverse landscape with altitudes reaching more than 2 000 m and valleys at 400 m. The lake Königssee (5 218 km^2) is an important touristic attraction. The landscape is still shaped by (extensive) agricultural use and represents a typical Alpine cultural landscape. The downtown areas are historically grown and contribute very much to the touristic attractiveness of the area. But in all, the urban sprawl is a danger that the municipalities need to be addressed through planning.

Photo 01: View on the Landscape in the Region of Berchtesgaden. Photo credit: © H. Stanggassinger, National Park Berchtesgaden.



Map 01: The Berchtesgaden Alpine Park covers the Berchtesgaden National Park and its northern buffer zone. The area lies in the vicinity of Salzburg, which has increasingly developed in the last decades as a metropolitan area with spatial and functional inter-dependency across the Austrian-German border.

Planning context, areas and documents

From an administrative point of view, Berchtesgaden Alpine Parks belongs to the southern district of Berchtesgadener Land, in the Administrative District of Upper Bavaria of the Free State of Bavaria. It belongs to the planning region 18 "Südostoberbayern" and comprises an area of 46 727 ha. The municipalities of the area are integrated to a certain number of larger scale planning systems defined by the Bavarian Development Programme (*Landesentwicklungsprogramm Bayern, LEP*) and the Regional Plan of the Southeast Upper Bavaria (*Regionalplan Südostoberbayern, N°18*).

The 5 municipalities were already cooperating closely on various issues. This is due to their particular natural location in a deep circular valley. The common historical background, originating specific traditions, customs, agricultural and forestry practices, and the Alpine settlement types are reasons for this close cooperation. In order to consolidate their cooperation for the future, they decided in 2012 to develop a common land-use and integrated landscape plan. At that time, the municipal land-use plans in force had all been developed and approved in the 1980s or early 1990s. These documents were outdated and unfit for guiding land use in a relevant way. Through the cooperation between the municipalities on the landscape plans the objectives of the supramunicipal landscape planning frame are coordinated with the municipal level. This contributes to a higher commitment of the involved parties to the supramunicipal and local planning levels.

In order to address common challenges, the municipalities have decided on a collective general orientation including 5 objectives: (1) moderate population growth, (2) development and enlargement of job offers, (3) common commitment to a touristic region, (4) safeguarding agriculture, and (5) reinforcement of the downtown areas.

Background and challenges regarding biodiversity and ecological connectivity

The cross-border pilot region "Berchtesgaden-Salzburg" was honoured by the Ministerial Conference of the Alpine Convention not only for its natural resources, but also for its exemplary commitment to this topic as a "pilot region for ecological networking in the Alpine region". The application procedure for the pilot region and previous pilot projects (including the Alpine Space ETZ project "ECONNECT" and the Continuum.Initiative) were coordinated regionally by the national park administration and supported to a large extent by the municipalities.

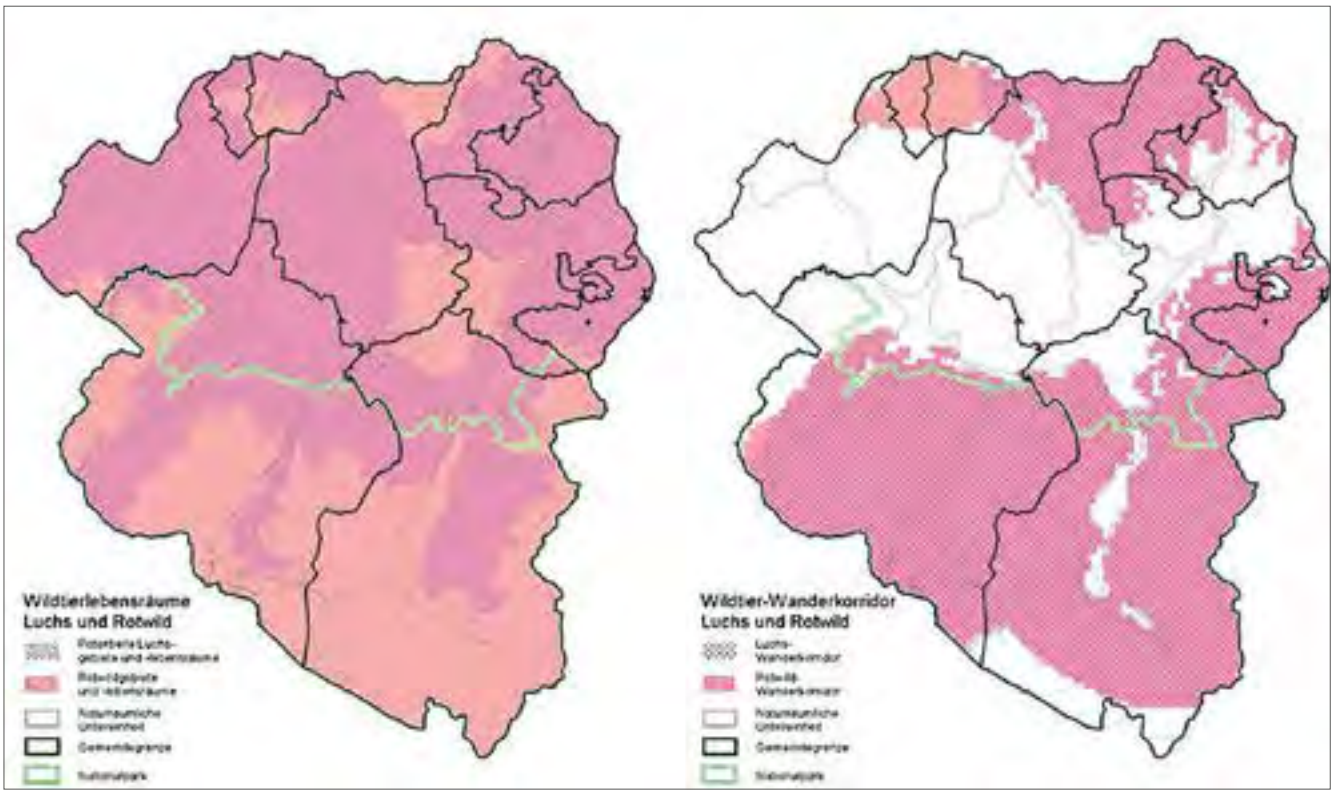
The present Supramunicipal Landscape Planning and Landscape Framework Plan now takes up these results, further developing them both technically by integrating them into the preparatory urban land-use planning at the municipal level. This approach is so far unique in the pilot regions of the Alpine Convention and can be regarded as exemplary.

As a logical continuation of the results obtained to date, interconnected areas of particular importance for the ecological networking of extensively managed grassland areas have been integrated into landscape planning. In addition, all the objectives of the ABSP relevant to the network and the proposed measures to improve the ecological continuity of watercourses from intermunicipal watercourse development planning have been combined in a new thematic map **(see map 03)**. This spatial development of the topic is intended to serve as a decision-making aid in questions of regional development.

In addition to this ECONECT implementation project, there are special international species protection programs that concern the Berchtesgaden valley basin: the Wildlife corridors lynx and red deer as well as the Wildcat corridor map. The concerned habitat is in these cases are forests. Large wildlife species such as wolves, bears, lynx and red deer require considerable space. The large, continuous forest areas in the Alps are important retreat areas for these species. Due to their sometimes enormous spatial requirements of certain individuals with territory sizes of several

hundred square kilometers and their strong migratory abilities of often several dozen kilometers per day, these species require landscape parts that connect their habitats; so-called migratory or wild animal corridors.

The Bavarian Office for Environment (LfU) identified and cartographically delimited important wildlife habitats and corridors on the basis of the two target and lead species in Bavaria: the lynx and red deer **(see map 02)**. Lynx and red deer represent other medium-sized and smaller mammals native to Bavaria, such as roe deer, wild boar, wild cat, badger or pine marten.



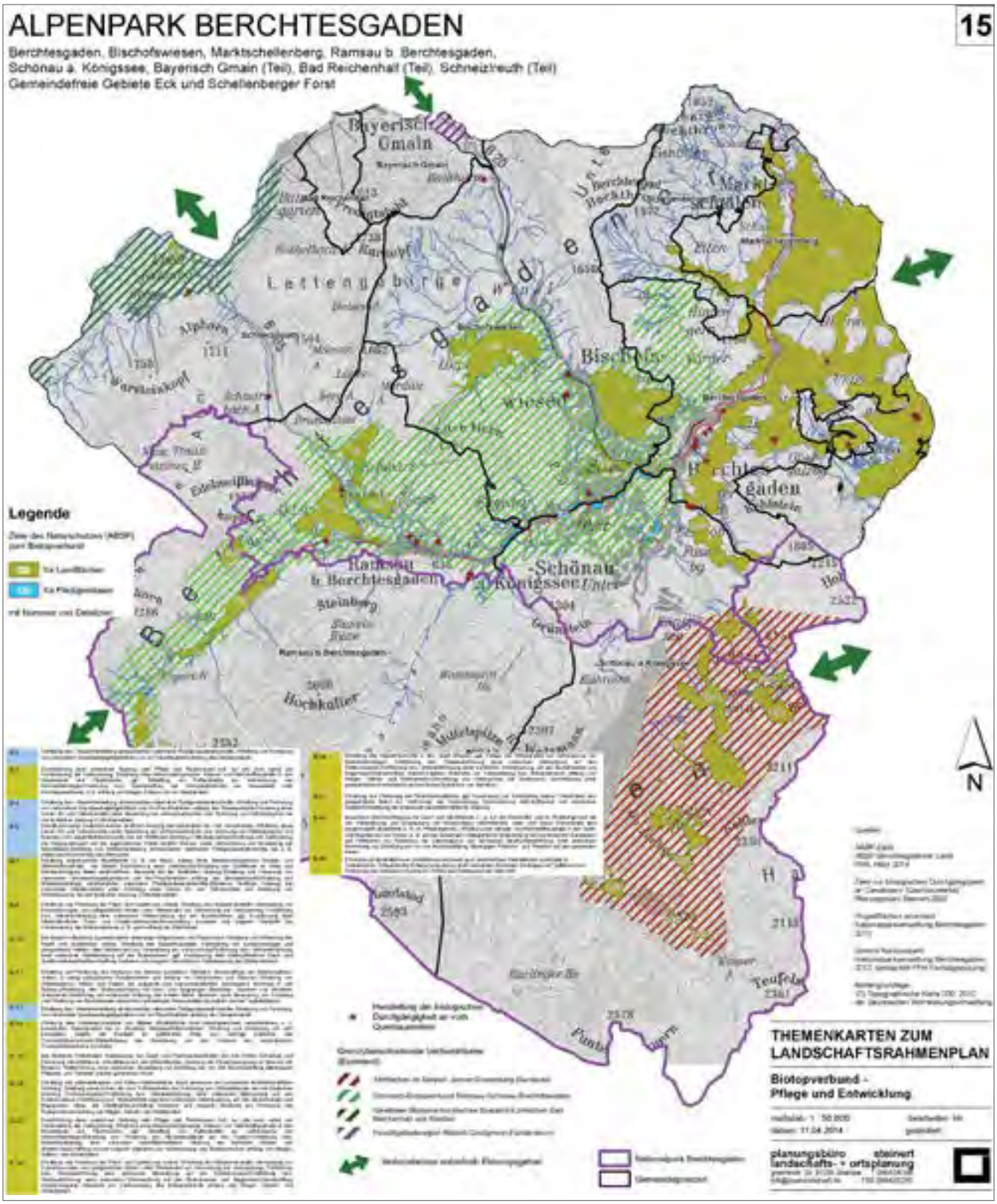
Map 02: Maps of the potential wildlife habitats (*left*) and migration corridors (*right*) established by the Bavarian Office for Environment (LfU) for lynx (*dark pink*) and red deer (*salmon pink*) in the Alpine Park.

Considerations for ecological connectivity in the planning processes and documents

It was a common agreement of all involved partners to consider the indications concerning the issue of ecological connectivity from the Bavarian Species and Biotope Conservation Program (Arten und Biotopschutzprogramm - ABSP) in the land-use planning.

In the landscape plan of the five basin communities, the objectives from the ABSP for the biotope network are included as an indication **(see map 03)**. This means that the referenced areas are integrated in the assessment within the framework of land-use planning (presentation of the "priority area for the biotope network"). The description has an evaluative character with the recommendation to pay particular attention to the objectives of species and biotope protection in the case of interventions and pressures. For a successful implementation of the biotope network, the coordination of agricultural and forestry use and the different conservation needs is required with the respective landowner.

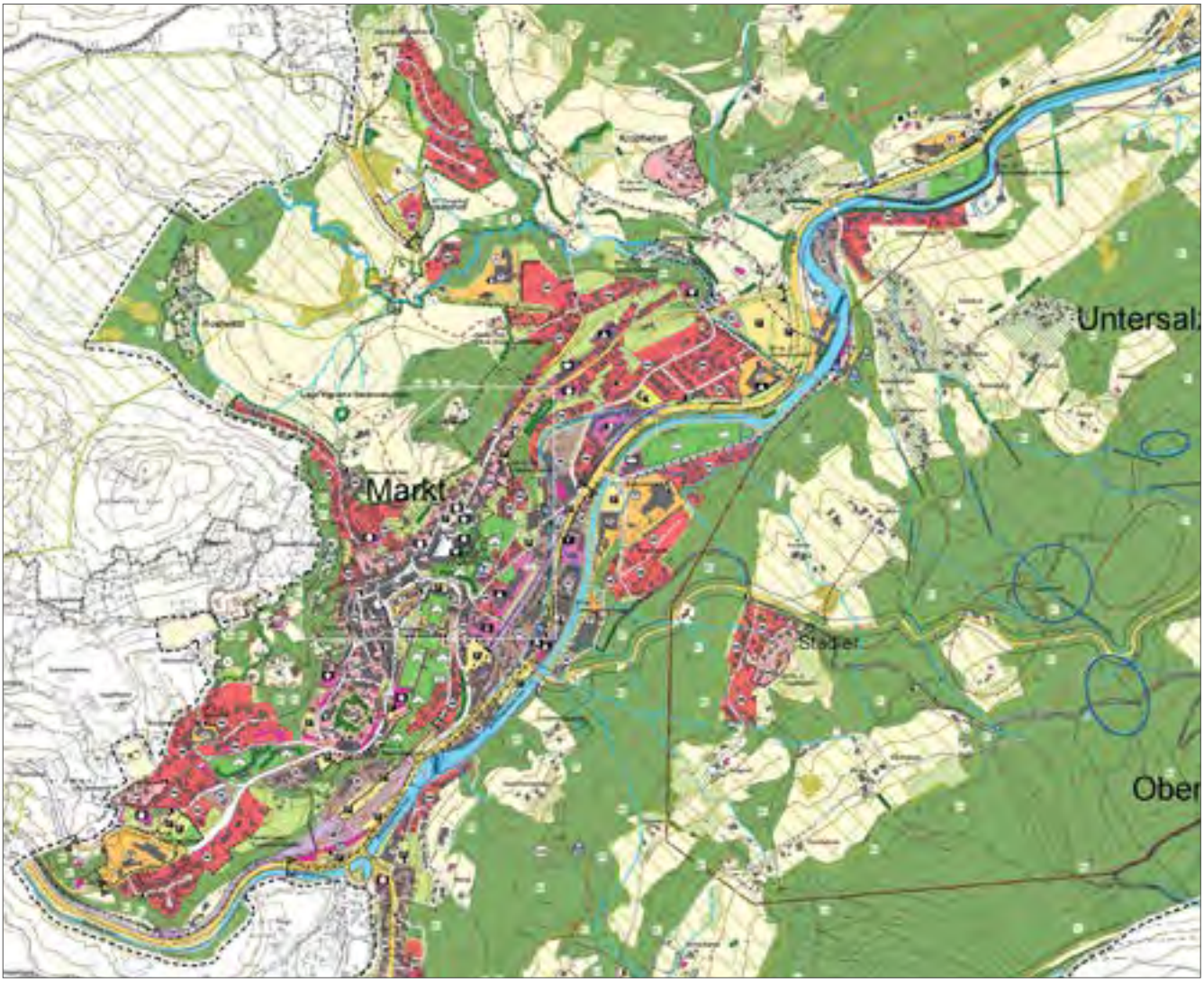
This can only take place in individual discussions and must have the aim that the individual agricultural or forestry enterprise can also integrate this recommendation economically within the enterprise. The initiator (municipality,



Map 03: This map from the supramunicipal landscape plan specifies the biotope network. It relies on 4 main connecting areas established in the context of Econnect - Restoring the web of life project. These are respectively the Alpine pastures of the Jenner-Gotzenberg-Bluntautal area, located on the eastern shore of the Lake Königssee (*red hatched areas*), the biotope network of the Ramsau-Schönau-Bischofswiesen area that covers the Berchtesgaden river basin as well as some parts of the Lattengebirge and Untersberg foothills (*light green hatched areas*), the biotope network axis that spreads over the Saalachtal waters (*dark green hatched areas*), and the Marzoll-Großgmain-Fürstenbrunn wetland (*purple hatched areas*). The objectives and measures provided by the Bavarian Species and Biotope Conservation Program (ABSP) for specific land areas (*olive areas*) and running waters (*light blue areas*) contributing to connectivity are mapped and listed. The transversal infrastructures requiring defragmentation measures (*red dots*) are also highlighted. Additionally, the spatial extensions of connecting areas (*large green arrows*) outside the Alpine Park are indicated.

national park administration, Lower Nature Conservation Authority, etc.) must meet the considerable need for coordination and, if necessary, cover it with supplementary subsidies and programmes. Existing municipal subsidies (meadow maintenance) can also be used for this purpose.

The species and biotope protection programme (2014) assigns the mapped areas to different zones with the aim of maintaining, optimising or developing them as part of a biotope network. As a result, a coherent biotope network is recommended that includes those areas that are particularly suitable for a biotope network. In order to simultaneously establish a link with urban land-use planning (evaluation of the intervention), these areas are presented as "priority areas for the biotope network" in the land-use plan **(see map 04)**.



Map 04: The Land-Use Plan and Landscape Plan map (detail) for the Markt Berchtesgaden municipality indicates the "priority areas for the biotope network" (*light green hatched areas*), largely based on the mapping carried out in the context of the Bavarian Species and Biotope Conservation Program (Arten und Biotopschutzprogramm - ABSP). These areas can in particular be seen to the northwest and east of the urbanised parts (*red areas*).

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ARTEN- UND BIOTOPSCHUTZPROGRAMM (ABSP) BAYERN / SPECIES AND BIOTOPE PROTECTION PROGRAMME OF BAVARIA.

Lessons Learned

4

Introduction

Based on the academic, legislative and technical literature (essentially exploited in Part 2) as well as on the interview material and planning documents collected on the different case studies (essentially exploited in Part 3), the ten following lessons were learned. These reflect the potential and challenges on how ecological connectivity can be integrated into spatial planning.

4.1. An uneven legal impetus for ecological connectivity in spatial planning

Article 12 of the Protocol "Nature Protection and Landscape Conservation" of the Alpine Convention commits the contracting parties to "pursue the measures appropriate for creating a national and cross-border network of protected areas, biotopes and other environmental assets protected or acknowledged as worthy of protection" (Alpine Convention, 1994). Article 12 thus encouraged different initiatives to develop spatial links between protected areas. Although there is a shared ambition, no supranational frameworks (international agreements, EU directive, etc.) explicitly determine how ecological connectivity should be addressed or how the establishment of an ecological network could be supported through spatial planning. Consequently, a variety of approaches can be observed in the ways that connectivity is legally enshrined in the different countries.

First, there is not always a legal obligation to protect or restore ecological connectivity, or to develop and implement an ecological network through spatial planning throughout the different countries. However, the content of the adopted or currently developed national biodiversity strategies suggests that national legislation could become more constraining in some countries (Austria, Slovenia, and Switzerland) in the years to come. In addition, it should be noted that legal obligations have sometimes been adopted at the regional level in countries that have no specific constraint related to ecological connectivity in spatial planning in their national legislation.

Second, the multiscale implementation of the ecological network concept, as stipulated under the law when it is the case, generally reflects the administrative organisation of the country (i.e. top-down approach versus mixed approach, prominence of the national level versus importance of the state/regional/cantonal level). However, these organisational frameworks do not always strictly determine the on-the-ground implementation (e.g. upper-level

authorities taking advantage of experiences led at lower level for developing their own methodologies and producing ecological network maps).

4.2. A difficulty in addressing the issue of ecological connectivity in its full complexity

The concept of ecological connectivity includes both a structural dimension (the configuration of landscape and habitat patches that may facilitate or obstruct the movement of organisms) and a functional dimension (the way populations, individuals or genes move and respond to the landscape). References to functional connectivity may be more or less explicitly expressed in national laws and strategies, especially for the specification of the goals pursued by state-promoted concepts (e.g. the Green and Blue Framework in France, the Biotope Network in Germany, the Ecological Infrastructure in Switzerland). However, the concept of ecological connectivity, as understood in spatial planning practices, appears to be largely confined to a structural dimension. Many factors can explain this orientation. Functional connectivity is species-specific and therefore complicated to address from a multi-species perspective. It is even harder to grasp for spatial planners and non-specialists. The species data required for assessing functional connectivity is also often missing as well as unsuitable and difficult to interpret for planning purposes. Additionally, spatial planning is an activity essentially based on the specification of land-use types and has less capacity to influence land management practices themselves. The latter may nevertheless have major impacts on the landscape, the quality of its components and ecosystem functioning. Consequently, ecological connectivity is usually understood in spatial planning practices in its structural dimension, in particular for pragmatic considerations.

4.3. A challenge in strengthening the coherence between planning scales and adjacent areas

The issue of ecological connectivity calls for a planning action that considers the different spatial scales and overlaps administrative boundaries. This is all the more relevant in an Alpine context where connectivity has to be considered across national borders and over mountains/valleys often covered by different territorial authorities. Spatial planning is usually recognised as having a certain potential both in terms of vertical and horizontal integration.

However, difficulties can be frequently observed when dealing with ecological connectivity across scales and borders. First, there can be a challenge in harmonising/matching methodologies, instruments and databases developed or used for addressing biodiversity and ecological connectivity in various contexts. Second, there appears to be a need to develop more coordination between spatial planning processes run at various levels and in adjacent areas. Although the supramunicipal/regional scale is generally considered of high importance for implementing ecological connectivity, planning practices at this intermediary level are often relatively recent or not fully structured in different countries.

More vertical and horizontal integration may be reached by means of formal configurations and/or mechanisms that encourage stakeholders involved in different planning processes to exchange and collaborate. Binding contracts between territorial authorities may be considered in some cases, often with the aim of implementing large-scale policies/concepts whilst respecting the prerogatives of lower administrative levels. More informal initiatives, such as interterritorial arenas and soft-spaces, which can be viewed as non-statutory areas deliberately shaped by governing actors for developing projects outside the traditional political-administrative boundaries and including across national borders, can also greatly contribute to this objective.

4.4. A challenge in producing and managing habitats/species data

The habitat/species data made available for designing ecological networks and assessing their relevance is a key factor. However, shortcomings and limitations can be reported in this respect.

First, a crucial point lies in the production of data. Inventories have often been developed with a view to assess wildlife stocks, and eventually their evolution, rather than ecological functions of the landscape. This task is generally carried out by scientists, professional naturalists, amateurs or even by lay people. Often, systematic methods and recurring efforts for counting and mapping species on the long-term are missing, particularly outside of protected areas. As a result, it may be possible to establish the presence of species in some places, but more difficult to conclude by inference their absence in other ones. It is also hard to determine how individuals or populations concretely migrate and take advantage of the existing landscape through lifecycles, seasons and other relevant periods.

Second, a critical aspect lies in the management of information. The organisation and access conditions to databases may vary between neighbouring areas and between environmental institutions. This implies difficulties in developing a comprehensive understanding of the whole-ecosystem functioning. Considering these different shortcomings and limitations, there is a need for improving the adequacy between data collection/management processes and the needs expressed by ecologists and planners for improving their capacity to design relevant ecological networks and to assess their effectiveness.

4.5. A challenge in shaping a well-structured and accessible ecological expertise

The challenge is twofold. First, it is often difficult to take advantage of the various competences available in ecology or in its related fields. A quite large panel of skills and resources (staffs, funds, methods, instruments, data, etc.) can be found in terms of biodiversity management, in particular due to the increasing number of protected areas, monitoring institutions, ecological consultants and environmental organisations in the past decades. However, these means may be unevenly distributed between areas and heterogeneously concerned by the more specific issue of ecological connectivity. Consequently, common arenas and other mechanisms fostering collaboration at various levels are useful to share knowledge, data, methodologies, instruments, ideas, etc.

Second, the integration of ecological expertise in spatial planning processes often remains a challenge. It requires specific abilities to select and adapt the necessary information in order to make it understandable and exploitable by the various stakeholders involved (i.e. planners, elected representatives, citizens, etc.). Some case studies suggest that the direct inclusion of ecological skills within spatial/urban planning departments/offices results in various benefits. Closer proximity and daily collaboration between planners and ecologists generally contribute to addressing the issue of ecological connectivity in a more integrated way. They also raise the overall awareness among practitioners despite the internal sectoral division frequently observed in the organisation of planning departments. Besides, it must be stressed that the added value of key actors, when present in the local context, is that they can be seen as facilitators or translators. These actors have the rare skills that give planners the opportunity to better grasp the ecological complexity (e.g. understanding specific mechanisms, awareness about the impacts, data interpretation, etc.). Conversely, these facilitators have the capacity to raise awareness among environmental experts of the various limits faced by planners (compliance with the legal provisions, need for a social acceptance, obligations regarding other sectoral issues, constraints in terms of planning scales, etc.).

4.6. A challenge in developing and taking advantage of a shared experience

Spatial planning cannot be reduced to a one-shot process and a decontextualized field of action. It can be observed that the succession of programmes, initiatives and other experiences in favour of ecological connectivity, or more broadly speaking biodiversity, have often had a positive influence on the attention paid to the issue in planning processes. The establishment of protected areas and associated awareness-raising efforts on nature conservation, the realisation of recurring species mapping, and other biodiversity-protection projects contributes to the progressive social construction of understanding, knowledge, and meaning. In other words, such experiences provide opportunities for people or organisations to learn from each other and their environment, thus contributing to what is called social learning. Moreover, it should be specified that it is hard to set firm ambitions in planning documents without sufficient adherence of the local community. It means that strong decisions in favour of ecological connectivity need to find resonance, at least at some level, among elected representatives, economic stakeholders, landowners, etc. In that sense, all initiatives aimed at raising awareness about the loss of biodiversity, ecosystem degradation and landscape fragmentation may be seen as a complementary effort to those intended by spatial planning.

4.7. The designing process and the importance of maps

The designing process is a key aspect of the implementation of ecological networks through spatial planning. At national and regional levels, more leeway is generally left to ecologists for determining the best options regarding ecological connectivity. Besides, scientists and research institutions are more frequently and deeply involved in designing processes at these larger scales. The task is sometimes and increasingly based on the outputs of software applications aimed at modelling ecological networks. Consequently, the maps produced at these national and regional levels are essentially technical and sectoral documents.

At supramunicipal and municipal levels, the delineated ecological networks are generally the result of difficult compromises between various stakeholders and different planning goals. In other words, the issue of ecological connectivity often becomes less of a priority when socio-economic aspects (e.g. housing, business activity, transportation, etc.) are at stake. However, it should be noted that ecological connectivity is sometimes instrumentalised, not necessarily to its disadvantage, in spatial planning processes for achieving other purposes. In particular, this issue of connectivity provides in some contexts advocators of slow-growth or no-growth policies with ecological arguments for supporting their view towards limited land development.

The graphical representations of ecological networks in the planning documents imply a variety of issues. For instance, the delineations and icons may reflect different understandings of a same concept. (e.g. corridors sometimes considered as landscape areas facilitating the movements of species between habitat patches and sometimes considered as narrow landscape areas under pressure from urban sprawl and other spatial dynamics). Furthermore, the scale and the graphical resolution of the ecological network map may imply legal consequences in some countries (e.g. sharp contours that allow identifying the parcels specifically covered by the ecological network even though this should not be the case).

4.8. A challenge in ensuring a long-lasting attention to ecological connectivity in spatial planning

Planning processes are frequently viewed as privileged frameworks for bringing local or regional communities together to pay attention to specific issues through their involvement into territorial projects and the definition of planning guidelines. However, the planning activity has its own rhythm, generally made up of sustained paces during the preparatory phases and slow paces in the intervals. There is thus a recurring risk of losing the bene-

fits that result from efforts of bringing attention to the issue of biodiversity and ecological connectivity amongst various stakeholders involved. There can be high turnover rates amongst planners and other technicians as well as a renewal of the political staff resulting from elections. Consequently, the same awareness raising task has to be done again, notably each time a new planning process is launched. These interruptions, during which attention to ecological connectivity is lower, should therefore be avoided. Mainstreaming efforts could certainly contribute to an increased and deep-rooted consideration for connectivity. It may also be relevant to think about planning timelines that boost long-lasting attention to the issue. Mid-term monitoring operations are often poorly considered (despite their importance) for checking the proper implementation and ecological relevance of planning decisions. However, these steps may be viewed as key events and opportunities for maintaining broad awareness.

4.9. Multifunctionality as a source of opportunities and drawbacks

The recognition of multifunctionality is frequently viewed as a relevant way to protect landscapes and areas that contribute to ecological connectivity. This is based on the assumption that the identification of benefits provided by ecosystems (e.g. provisioning, regulating and cultural services) to human society and thus the attribution of their specific value can contribute to their conservation and restoration. Such an approach largely echoes the founding principles of the EU green infrastructure policy, in which the green infrastructure concept is understood 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 and functions such as water purification, air quality, space for recreation and climate mitigation and adaptation* […] *in rural and urban settings*" (European Commission, 2013).

In addition to the recognition of the multifunctionality of areas belonging to an ecological network (e.g. corridors, stepping stones, etc.), some approaches also consider the contribution of areas in terms of fluxes (animal and vegetal moves between habitat patches, human soft mobility, connection of cultural sites, etc.).

The recognition of the multifunctional quality of specific landscapes and areas provides an interesting potential for justifying the integration of ecological connectivity aspects into spatial planning decisions. However, possible detrimental effects should not be neglected. Too much traffic and disturbances related to human presence can have negative impacts on biodiversity and ecological connectivity. On another note, the attribution of a multifunctional quality to specific areas in spatial planning documents can raise concerns among stakeholders (farmers, landowners, residents, etc.) about disturbances in the surroundings due to new anthropogenic uses.

4.10. An Alpine way to ecological connectivity?

The Alpine region cannot be considered as a pioneer when compared to other European regions in terms of addressing ecological connectivity in spatial planning. The different constraints were discussed in this report. However, numerous transnational projects that foster the consideration for ecological connectivity were conducted in the Alpine region in the last two decades and the link to spatial planning is increasingly becoming more obvious. Three main specificities and corresponding challenges can be identified in this context.

The preferential location of human settlements and infrastructures in the valleys tend to intensify land competition and landscape fragmentation on specific spots and linear spaces, although urbanisation dynamics may vary between regions. Consequently, there is a reinforced need for protecting or restoring the connectivity between mountains ranges, which are generally recognised for their high-quality nature and for being largely undisturbed by anthropogenic activities.

The abandonment of agricultural lands, such as pastures, orchards and vineyards, is all the more significant in rugged areas. These extensively exploited lands are generally considered of high ecological interest because of their habitat and connecting functions for various animal and vegetal species. In some cases, this two-faced issue is partially

addressed in spatial planning documents, even if doubts may be raised about their capacity to solve the problem in its entirety without additional measures or sectoral policies for supporting this extensive agricultural activity.

The Alpine Convention perimeter includes a large number of protected areas (national parks, regional nature parks, natural reserves, biosphere reserves and other specific protections) and associated competences regarding biodiversity management. Historically speaking, protected area staffs did not always seek to develop specific skills in the field of ecological connectivity despite their high knowledge in biodiversity conservation. This may be related to their spatial focus on ecosystems recognised for their intrinsic quality. However, theses specific resources in terms of biodiversity management have been directly involved in an increasing number of spatial planning processes and contributed to the development of methodologies for designing ecological networks in recent years. This expertise may provide a real opportunity for fostering the consideration for ecological connectivity in spatial planning processes in and even around protected areas in the years to come.

Additionally, consideration for ecological connectivity in spatial planning should be influenced by the specific attention paid to water issues and natural hazard risks. These two aspects – which have not been investigated in the context of this report – are certainly not exclusive to Alpine regions, but tend to manifest strongly in this context.

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5 Suggestions for Further Developments

PLACE study has highlighted the growing consideration for landscape fragmentation and ecological connectivity in spatial planning in the various national and regional contexts of the Alps. In the recent decades, the issue has been increasingly integrated into spatial planning systems in particular through the introduction of legal provisions that encourage or compel authorities to maintain and restore ecological connectivity. Alpine countries and regions are nevertheless showing different degrees of progress in the field. This process is still ongoing. On the ground, the focus on ecological connectivity has led some of the actors involved in planning processes to start paying closer attention to biodiversity and incorporating some of the needs of animal and plant species into their reflections and decisions. It may be seen as an encouraging progress and a first step towards a paradigm shift in spatial planning. This field of intervention was and still is largely dedicated to the organisation of space and allocation of land-use functions to strictly serve human needs.

However, there is still room for improvement. Among other things, the PLACE study has revealed the common challenge that administrations are facing in ensuring a proper and comprehensive consideration for ecological connectivity at the various planning levels. Above all, a part of the difficulty lies in the high complexity of the ecological dynamics to be apprehended in spatial planning processes. However, other obstacles can also be identified. Dealing with ecological connectivity entails introducing new expectations regarding biodiversity on lands that are devoted to diverse social and economic purposes and thus requires efforts in terms of governance, given the increased number of technicians and stakeholders potentially concerned by the decision. The task also requires an important effort in terms of sectoral integration as well as multiscale and cross-border collaboration given that ecological processes transgress the boundaries established by human communities. Although spatial planning is frequently acknowledged for its potential in terms of policy coordination, the emergence of new environmental, and in particular ecological, issues calls for further improvements in the field. In other words, ecological connectivity challenges spatial planning in many respects, although it can often be seen as the most appropriate field for addressing this issue.

Various aspects could have been addressed more closely in this study. Some of them are underlined below. These can be seen as new areas of investigation for future studies and as rooms for improving the consideration for ecological connectivity in spatial planning.

First, little attention has been paid to ecological connectivity in and around the hydrographical system in the report. The issue of connectivity takes a whole new face when focused on habitats and species related to riverine and lacustrine milieus as well as wetlands. The anthropogenic impacts on ecological connectivity in and around aquatic and wet ecosystems are various, notably in mountainous environments. Dams and weirs, including small ones, can significantly hinder the longitudinal movement of animal and plant species/populations alongside rivers and streams. The channelling and burial of watercourses also have big impacts on aquatic ecosystems and ecological connectivity. These are the most discernible factors of fragmentation. Nevertheless, other processes such as the construction of river embankments, the dredging of watercourses, the drainage of riverine areas and wetlands or the chemical alteration of water sections may have major impacts on ecological connectivity because of their altering effects on water quality, current speed, instream and riparian habitat integrity, etc. Additionally, the influence of river flow changes associated with water withdrawals for human consumption or flow regulations should not be neglected, especially in a context of climate change with an already observed and expected increase in number, duration and intensity of drought events. On the one hand, low waters can strongly affect the movement of animal or plant species. On the other hand, floods may be necessary for temporarily restoring hydrological and ecological connectivity between ponds. The functioning of the hydrographic system therefore implies another kind of complexity which is hardly considered in spatial planning processes. On this point, it should be noted that the distinction frequently made between land and water in dedicated policies does not account for the intricacy and interdependence of ecological processes between both milieus. Ideally, ecological connectivity should be considered with this interlinked relationship between blue and green components in mind.

Second, the question of the synergy between sectoral policies and spatial planning has received little consideration in the report. Spatial planning is often seen as a preferential field for dealing with ecological connectivity, especially because of the potential offered in terms of zoning policies and land-use regulations. However, it does not provide as much capacity in steering or guiding land-use management, which can have as much influence on landscape quality and ecological connectivity as the land-use zoning itself. For example, intensive agricultural practices often imply significant changes in the landscape organisation that can alter the ability of animal/vegetal species to take advantage of areas. Therefore, the impact of sectoral considerations (e.g. agriculture, forestry, energy, water, natural hazards, etc.) and related instruments (farmland protection programmes, agri-environmental measures, management plans, etc.) on landscape quality and ecological connectivity should not be neglected. However, significant differences can be observed between spatial planning systems in the range of sectoral issues to be considered through the processes and in the linkage established with other policy instruments. In other words, frameworks do not offer the same potential in terms of sectoral integration and, therefore, may limit the capacity of spatial planning to develop comprehensive solutions to improve or restore ecological connectivity.

Third, a focus could have been made on landscape cultures and landscape planning traditions given their influence on the way ecological connectivity is addressed. While the understanding of the landscape concept has been largely influenced by a strong tradition in landscape ecology in some countries, it has historically been associated with an aesthetic dimension in other ones. Additionally, the importance attributed to landscape varies significantly according to the national planning contexts. While landscape planning is recognised as a field in itself in some national planning systems, with documents to be formally developed and considered from a legal perspective, landscape may be viewed in other contexts as an issue to be considered among others in spatial planning processes. It may therefore be appropriate to investigate the place attributed to the landscape approach in planning systems and the influence this prism may have on the way ecological connectivity is addressed in the different countries.

Last, little has been said about the green infrastructure policy and the potential it may offer for restoring or maintaining ecological connectivity. Despite not having a fixed and univocal definition, the concept of green infrastructure has gained widespread resonance over the last decades, in particular through its popularisation in the spatial planning field. In the recent years, the concept has benefited from an increased visibility with its recognition and

promotion by the European Union as part of its post-2010 biodiversity policy. The green infrastructure has been seen in this specific context as the cornerstone of a strategy aimed, among other things, at tackling landscape fragmentation, ensuring wildlife existence outside protected areas, and allowing a more integrated approach to land use (European Commission, 2010). However, green infrastructure has been defined more recently as a "strategically planned network of natural and semi-natural areas with other environmental features which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings" (European Commission, 2013), thus placing less emphasis on the issue of ecological connectivity. Although some doubts have been raised about the actual capacity of this policy in effectively contributing to the maintenance or restoration of ecological connectivity, green infrastructure is frequently acknowledged as boundary concept that establishes links between decision-makers, spatial planners and other technicians. Additionally, the green infrastructure is increasingly seen as an adaptive solution to respond to the impacts of climate change. From a biodiversity perspective, the concept is sometimes expected to improve the resilience of ecosystems and to provide wildlife populations with a capacity to move and respond to climate change impacts on habitats.

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Glossary

Biodiversity refers to "the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems". (United Nations, 1992)

Design/designing refers, in this study, to the original delineation as well as to the transposition of ecological networks/corridors planned in upper-level documents (scheme, plan, map, etc.) into supralocal or local plans.

Ecological connectivity (also frequently mentioned under the concept of landscape connectivity) describes the degree to which the landscape facilitates or impedes, by its structure and composition, the movements of animal/vegetal populations, individuals, pollen, seeds and genes between habitat patches (Taylor et al., 1993; Rudnick et al., 2012). Connectivity relies both on a structural (i.e. the way physical characteristics of a landscape allows for movement) and a functional (i.e. the way populations, individuals, pollen, seeds and genes move through the landscape) components (Rudnick et al., 2012).

Ecological corridor refers to a landscape component "which serve[s] to maintain with ecological or environmental connections by providing physical (though not necessarily linear) linkages between the core areas [or habitat patches]" (Bennett, 2004), or to "a strip-like zone connecting wildlife populations separated by human activities or structures, which allows an exchange of individuals between populations" (Duflot et al., 2018).

Ecological data refers, in this study, to a combination of species-related data (fauna, flora, fungi), landscape-related data (topography, land-cover, land-use, soil, water) and mixed data (e.g. inventory of wildlife habitats and of other natural areas of ecological interest).

Ecological network refers, in this study, to "a coherent system of natural and/or semi-natural landscape elements that is configured and managed with the objective of maintaining or restoring ecological functions as a means to conserve biodiversity […]" (Bennett, 2004). The establishment of an ecological network generally relies on the identification of core areas, buffer zones and connecting corridors, in line with the "patch-matrix-corridor" model conceptualised in the field of landscape ecology (Forman and Godron, 1986).

Ecology expert refers, in a broad sense, to professionals or skilled individuals that are recognised in the spatial planning processes for their expertise in ecology and biology.

Landscape planning can be understood as the process of understanding and directing the dynamic human-nature interactions that are determined, in a given geographic space by biophysical characteristics, societal perception and governing institutions (von Haaren, 2002; Mann and Plieninger, 2017). It should be noticed that each country/language has its own understanding of the concept of landscape and therefore its own landscape planning tradition (Séguin, 2017).

Legally binding indicates the nature, in the field of spatial planning, of the processes, documents, norms and goals that are enforceable by law.

Local planning level refers to the lowest planning level (usually the municipality) recognised in the state/regional or national/federal spatial planning system. It frequently corresponds to the land-use regulation level.

Spatial planning refers, in a broad sense, to a combination of methods essentially used by the public sector to influence the distribution of resources and activities in spaces of various types and scales. Spatial planning will thus simultaneously be understood as a generic term referring to regional planning, urban planning and town planning from a scale perspective, and to land-use planning, urban/town development planning, strategic planning or even landscape planning from an approach perspective.

Supralocal planning level refers to an intermediary planning level (usually the district, the province, the metropolitan area, a specific planning area, etc.) recognised or not (there may exist non-statutory planning processes) in the state/regional or national/federal spatial planning system.

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Abstract

The PLACE report provides an overview of how the issue of ecological connectivity is addressed in spatial planning systems and practices throughout and around the Alpine arc. Early in the 1990s, ecological connectivity became a cornerstone for different nature conservation policies across Europe, considering that the traditional approaches, based on the protection of isolated areas, were essentially failing in tackling the loss of biodiversity observed worldwide. Recent developments in the scientific field of landscape ecology have called for apprehending ecological dynamics throughout the overall territory. Moreover, restoring and maintaining ecological connectivity have been considered as objectives that land management and spatial/landscape planning policies at the EU, national and regional levels should reach.

However, the way of planning ecological networks/corridors to this end differs between countries and between regions, in a context of a growing questioning of the actual ecological functionality ensured by the projected infrastructures. This takes a specific form in the Alpine context given that the landscape fragmentation process manifests quite differently for geographical reasons; with a concentration in the valleys or on the foothills of human activities, urban settlements and transport infrastructures that hinder the capacity of wildlife species to move.

These different considerations led the "Ecological Network" Platform of the Alpine Convention to carry out a study on the topic. The results are compiled in this report. Among other things, it provides a comparative overview specifying the consideration for ecological connectivity in the different national spatial planning systems (Austria, France, Germany, Italy, Slovenia, and Switzerland), a depiction of the way ecological networks/corridors are designed/integrated in planning practices on the basis of 6 case studies located in or around the Alpine Convention area, as well as a set of lessons learned that reveal current challenges and potential improvements on the matter.

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