Federal Ministry
for Housing, Urban Development
and Building

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

Towards an Alpine Spatial Development Perspective

Synthesis Report: Compilation of three input papers

On behalf of the Spatial Planning and Sustainable Development Working Group of the Alpine Convention
Mandate 2023-2024

September 2024

Tobias Chilla, Hannah Paul, Dominik Bertram, Markus Lambracht
FRIEDRICH-ALEXANDER-UNIVERSITÄT ERLANGEN-NÜRNBERG

Friedrich-Alexander-Universität
Erlangen-Nürnberg

Summary

This synthesis report takes first steps towards an *Alpine Spatial Development Perspective* (ASDP). The document summarises the state of the art in literature and project reports, and gives an insight into the reflections of the *Spatial Planning and Sustainable Development Working Group of the Alpine Convention* (WG SPSD). The ASDP takes three sectoral perspectives and positions them in relation to spatial development in the Alpine region. The sectoral perspectives include transport & connectivity, green infrastructure and economic development.

Even if the wording of Alpine spatial planning and development sounds rather intuitive, it addresses a complex setting with several dimensions. The pan-Alpine level brings together eight countries, including more federal or centralized systems, EU and non-EU countries, and large and small states. All these countries are organized in a multi-level way, including regional, local and European levels. Further, spatial planning and development must be distinguished. Formal and legally binding planning is mostly assigned to the local and regional level. Spatial development functions in a ‚softer' way. Strategic plans, funding programs and governance processes play an important role. Both planning and development have the task of coordinating sectoral policies and dynamics from a spatial perspective, and vice versa, spatial planning and development are strongly influenced by sectoral dynamics.

The chapter on transport and connectivity highlights the main challenges for transport in the Alpine region (environmental issues and accessibility) and gives a brief overview of current policy options. At the EU level, the TEN-T regulations and the Sustainable & Smart Mobility Strategy are most prominent. Pan-Alpine approaches include the Transport Protocol of the Alpine Convention, the EUSALP Declaration on Rail Transport, the Common Transport Strategy for the Alpine Regions of iMONITRAF! as well as the first Report on the State of the Alps on Transport and Mobility. Most of these approaches are of a rather 'soft' instrumental character. At national and regional level, a variety of instruments ensure concrete measures and technical implementation. In addition, a number of strategic documents are also in force at this level. The number of general guidelines, policy documents and concrete measures is high, both in the field of transport and connectivity and in the field of spatial planning and development. At the pan-Alpine level, the linkage between transport and spatial development is rather incremental.

The chapter on green infrastructure and energy highlights key topics and challenges for the Alpine region. Climate change and adaptation, biodiversity, land use and risk mitigation are closely linked to green infrastructure and spatial development. Furthermore, energy challenges are particularly relevant and the current dynamics of energy policies go hand in hand with the question of land competition and environmental issues. The number of related spatial development targets and vision-making documents is high on the pan-Alpine level. Technical planning instruments are not in place, even if several Alpine Convention protocols are topical (e.g. nature protection, soil conservation). In parallel, a number of soft instruments play an important role, mostly in form of project reports (e.g. by OpenSpaceAlps). At national and regional level, a variety of strategic documents formulate targets and strategic pathways. Again, binding planning instruments are to be found on domestic levels.

The discussion on Alpine economy is relatively recent compared to the discourses on transport and environmental issues. This third chapter starts with the economic challenges of the Alpine region, including 'drop height' after rather successful decades in most parts, topogra-

phical challenges for infrastructure, demographic trends, lacking critical mass in globalisation dynamics, and environmental and sustainability issues. The spatial perspective in economic development differs widely across the multi-level system. At the EU level, the Green Deal Industrial Plan and the European Employment Strategy have to be mentioned. At the pan-Alpine level, several documents formulate strategic targets and visions. Pan-Alpine approaches include several declarations of the Alpine Convention (e.g. 'Fostering a sustainable economy in the Alps'). From its early years on, the Alpine Convention has underlined the importance of endogenous economic potential of the Alpine region. The pan-Alpine level is dominated by strategic approaches, while the domestic levels are most relevant in terms of specific target formulations, binding regulatory frameworks and implementation.

In the coming years, the ASDP will position and develop the different elements towards a common (spatial) vision, including thematic, geographical and procedural aspects. In the coming steps, the sectoral perspectives have to be completed, and an integrated reflection has to provide a cross-sectoral vision. The spatial dimension of sustainable development entails the promotion of a cross-sectoral and cross-border approach, which is a crucial element in achieving harmonious sustainable development.

Table of contents

List of figures

1 Introduction

1.1 The 'Alpine Spatial Development Perspective'

The aim of this document is to make first steps towards an 'Alpine Spatial Development Perspective'. This objective is part of the mandate of the Spatial Planning and Sustainable Development Working Group of the Alpine Convention. The background is as follows:

- The Alpine region can be seen as the 'contact zone' of a number of nation states and their regions, bringing together a high territorial diversity. This setting comes along with a variety of planning systems and administrative cultures which can challenge consistent policy development.[1]
- At the pan-Alpine scale, spatial planning and development is organised in a rather complex way. Three transnational cooperation formats have to be mentioned in this context, namely the Alpine Convention (AC), the EU Strategy for the Alpine Region (EUSALP) and the INTERREG Alpine Space Programme (ASP). All of them have underlined the need for sustainable spatial development on the pan-Alpine scale – in particular the Alpine Convention's Protocol on Spatial Planning und Sustainable Development[2], the EUSALP Joint paper on Spatial Planning, the Reports on the State of the Alps[3] and many ASP projects.[4]

The SPSD WG has initiated a process aiming at a long-term perspective for spatial planning and development. This Alpine Spatial Development Perspective has to be seen as a process rather than just a document. The mandate phase 2023/24 of the Working Group provides important elements, based on three participatory elements and feedback loops, exploring important thematic foci, namely linking the Alpine Spatial Development Perspective with

a) transport and connectivity,
b) green infrastructure and energy, and
c) economic development.

Each participatory event was accompanied by an input paper, presenting important background information and guiding questions. Fig. 1 illustrates this approach.

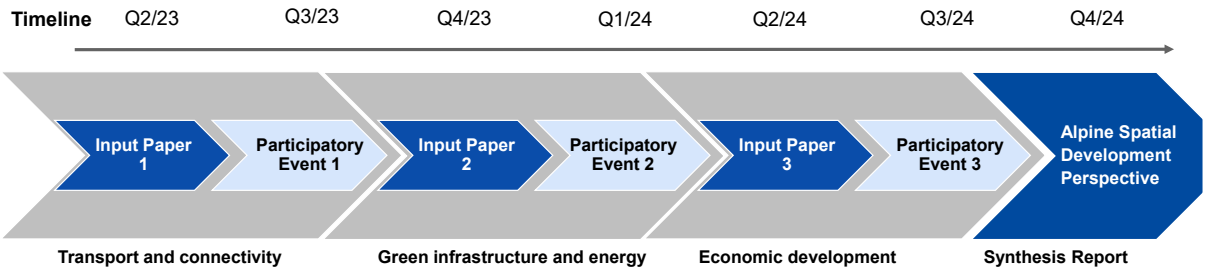

Fig. 1 Elaboration process towards the Alpine Spatial Development Perspective (FAU, 2024)

1 https://www.espon.eu/Alps2050
2 https://www.alpconv.org/en/home/topics/spatial-planning/
3 https://www.alpconv.org/en/home/soia/report-on-the-state-of-the-alps/
4 For projects with a focus on cross-border regional development see this overview: https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/SPSD/Assessment_study_Cross-border_Cooperation.pdf

This synthesis report brings together the three input papers. The aim is to provide a structured overview that can feed the debate. Chapter 2 addresses transport and connectivity in the Alpine region, Chapter 3 green infrastructure and energy, and chapter 4 economic development in the Alps. This process towards a joint vision helps to facilitate the dialogue between actors with very different mandates for Alpine development and can increase the consistency of concrete measures. The approach is inspired by the long-term vision in the Baltic Sea region. Already in 1992, the involved partners decided to develop visions and perspectives. The VASAB long-term strategy shows that joint efforts can lead to important spatial development objectives.[5]

1.2 Challenges of Alpine spatial planning and development

Even if the wording of Alpine spatial planning and development sounds rather intuitive, it addresses a complex setting with several dimensions. The pan-Alpine level brings together eight nation countries including rather federal or centralist systems, EU and non-EU countries as well as large and small states. All these countries are organised in a multi-level way, involving the regional, municipal and European level.

Moreover, one has to differentiate spatial planning and development. First, planning in a formal and legally binding way is mostly assigned to the local and regional level. Second, spatial development addresses the topic in a less binding, 'softer' way. Funding programs, strategic plans, and governance processes play an important role in this field. Spatial planning – in a formal, juridical and technical sense – is mostly organised via domestic mandates (and with the implications of the Alpine Convention Protocol on Spatial Planning). Spatial development can be found throughout the multi-level system, including the pan-Alpine level.

Both spatial planning and development have the task of coordinating sectoral policies and dynamics from a territorial perspective; and vice versa, spatial development and planning are strongly influenced by sectoral dynamics (as visualised in Fig. 2)[6]. The integrated perspective is an important aspect of the sustainability objective of spatial planning and development: Balancing sectoral demands helps safeguarding future qualities of the Alps as a living space and habitat.

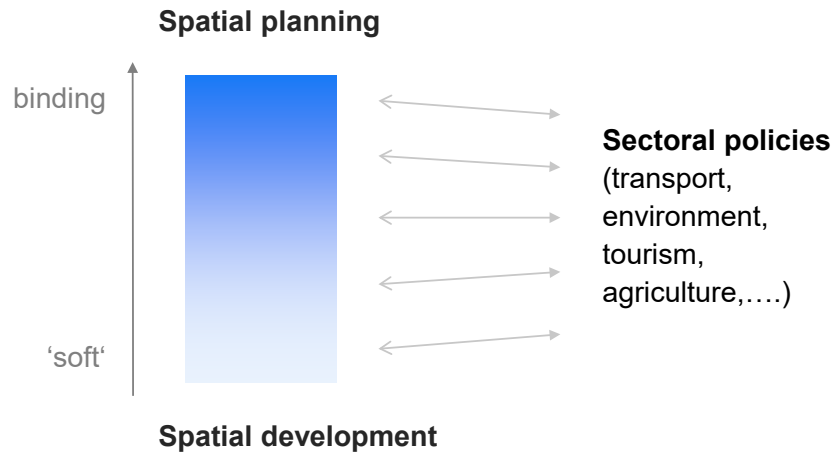

Fig. 2 Spatial planning, spatial development and sectoral policies (FAU, 2024)

5 https://vasab.org/home/about/long-term-perspective/; https://www.arl-net.de/system/files/pdf/2024-07/01_meltzian_0.pdf
6 https://doi.org/10.1659/mrd.2023.00021

2 Linking spatial development and transport

2.1 Challenges of Alpine transport and connectivity

2.1.1 Overview

Mountain regions exist all across the European continent. Fig. 3 shows the European mountain ranges from a transport perspective.[7] [8] Geographic features vary widely, including long mountain ranges (e.g., Alps, Apennines, Carpathians, Pyrenees, Scandes) and isolated mountain massifs such as those of Central Europe (e.g., the middle mountain ranges of Germany, mountain ranges in Spain, and mountains on many islands).

The Alpine mountains include both sparsely populated rural areas and large urban centers. While some valleys have little transport infrastructure, others are part of the Trans-European Transport Network (TEN-T). In most other European mountain regions, the core networks largely bypass the mountains rather than crossing them.

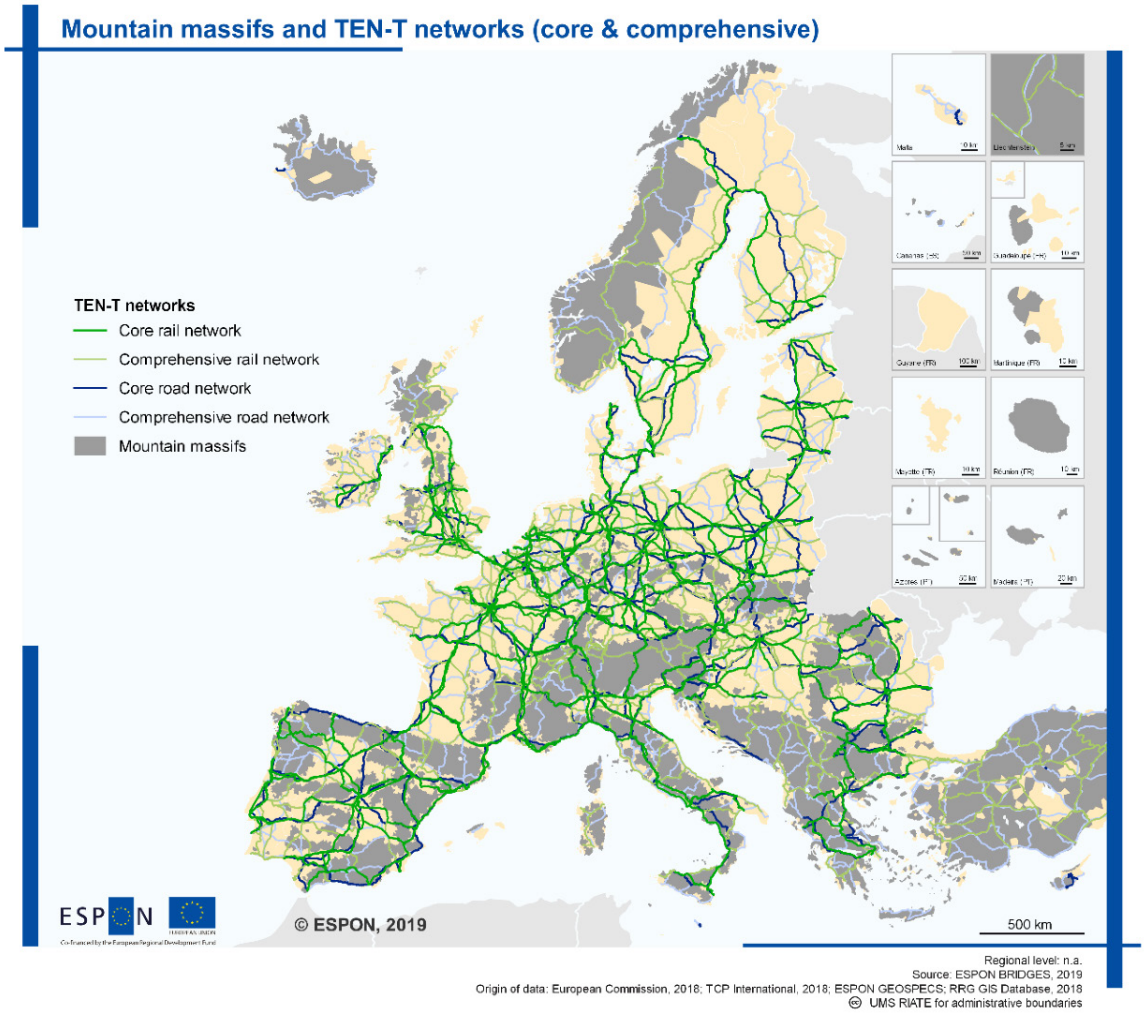

Fig. 3 Mountain massifs and TEN-T networks (ESPON BRIDGES, 2019)

7 This report addresses overlapping concepts and wordings:
- 'Transport' focuses in particular on technical infrastructure and capacities, both for passengers and freight
- 'Mobility' focuses on people and their behavior (radius of mobility, modal split etc.)
- 'Accessibility' focuses on the effort needed to reach certain destinations
- The wording of 'connectivity' is used in the coming sections as the concept that aims at a sustainable organization of transport, mobility, and accessibility.

8 https://www.espon.eu/sites/default/files/attachments/BRIDGES%20-%20Final%20Report.pdf

When reflecting on Alpine connectivity from a territorial perspective, some specificities have to be taken into account. It is in particular true that concrete measures and projects…

- … tend to be much more expensive, difficult, and sometimes dangerous in mountain regions than in non-mountain regions.
- … have to accept that the share of suitable sites for connectivity measures is lower than in non-mountain regions.
- … have to respect a high vulnerability of the mountain context (ecological threats, specific sound and air emission distribution etc.).

Moreover, and from the perspective of sustainability, the following dimensions have to be addressed: The social dimension of sustainability means, amongst others, that services of general interest have to be accessible for all, and with affordable costs. From an economic perspective, it is crucial that the financial investments are in a reasonable proportion to the expected benefits. The environmental postulates of sustainability request in particular the minimisation of the ecological footprint. The following sections provide some more background on these challenges.

2.1.2 Environmental challenges

Transport with its fundamental socio-economic functions on the one hand and environmental concerns on the other hand is often in a systemic conflict. A good provision of infrastructure is a key to socio-economic development. However, the environmental impact of traffic and mobility is enormous – especially in the Alpine region.[9]

Mountains function as natural barriers, forcing traffic flows onto a limited number of corridors, including some high mountain passes and tunnels. These transport corridors are often located in those valleys where population density is high. At the same time, the morphological shape of valleys often leads to higher concentrations of emissions. Due to the topography, the emission load in Alpine valleys is three times higher than in non-mountainous areas (inversion effects etc.). Therefore, some rural areas in the Alps have similar air quality problems as highly urbanised areas elsewhere.[10] In addition, the increasing volume of freight and passenger traffic by road and rail leads to high noise levels in the narrow Alpine valleys. The 'amphitheater effect' results in strong noise propagation along the valley and uphill.[11] Another environmental challenge is the barrier or fragmentation effect of habitats caused by traffic routes and the associated separation of animal populations and their migration.

The Alps are an important transit region as they are located between major economic centers such as Milan, Munich and Vienna. In recent decades, the traffic volume crossing the Alps has increased significantly.[12] The high growth rates of freight transport in the mountain regions are the result of the growing economic integration in Europe.

It must be emphasised that climate change is a major issue in the Alpine region, in particular due to its accelerated pace. The urgency of measures towards a decarbonised transport system is obvious. The Alpine Climate Board has developed concrete pathways in order to implement the Alpine Climate Target System 2050, including the transport sector.[13]

9 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/2-Report_policies_FIN.pdf, https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016
10 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/Transport_Annex4_IT_Air-quality-sustainable-mobility.pdf
11 https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Topics/transport/AlpineConvention_TransportWG_ExternalCostsNoise_112018_web.pdf
12 https://transport.ec.europa.eu/system/files/2020-07/2020-alpine-traffic-observatory-key-figures-2019.pdf
13 https://alpineclimate2050.org/climate-action-plan-2-0/transport/

2.1.3 Accessibility challenges

As mentioned above, the Alps are part of the Trans-European Transport Network (TEN-T). Seven of the nine core trans-European corridors cross the Alps. Some pass the mountains on a north-south axis (Scandinavian-Mediterranean corridor, North Sea-Alpine corridor and Baltic Sea-Adriatic Sea corridor), while the Rhine-Danube corridor shows an east-west orientation.[14] The Brenner Base Tunnel project is a link and core element of the Scandinavia-Mediterranean axis.[15] In terms of transit transport, the number of net tons transported per year has increased on almost all corridors.[16]

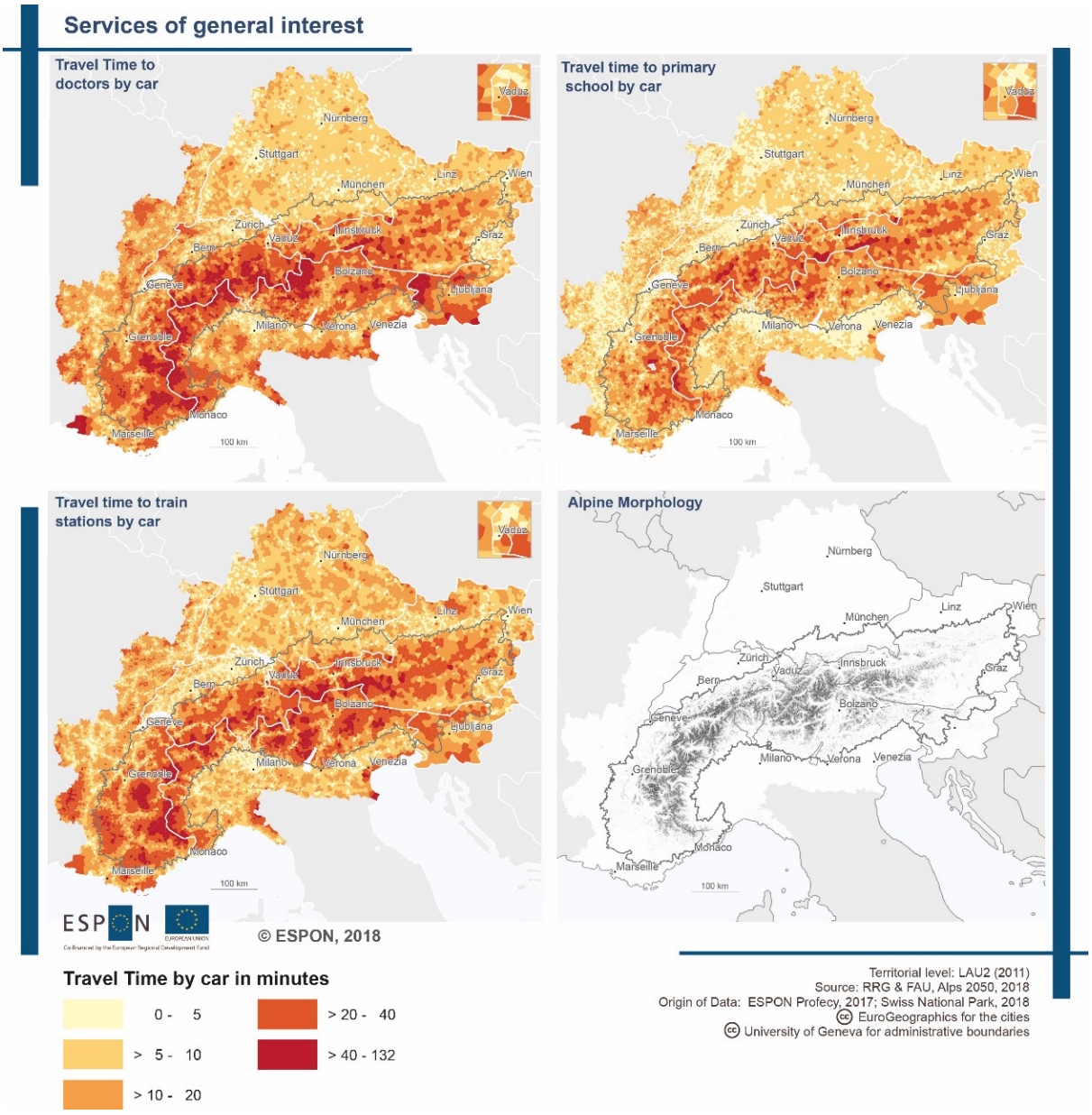

Fig. 4 Accessibility of services of general interest in the Alpine region (ESPON Alps2050, 2018)

14 https://transport.ec.europa.eu/system/files/2021-12/COM_2021_812_annex3_4.pdf
15 https://www.bbtinfo.eu/ten-achse/
16 https://www.tirol.gv.at/fileadmin/themen/verkehr/verkehrsplanung/Carole/Dokumente/Policy_scenarios_2030.pdf

One has to mention that the major transport links are not only important for transit purposes but also for the functioning of the Alpine economy. Many production and service sectors in the Alps are highly integrated into the European and global economy. The prosperity and demographic development of the Alps depends to a large extent on a functioning transport system that allows for a diversified economy.

However, Alpine connectivity is not only relevant from a European point of view, but also from an internal accessibility perspective. The accessibility of services of general interest in the Alps is shown in Fig. 4, in particular the travel times by car to doctors, primary schools and train stations.[17] It is obvious that the provision of services of general interest is much more difficult in mountainous areas than in non-mountainous areas. This underlines the relevance of connectivity with regard to territorial cohesion and its socio-economic dimension.

2.2 The instrumental perspective

In addressing the interface between spatial planning & development and transport & connectivity in the Alps, we propose to take an instrumental perspective. Fig. 5 provides an overview of prominent documents and strategies in these fields.

	General	Spatial planning & development	Transport & connectivity
European	– UN 2030 Agenda for Sustainable Development – European Green Deal – 2030 Climate Target Plan – European Recovery Plan – Green Deal Industrial Plan	– Territorial Agenda 2030 – Leipzig-Charter (2007) / New Leipzig-Charter (2020)	– Sustainable & Smart Mobility Strategy – TEN-T Regulations of 2013 (currently revised)
Pan-Alpine	– "Alpine Convention (Framework Convention") – EU Strategy for the Alpine Region (EUSALP) – Alpine Climate Target System 2050	– Spatial Planning and Sustainable Development Protocol of the Alpine Convention – EUSALP Joint Paper on Spatial Planning – ESPON Alps 2050 – RSA 9: Alpine Towns – Works by OpenSpaceAlps and AlpPlan network	– Transport Protocol of the Alpine Convention – Climate Neutral Alpine Mobility – Report on Policies for Sustainable Mobility in the Alps of the Alpine Convention – EUSALP Declaration on rail transport – iMONITRAF! Common transport strategy for the Alpine regions – RSA 1: Transport and Mobility in the Alps
National	– [div.]	– CIPRA Handbuch Alpine Raumordnung (AT) – National plans, planning concepts and guidelines (e.g. Spatial Development Strategy (SI)	– National energy and climate plans (NECPs) – National mobility strategies (e.g. Austria's 2030 Mobility Master Plan, Swiss Transport Outlook 2050) – Technical plans
Regional & local	– [div.]	– Plans, planning concepts and guidelines	– Mobility strategies (e.g. Tirol auf Schiene) – Technical plans

Fig. 5 Relevant documents and strategies for the spatial planning and transport nexus (FAU, 2024)

17 https://www.espon.eu/sites/default/files/attachments/02_alps_2050_FR_annex_ATLAS.pdf

The figure shows a thematic differentiation in the columns:

- **'General'** documents comprise overarching strategies that do not concentrate on transport or spatial planning as such, even if they do have an impact on these fields. At the EU level, the European Green Deal and the 2030 Climate Target Plan have indirect implications, both on transport and connectivity and spatial planning and development. At the pan-Alpine level, the Alpine Convention and the EUSALP provide an important framework. These documents contribute to the UN Sustainable Development Goals on the global level.
- A series of **spatial planning and development** strategies include more formal (binding) and 'soft' approaches. At the European level, two perspectives are prominent: The Territorial Agenda 2030 (TA2030) and the Leipzig Charter (New Leipzig Charter of 2020). The TA2030's objectives for transport in mountain areas ask for reliable secondary and local transport networks, linked to transnational networks and urban centers, are essential for quality of life and business opportunities. At the pan-Alpine level, a number of soft instruments play an important role, some of them more in the form of reports than political documents (such as the ESPON Alps 2050 project). Only the Alpine Convention Protocol on Spatial Planning has a juridical character. At the national and regional level, a series of plans, guidelines, and strategies for spatial planning and development are in place.
- In the field of **transport and connectivity**, several documents provide different access points. The EU level is particularly relevant with the TEN-T Regulations and the Sustainable & Smart Mobility Strategy. Pan-Alpine approaches include the Transport Protocol of the Alpine Convention, the EUSALP Declaration on Rail Transport, the Common Transport Strategy for the Alpine Regions of iMONITRAF![18] and the first Report on the State of the Alps on Transport and Mobility[19]. Similar to spatial development, most of the documents are of a rather 'soft' nature. At national and regional level, a variety of instruments ensure concrete measures and technical implementation. In addition, a number of strategic documents are also in force at this level.

Obviously, this compilation is far from being complete, but it provides a structured overview. At the pan-Alpine level, it also shows the incremental character of both, the spatial and transport policies. In the coming years, the strategic development can take important steps towards a more integrated vision. The Alpine Spatial Development Perspective aims to contribute in this sense. The following sections provide some more background information on the current debates on policy options.

2.3 Policy options from the transport and connectivity perspective

The ongoing efforts to address the connectivity related challenges in the Alpine region are enormous. Simplifying largely, measures can be categorised in four groups, as illustrated in the following sections.

18 http://www.imonitraf.org/i4Def.aspx?TabId=364&lang=en
19 https://www.alpconv.org/en/home/news-publications/publications-multimedia/detail/rsa1-transport-and-mobility-in-the-alps/

2.3.1 Infrastructure investment

Improving infrastructure is a very obvious approach, but often a controversial issue. Prioritising investment is a challenge, given the high volumes that are necessary to make a difference.

The priorities have to be clarified: How to balance transit and internal accessibility aims? How to balance the different transport modes and intermodal infrastructure investment needs, etc.?

The bottlenecks in transport infrastructure are an important example, many of which have a cross-border dimension. As infrastructure was for a long time a purely domestic mandate, many border regions still suffer from relatively poor connectivity, despite the efforts of European programs and cross-border cooperation. The macro-regional cooperation has provided an inspiring example of how to support the closing of gaps. Moreover, large differences in per capita investment in rail infrastructure within the Alpine region must also be taken into account.[20]

The ARPAF project (WP2 cross-border mobility in the Alpine region) showed that fast train connections mainly exist between metropolitan regions along the fringe of the inner-Alpine area (e.g. Milano-Verona, Munich-Vienna).[21] Moreover, national rail connections tend to be much better than international ones. This is due to the high path-dependency of transport infrastructure, which relies on large investments and long planning and implementation periods.

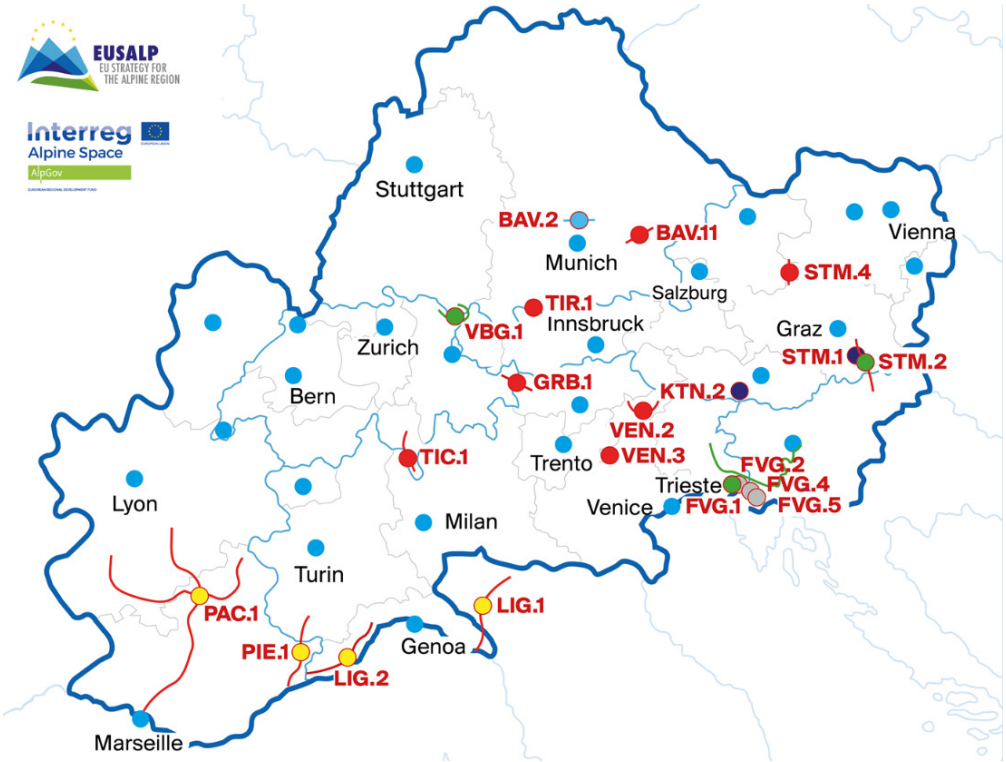

Fig. 6 Sustainable mobility solutions with high macro-regional relevance in the Alpine region (**Cooperation:** FVG.2: COMODALCE, FVG.4: New cross-border rail, FVG.5: SMARTLOGI; **New infrastructure:** GRB.1 Alpine Crossrail, STM.4: Alpine Western Balkan Corridor, TIC.1: AlpTransit Sud, TIR.1: Fernpass Railway, BAV.11: Four-track expansion, VEN.2: Treno delle Dolomiti, VEN.3: Collegamento Ferroviario; **Public transport rail:** STM.2: Inter-Regio rail, FVG.1: CROSSMOBY, VBG.1: Bodensee-S-Bahn S7; Terminal infrastructure: KTN.2: Logistics Center Austria South, STM.1: Cargo Center Graz (CCG); **Upgraded, electrified infrastructure:** LIG.1: Parma; LIG.2: Genoa-Marseille, PAC.1: Multimodal axis Valence-Val de Suze, PIE.1: Cuneo-Ventimiglia-Nice; **Digitalisation, ticketing:** BAV.2: Expansion of the MVV network; EUSALP, 2018)

20 https://de.statista.com/statistik/daten/studie/70006/umfrage/investitionen-in-schieneninfrastruktur-pro-kopf/
21 https://www.alpine-region.eu/projects/arpaf-crossborder

Based on these insights, the EUSALP Action Group 4 on mobility has prioritised sustainable mobility solutions in the Alpine Region with a high macro-regional relevance. So far, after two assessment rounds, 20 projects have been included in this group, many of them having a cross-border dimension (see Fig. 6).[22] This procedure helps to communicate the projects' support by the macro-region towards decision-making authorities at all levels.

2.3.2 Digitalisation and technical optimisation

Digitalisation is a major trend that can improve the efficiency and also the comfort of mobility solutions. In principle, this applies to both passenger and freight transport.

In practice, this means e-ticketing for public transport and real-time booking for freight, artificial intelligence for timetable optimisation, on-demand services for last-mile mobility, and many other options. Many sharing options are also based on digital (platform) solutions.[23] Even if the current state is experimental, autonomous driving has a potential for the accessibility and mobility, especially in peripheral regions.[24]

Moreover, and more generally speaking, the trend towards digitalisation could reduce the need for mobility, e.g. in terms of teleworking, home-based healthcare services, e-banking services, e-government (e-ID, e-Voting) etc. However, it remains to be seen whether this will lead to a real reduction in mobility or rather to a change in mobility patterns (second homes, leisure mobility etc.).[25]

Even if digitalisation can help optimising the use of transport infrastructure, it must be seen as an infrastructure demand, including hardware facilities (broadband qualities), software solutions (ticketing) and social issues (skills, digital divide etc.). In particular, the cross-border character of the Alpine region poses fundamental challenges for data infrastructure. A good digitalisation framework must be based on a harmonised (open) data infrastructure among different actors, including public institutions and private enterprises, involving different languages, technical solutions etc.[26]

2.3.3 Modal shift measures

One of the key concerns in Alpine transport debates is to shift the modal share from road to rail (and partly soft mobility forms as bicycles). This is a cross-cutting objective and relevant for many policy options[27]. It requires infrastructure investments, especially in attractive rail-based services and in interfaces linking different mobility modes. Pricing and ticketing are important issues, asking for simple solutions that integrate different transport and mobility modes. Information and marketing are also important parts of the mobility transition.

The Alpine Convention, EUSALP and the Alpine Space Program have all contributed to this field with a high number of activities. To mention just a few:

- The EUSALP AG4 on mobility promotes specifically intermodality and interoperability, amongst others with Alpine Platform of Knowledge (PoK) for Mobility and Transport[28]
- The Alpine Convention Transport Working Group has recently formulated the report on policies for sustainable mobility in the Alps, summarising the key aspects of a more rail-based connectivity[29]

22 https://www.alpine-region.eu/sites/default/files/uploads/result/1563/attachments/study_2018_-_overview_of_existing_pricing_components.pdf
23 https://www.alpine-space.eu/project/e-smart-2/
24 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/3-Report_technologies_FIN.pdf
25 https://www.eea.europa.eu/en/newsroom/news/digitalisation-can-support-shifting-to-more-sustainable-transport-in-europe
26 https://www.alpine-region.eu/sites/default/files/uploads/publication/2468/publications/digitalization_and_services_of_general_interest.pdf
27 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/Transport_Annex1_FR_Modal-shift.pdf
28 https://www.alpine-region.eu/results/alpine-platform-knowledge-mobility-and-transport
29 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/2-Report_policies_FIN.pdf

- A series of INTERREG Alpine Space projects has supported these ambitions, e.g. with 'Linking Alps' or, more recently, 'H2MA (Green Hydrogen Mobility for Alpine Region Transportation)'

Fig. 7 shows the trend for trans-Alpine transport.[30] The mobility demand is increasing and the share of road-based transport is rising, despite all the efforts across the multi-level system. Thus, innovation and digitalisation of road logistics are essential to manage flows in the Alpine area, especially in an intermodal manner. These measures can be even more effective if infrastructural bottlenecks are addressed (e.g. maintenance management).

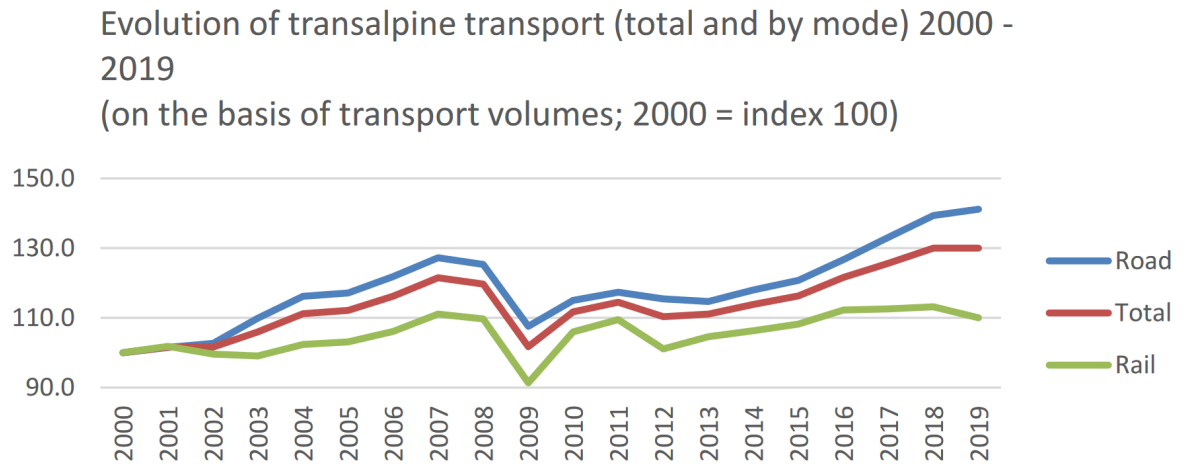

Fig. 7 Evolution of transalpine transport (Sigmaplan, Interface Transport, Fusseis, Trasporti e Territorio, 2020)

2.3.4 Cooperation and harmonisation

Most Alpine countries and regions have introduced measures to improve modal splits and reduce the environmental impact of freight and passenger transport. These measures range from regulatory measures, such as driving bans or speed limits, to pricing measures. However, uncoordinated approaches can lead to undesirable effects such as avoidance routing. The different toll policies in Alpine countries are amongst the most controversial issues.[31] Fig. 8 shows the average tolls charged on the large Alpine transit corridors.[32]

The toll level is amongst the most important factors influencing individual route choices. Avoidance routing can lead to congestions, higher maintenance costs and to higher air pollution. Against this background, a better-aligned toll policy is discussed as important policy option.[33]

This example shows that policy development can profit from cross-border and Pan-Alpine alignment. The 'Follow up Zurich' process is promising in this regard. It provides a platform for the transport ministers of the Alpine countries. The aim is to find common solutions to the various challenges affecting the Alps and transport. These include safety, traffic management and modal shift from road to rail.[34]

30 https://transport.ec.europa.eu/system/files/2020-07/2020-alpine-traffic-observatory-key-figures-2019.pdf
31 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/1-Report_Eurovignette_FIN.pdf
32 https://www.alpine-region.eu/sites/default/files/uploads/result/1563/attachments/study_2018_-_overview_of_existing_pricing_components.pdf
33 https://www.alpine-region.eu/sites/default/files/uploads/result/1563/attachments/study_2018_-_overview_of_existing_pricing_components.pdf
34 https://www.bav.admin.ch/bav/de/home/allgemeine-themen/internationale-abstimmung/suivi-de-zurich.html

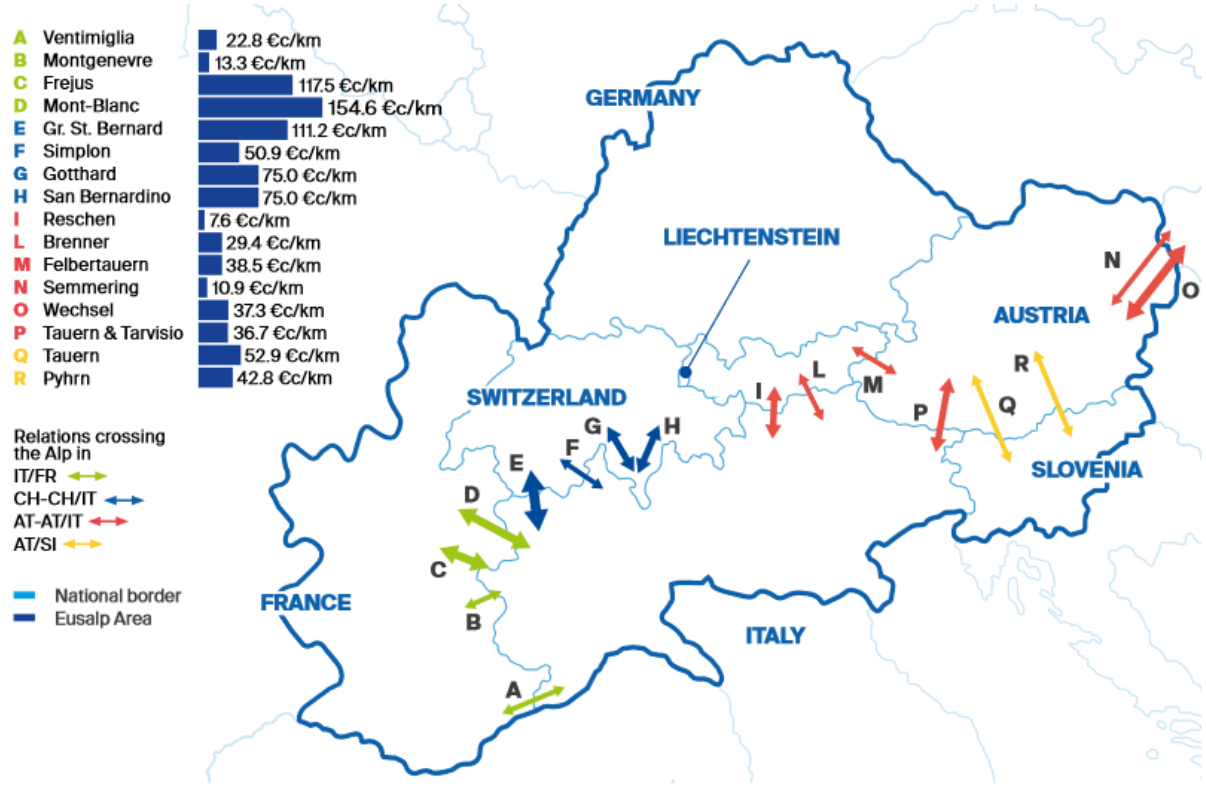

Fig. 8 Average tolls per km from a pan-Alpine perspective (EUSALP, 2018)

2.4 Policy options from the spatial perspective

The illustrated examples show that transport and connectivity have a strong spatial dimension. At the same time, spatial planning and development have a prominent link to connectivity issues. In highly simplifying terms, the role of spatial planning and development for transport and connectivity policies can be summarised in two lines of thought.

2.4.1 Implementation and cross-sectoral coordination

Obviously, spatial policies have a rather technical role to play as they have to ensure the implementation and realisation of infrastructure measures. For example, transport corridors have to be part of regional and municipal plans that guarantee planning reliability. Spatial planning might also help to anticipate future needs for more innovative solutions (e.g., areas for inter-operability facilities). In any case, planning solutions have to take a 'place-based perspective' that thoroughly considers the concrete contexts (touristic hotspots, inner Alpine peripheries, sub-metropolitan settlements etc.).

Spatial planning has a coordinative role to play. It has to anticipate potential contradictions and problems that can arise when other sectors come into play. Tourism infrastructure investment or new production facilities with freight flows are just two examples that illustrate the need for intersectoral coordination. Most of these issues are part of the daily planning routines on the domestic, regional, and local level. However, cross-border alignment and pan-Alpine strategies can rather be regarded as a potential, given the domestic character of spatial planning systems.

2.4.2 The strategic role of spatial structuring

Transport and connectivity measures are often discussed as a need for action *resulting* from existing spatial structures: passenger mobility between places of residence and of work 'exist'; economic flows between places of production and trade 'are there'; etc.

In a perfect planning scenario, the spatial structure *anticipates* transport and infrastructure needs. This applies in particular for the spatial organisation of settlement systems.[35] For example, it is important not to have an over-dense concentration that leads to congestions and overloads of the central areas. On the other hand, a too dispersed organisation leads to inefficiency and unnecessary mobility. The optimal planning principle in this context is *decentral concentration*, allowing for efficient linkages between the important activity zones and the efficiency of territorial functions. This means to define development and infrastructure corridors, functional linkages as well as protected zones. Even if – in practice – planning has to deal with existing structures, it can still influence future development. In this context, there are already a number of municipal and regional activities.

Ambitious planning does not only anticipate dynamics across sectors, but also formulates strategic objectives and long-term priorities in a thematic and geographical way. This applies to all scales – most obviously to the urban and regional scale, where this perspective is often part of the daily work. But it should also apply to border regions and on the transnational scale. The ESPON Alps 2050 project already showed first ideas without being very concrete.[36]

35 https://alpinetowns.alpconv.org/
36 First steps towards a common vision from spatial planning & development were proposed in the ESPON project Alps 2050

2.5 Towards vision making

As pointed out, the number of general guidelines, policy documents, and concrete measures is high – both in the transport and connectivity field as well as in spatial planning and development. However, at least at the pan-Alpine level, the setting is somewhat incremental.

An Alpine spatial development perspective can complement this setting with a common vision including thematic, geographical and procedural aspects. The elaboration of a more concrete vision would help to broaden the debate and to speed up the implementation processes. This is where the two Alpine Convention working groups **'Spatial Planning and Sustainable Development'** and **'Transport'** came into play. In a joint meeting, the two working groups participated in a workshop (September 2023, Paris) to work towards integrated perspectives and visions (see Fig. 9).

Fig. 9 Participative mapping in the joint workshop of the Alpine Convention working groups 'Spatial Planning and Sustainable Development' and 'Transport' (Photos: Florian Lintzmeyer)

As a first step, the two working groups worked on important thematic interfaces between spatial development and transport. The most relevant interfaces discussed are mainly of a functional character. Accessibility of services of general interest, transport infrastructure, public transport, multimodality, interoperability and modal split/shift were addressed as key elements of Alpine transport and mobility. In Fig. 10 the Alpine infrastructure network is visualised. In addition, Fig. 11 illustrates the generalised documentation of the drawing elements of the workshop. At three work tables, the participants created three maps in a cooperative mapping approach. They drew maps on paper templates based on the following question: Where are the geographic priorities to address the link between spatial development and transport?

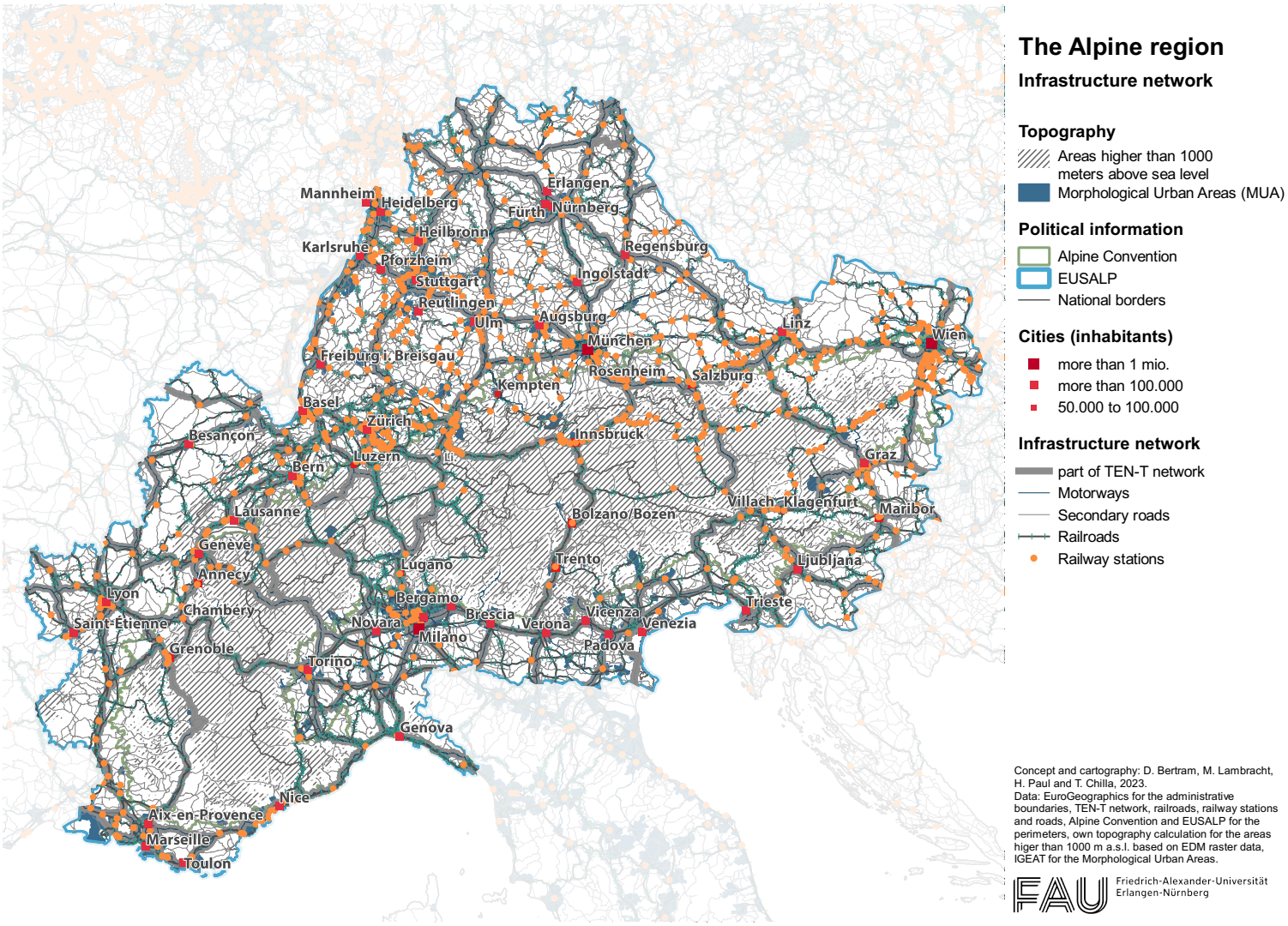

Fig. 10 Infrastructure network (FAU, 2024)

Indicator: Fig. 10 shows the Alpine infrastructure network consisting of railroads, railway stations, motorways and secondary roads and parts of the TEN-T network.

Description: In principle, the map illustrates a less densely organised infrastructure network in the inner-Alpine region than in the peri-Alpine region. The TEN-T network is mainly organised in a north-south direction crossing the Alps. The spatial pattern of railway stations and railroads displays clearly the morphology, in particular the valleys that host the rail infrastructure and railway stations.

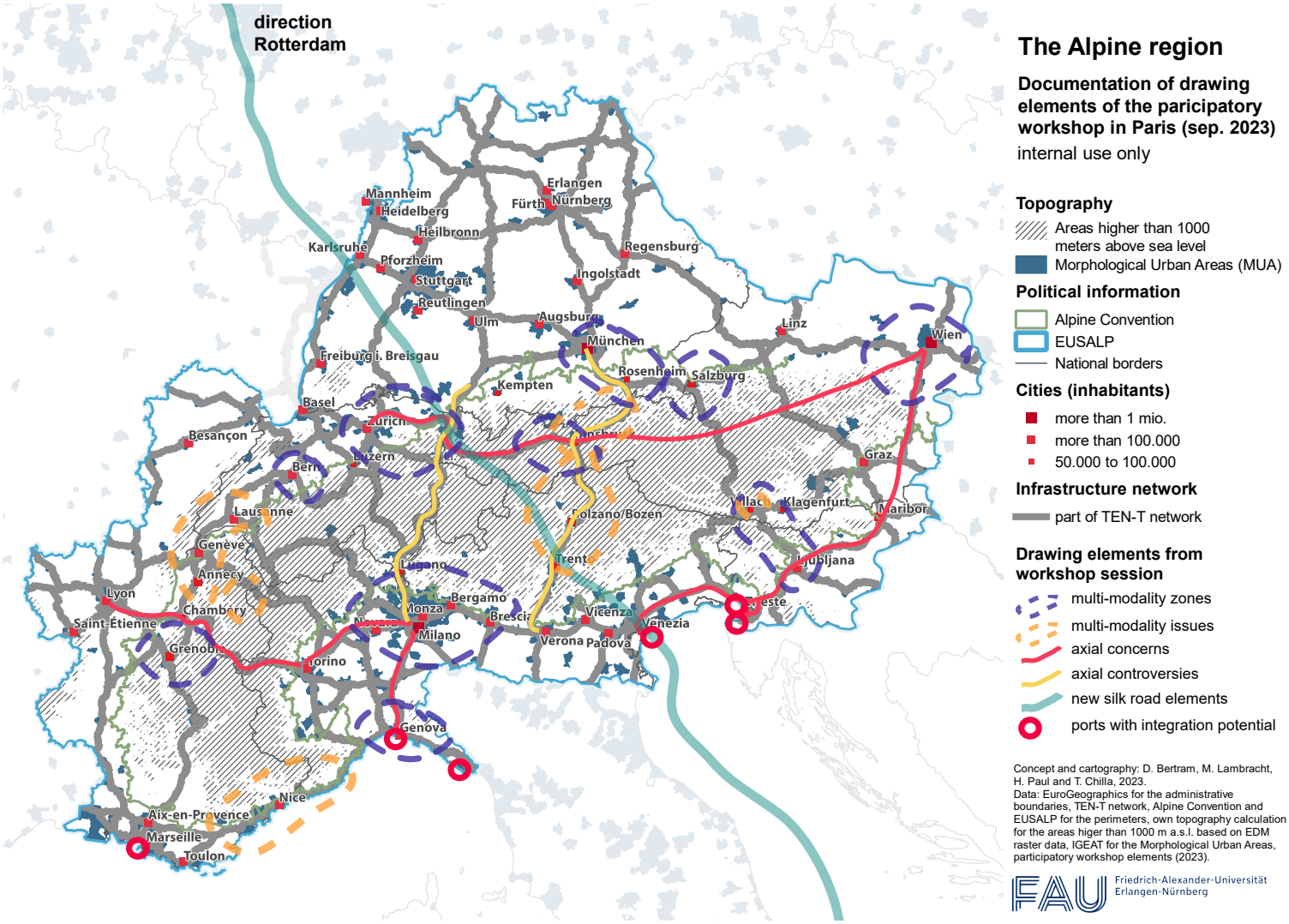

Fig. 11 Documentation of drawing elements of the workshop in Paris (FAU, 2024)

Indicator: Fig. 11 summarises and consolidates the results of the Paris workshop. The map focuses primarily on the areas identified in the workshop as those where the link between spatial development and transport is most relevant. The map differentiates between „multi-modality zones" (purple signatures) and „multi-modality issues" (orange signatures). Multi-modality zones were discussed as commuting zones where multi-modality elements are already implemented. ‚Multi-modality issues' are identified as areas with a particular need for further multi-modal activities. The red line signature indicates ‚axial concerns', i.e. corridors with high potential for improved connectivity. The yellow line signature refers to those corridors that have been identified as particularly sensitive. In addition to new silk road elements (teal signature), the map illustrates ports that the participants identified as potentially better integrated in the Alpine transport network. The map does not claim to be comprehensive; it merely documents the results drawn by the workshop participants.

Description: The overall picture illustrates high relevance of multi-modality within inner-Alpine commuting zones. The accessibility of important core areas in the Alps by multiple transportation modes is of key priority for sustainable Alpine spatial development. The Gotthard and Brenner axes have been discussed as specific bottlenecks. In this case, an integrated spatial development with a particular focus on modal split is essential. It is interesting that mostly east-west routes were discussed as axes with potential for further development (e.g. Lyon-Milan, Zurich-Vienna). A key aspect of Alpine spatial development is the integration of major ports into the existing infrastructural network as well as the discussions on new silk road elements.

The Alpine Spatial Development Perspective will further elaborate on these arguments.

3 Linking spatial development and green infrastructure

3.1 Challenges of green infrastructure and energy in the Alps

3.1.1 The sectoral focus of this paper: Green infrastructure

The concept of green infrastructure (GI) brings together natural and semi-natural areas in a networked manner. These areas provide a wide range of ecosystem services such as water purification, air quality, space for recreation, and climate mitigation and adaptation. The notion of GI also covers blue infrastructure (for aquatic ecosystems), as defined by the EU Commission.[37] Therefore in this document, the notion of GI is understood in a larger sense, including the 'blue' dimension and the links in particular to climate change/adaptation, biodiversity, land take and risk reduction.

Energy is currently a particularly relevant issue, especially in the Alpine region. The current dynamics of energy policy issues go hand in hand with questions of competition for land and with environmental issues. This is why this document also addresses energy aspects, that are closely linked to green infrastructure.

In terms of green infrastructure in the stricter sense, three dimensions are of high relevance.[38] First, multifunctionality of GI provides a series of environmental, social and economic benefits. This is very much linked to the debate of so-called ecosystem services (ESS).[39] Second, connectivity describes that individual GI elements must be part of an interconnected network. Ecological connectivity is a key precondition for the unimpeded movement of species and the flow of natural processes and includes a structural (physical dimension) and functional (species-specific) dimension.[40] Third, scale matters. GI assets are categorised on several spatial scales that come along with different functionalities. This is also important for spatial planning.[41] In general, GI can be seen as a cross-cutting, multi-scale and multi-functional issue. The basic meaning of multifunctionality is to provide a variety of ecological, social and economic functions. An example of this is grassland, which is important for biodiversity, economy, landscape and tourism.[42]

Green infrastructure is a conceptual tool for safeguarding the wide range of ecosystem services[43] through the strategic planning of green and open spaces.[44] GI can be considered as a potential element and/or objective of land use planning including zoning and protection measures at multiple spatial scales as well as including other sectoral policies (agriculture, transport, energy). Furthermore, process-oriented measures and strategic master planning are further instruments to strengthen GI networks and their functionalities. The EU strategy on GI – "Enhancing Europe's Natural Capital" (2013) – underlines that consciously integrating the protection and enhancement of natural processes in spatial planning and development will benefit both biodiversity and society.[45]

37 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0236&qid=1562053537296&from=EN
38 https://www.researchgate.net/publication/361636835_Shaping_a_sustainable_future_with_Green_Infrastructure
39 https://doi.org/10.1016/j.scitotenv.2018.09.235
40 https://www.cms.int/en/topics/ecological-connectivity
41 https://doi.org/10.3390/land11091605; https://archive.espon.eu/green-infrastructure; https://webassets.eurac.edu/31538/1661510139-d-t1-1-1b_green-infrastructure-for-the-alpine-space-from-theory-to-practise-part-b.pdf
42 https://doi.org/10.1016/j.ecolind.2017.09.042
43 https://doi.org/10.1016/j.landusepol.2019.01.007
44 https://programme2014-20.interreg-central.eu/Content.Node/MaGICLandscapes-Green-Infrastructure-Handbook.pdf
45 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0236&qid=1562053537296&from=EN

Further steps include the EU Biodiversity Strategy for 2030[46], the Nature Restoration Law[47] or the EUSALP Joint declaration on Alpine Green Infrastructure[48] which set specific targets for the enlargement of protected areas and the restoration of degraded areas.

Regarding blue infrastructure in the Alps, changing precipitation patterns and the gradual melting of glaciers are affecting the availability of water resources.[49] Shifts in precipitation patterns are putting additional strain on Alpine water resources, leading to unprecedented cases of both water scarcity and flooding. Winter seasons are characterised by a decrease in snowfall but an increase in rainfall, while summers are characterised by a decrease in water levels, which may lead to an increase in droughts, particularly in the southern and south-eastern regions of the Alps. Reduced snow cover and glacial melt further reduce the volume of stored water. It is essential to monitor the allocation of water resources for agricultural, domestic, hydropower and tourism purposes in order to manage conflicts and ensure the continued functioning of water ecosystems.[50]

3.1.2 Climate change and adaption

Climate change patterns show a very high spatial differentiation. The Alps are particularly vulnerable due to their unique geography and ecosystems. Climate in the Alpine region is significantly affected by global warming.[51] Fig. 12 shows that the Alpine region will face a higher temperature increase than the peri-Alpine regions.[52]

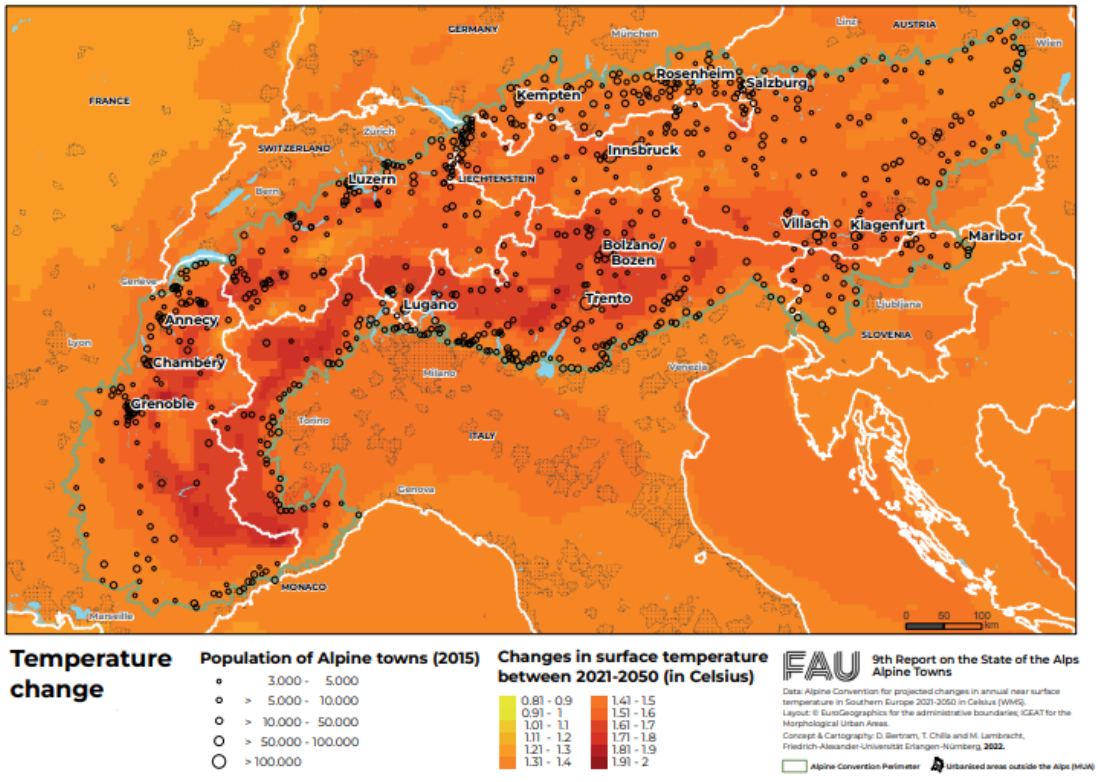

Fig. 12 Projected changes in surface temperature 2021-2050 (RSA9, 2022)

46 https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en
47 https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en
48 https://alpine-region.eu/fileadmin/user_upload/IMAGES_AND_DOCUMENTS/eusalp_political_declaration_green_infrastructure_final.pdf
49 https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Topics/watermanagement/Report_water_conference_Annecy_EN.pdf
50 https://alpineclimate2050.org/climate-target-system/water/
51 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/ACB/AlpineConvention_ClimateActionPlan2.0_EN.pdf
52 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf

Already now, temperature increase is much higher in the Alps than beyond. Against this background, the Alps can be seen as a 'frontrunner' in the context of climate change, as they face the challenges of climate adaptation at an early stage and with a rapid pace.[53] Climate change in the Alps refers not only to rising temperatures, but also to changes in the seasonal cycle of precipitation, global radiation, humidity and precipitation extremes. Those dimensions are closely linked to natural hazards like floods, droughts, avalanches, landslides and others.[54]

Green infrastructure can contribute to mitigating the effects of climate change in many ways. Most importantly, fostering GI helps to enhance resilience and adaptation to climate change, and through the CO_2 storage function of (semi-) natural ecosystems, GI also contributes to mitigation.[55] Fig. 13 describes the multiple territorial contexts and functional potentials of GIs in the Alpine region.[56]

Fig. 13 Alpine Green Infrastructure (EUSALP)

3.1.3 Biodiversity challenges

The Alpine area, characterised by its diverse habitats, flora and fauna, faces multiple challenges that threaten its biodiversity. Amongst the most important challenges are habitat fragmentation and land use dynamics resulting from anthropogenic activities such as urban expansion, agricultural intensification and infrastructure development.[57] In this regard, ecological connectivity is a key concern that is directly linked to climate change, as adaptation to climate change requires a network of physically connected natural areas, combined with compatible land use practices, to allow species and populations to move between areas as needed. The changes in land use are leading to conflicts over land management priorities, highlighting the complex in-

53 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
54 https://doi.org/10.1016/j.scitotenv.2013.07.050
55 https://doi.org/10.1016/j.jenvman.2014.07.025
56 https://alpine-region.eu/action-groups-publications/new-graphic-for-the-visualization-of-alpine-green-infrastructure *(All rights reserved – Contracting entity and owner of the graphic is the Bavarian State Ministry for the Environment and Consumer Protection)*
57 https://www.researchgate.net/profile/Annapaola-Rizzoli/publication/216340110_Land_use_change_and_biodiversity_conservation_in_the_Alps/links/02e7e517a5c62b6a4f000000/Land-use-change-and-biodiversity-conservation-in-the-Alps.pdf

terplay between biodiversity conservation and socio-economic interests in the region. Habitat fragmentation is a particular challenge in the Alps due to the typical Alpine settlement system with its valley orientation and highly concentrated socio-economic dynamics, heavy traffic and infrastructure.[58]

Moreover, the reduction of biodiversity in the Alps has significant consequences for ecosystem services, and, in the long run, human well-being, and socio-economic development. Ecosystem functions, such as water regulation, soil fertility, and carbon sequestration, are crucial for maintaining a critical ecological balance. Furthermore, the loss of biodiversity can indirectly affect tourism, an important economic sector in the region, as the landscape amenities that provide the basis for tourism are often biodiversity assets (see Fig. 14).[59] [60]

To summarise, it is crucial to preserve biodiversity in the Alps to maintain ecosystem resilience, support sustainable development, and safeguard the region's ecological heritage. To achieve this, stakeholders must address the complex interplay of environmental, landscape, social and economic factors.

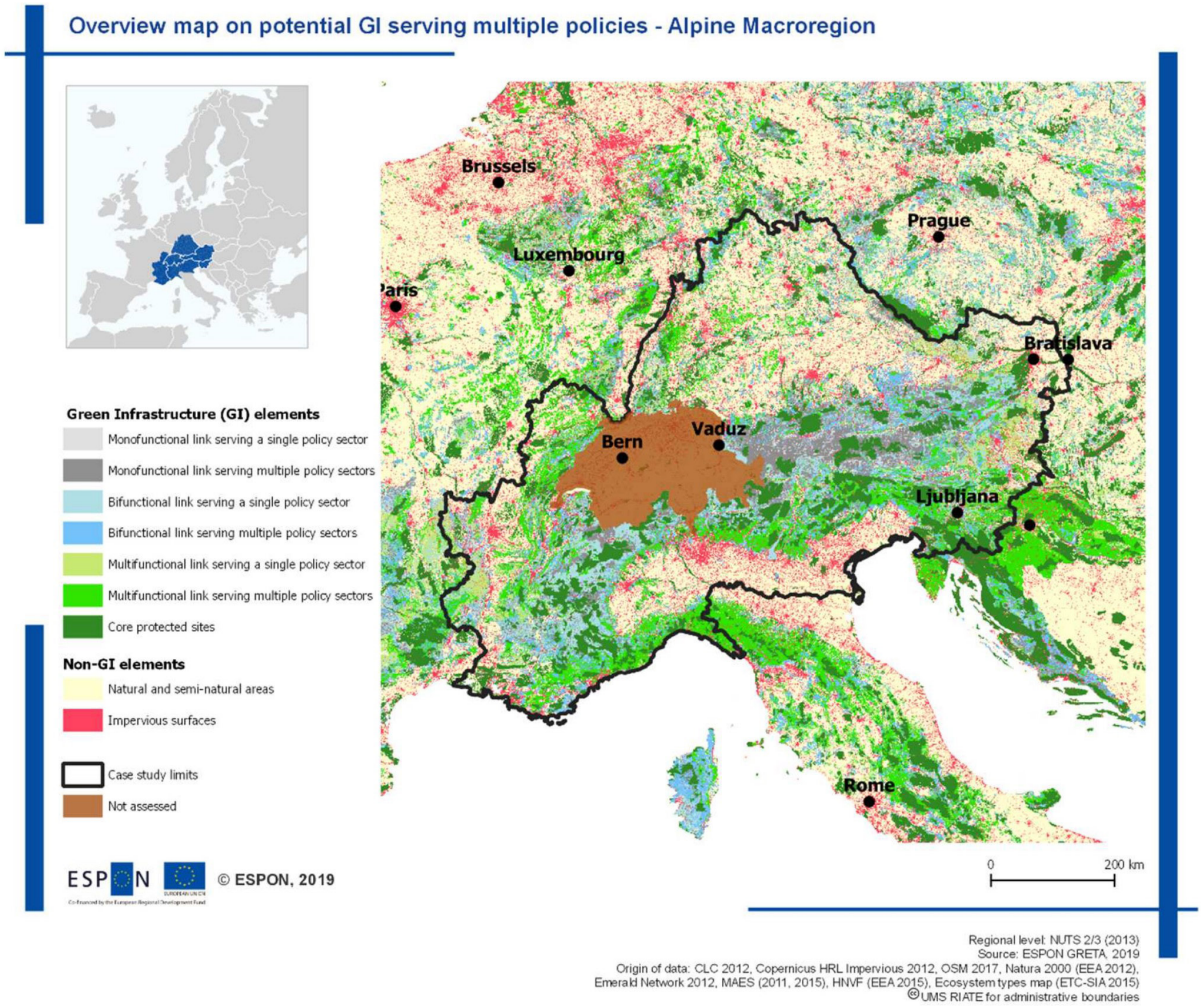

Fig. 14 Overview map on potential GI serving multiple policies (ESPON GRETA, 2019)

58 https://alparc.org/de/alpine-resources/atlas-alpbionet2030
59 https://www.sciencedirect.com/science/article/pii/S0301479707002381?via%3Dihub
60 https://archive.espon.eu/sites/default/files/attachments/GRETA_Alpine_Macro_Region.pdf

3.1.4 Land take challenges

Even though the pace of land take has slowed down in some Alpine countries, land is still being taken for settlements and technical infrastructure and the resulting sealing of the soil continues at many places in the Alpine region. Soil is a limited resource that cannot be renewed within a few human generations (Fig. 15).[61] [62] Also climate change is challenging Alpine soils. Climate change affects soil functions directly and indirectly. Direct effects include changes in temperature, precipitation and moisture regimes. Indirect effects include those caused by adjustments such as watering, changes in crop rotation and soil cultivation methods.[63]

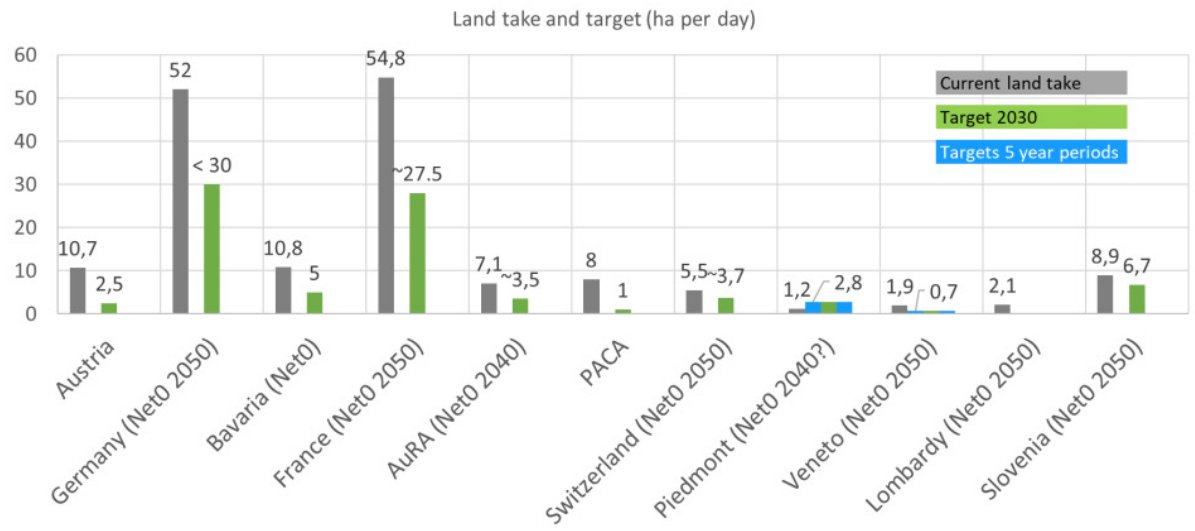

Fig. 15 Current land take and land saving targets in selected Alpine countries and regions (2,5 target for AT is not politically decided) (Alpine Convention, 2022)

Soil provides many ecosystem services that are essential for human life and is the basis for a wide range of human activities. Soil conservation is therefore of vital importance.[64] This is particularly true for mountainous regions such as the Alps, where soils are much more vulnerable and at risk due to the steep relief, shallow soils and longer formation times. The Alpine region shows heterogeneous land use patterns, with urban agglomeration along the valleys and depopulation in some remote areas. The limitation of the habitable surface increases the competition for different demands (such as settlement, transport and tourism infrastructure, energy production, agricultural infrastructure and production, environmental protection or measures to adapt to climate change).[65] Some Alpine regions, where a limited proportion of habitable land already imposes strict limits on the expansion of settlements, have adopted land conservation policies to a greater extent than regions where these resource constraints are less evident.[66] Obviously, spatial differences between peri-Alpine plains and inner-Alpine mountain areas have to be addressed. This geomorphological diversity of the Alpine regions demands to differentiate land take issues in the mountain area and beyond.

61 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Soil/Long-term-action-plan_soil-protection.pdf
62 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/SPSD/CDR_ACTS_IP_SP1_3_Land_Saving_Targets.pdf
63 https://doi.org/10.1002/ldr.3006
64 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/SPSD/CDR_ACTS_IP_SP1_3_Land_Saving_Targets.pdf
65 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Soil/Long-term-action-plan_soil-protection.pdf
66 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/SPSD/CDR_ACTS_IP_SP1_3_Land_Saving_Targets.pdf

Land take comes along with the loss of agricultural land and open spaces.[67] Depending on the development dynamic, this leads to landscape degradation and GI fragmentation, resulting in the isolation of natural habitats and reduced ecological connectivity particularly at the lower altitudes.[68]

3.1.5 Risk reduction challenges

The frequency and probability of disasters has increased and intensified due to climate change. Within the Alpine Convention region, a series of extreme events has been recorded in recent decades. The following map shows the distribution of such extreme events for debris flows and floods in catchment areas smaller than or equal to 100 km² (Fig. 16).[69] Even if the map suffers data availability problems, it becomes obvious that serious risks must be expected throughout the Alps, demanding proactive risk management strategies.[70]

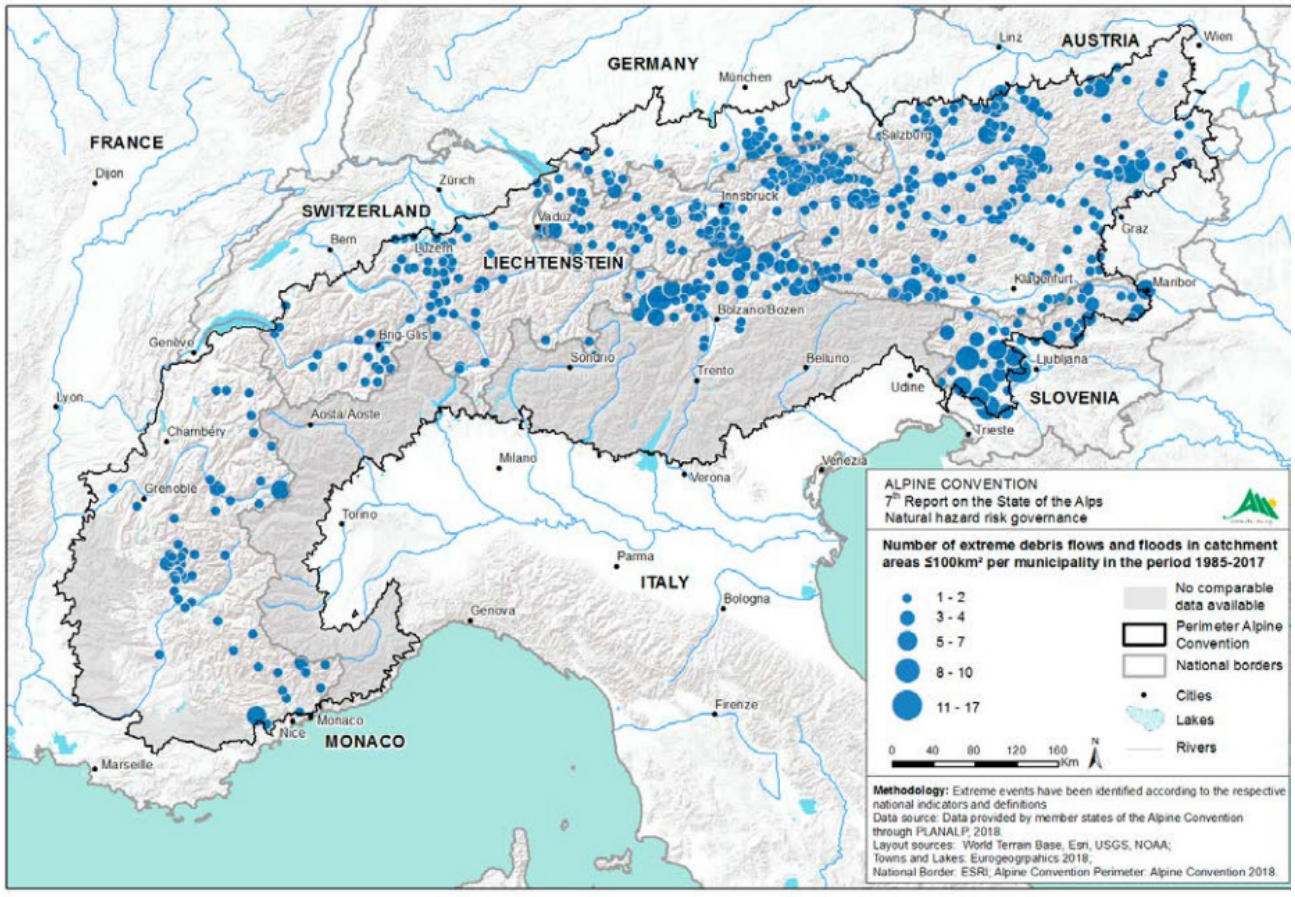

Fig. 16 Number of extreme debris and floods in catchment areas smaller than or equal to 100 km 2 in the period 1985-2017 (RSA7, 2019)

67 https://www.arl-international.com/knowledge/thematic-collections/spatial-planning-open-spaces-and-green-infrastructure-alpine-region
68 https://www.arl-net.de/system/files/media-shop/pdf/pospapier/pospapier_133.pdf; https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/WISO/WISOLandscapeConnectivity_final_version.pdf
69 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA7_EN.pdf
70 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA7_EN.pdf

Green Infrastructure is essential for enhancing resilience and mitigating risks associated with extreme events in the Alps.[71] It addresses challenges posed by extreme weather events, avalanches, debris flows, landslides, floods, droughts and heat periods. GI interventions such as vegetated buffers or retention zones can help to control the effects of rainfall, reducing the risks of flooding, erosion and landslides. Natural barriers, such as forests, can mitigate avalanche hazards by stabilising slopes. GI measures such as vegetation cover and soil stabilisation techniques are employed to intercept sediment transport and debris flows and to minimise erosion.[72] Flood risks are reduced through strategies such as floodplain preservation and riverbank restoration, which enhance water storage capacity.[73] Studies have shown that GI initiatives have had promising results in climate change mitigation, managing floods, landslides among many other applications for risk reduction.[74] Integrating GI into planning and development can enhance Alpine resilience, ensuring sustainable communities and ecosystems in the face of extreme events. In addition, nature-based solutions (NbS) can help to adapt to climate risks.[75]

3.1.6 Energy challenges

The Alpine region is a strategic area for the production (and storage) of renewable energy. In terms of production, the Alps host a series of renewable energy sources, including water for hydropower, (fire)wood, biomass, sun (photovoltaic) and wind power.[76]

The Alps face various challenges during the energy transition and the involved demand for an increase in energy storage and powerline capacity. This transition is driven by the growing need for sustainable energy sources and grid stability. The production of renewable energy has an impact on the surrounding environment and ecosystems.[77] It comes along with competition regarding land use demands, including competition with conservation efforts, agricultural use, landscape character and tourism expectations.[78]

The Alps as Europe's 'water towers' offer the opportunity for flexible, low-carbon power generation and energy storage. Hydropower facilities are challenged by the fast melting of glaciers, even if the exact impact is difficult to anticipate.[79] The energy transition at national and European level can be facilitated by increasing the capacity of pumped storage plants. However, the expansion of hydropower, especially pumped storage, is highly controversial due to environmental and biodiversity concerns and opposition in the concerned communities. In addition, the amount of water in rivers is becoming increasingly limited or erratic due to climate change.[80]

Also wind power comes along with a number of potential conflicts. Many windmill projects are met with opposition. The reasons for this resistance include impacts on landscape aesthetics, threat to flora and fauna, noise level, and more.[81] Community-based renewable energy projects are a promising approach to overcome subjective resistance at the local levels.

71 https://doi.org/10.3390/su142316155
72 https://alpineclimate2050.org/climate-target-system/natural-hazards/
73 https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Organisation/thematic_working_bodies/Part_02/water_management_in_the_alps/4_FD_WFD.pdf
74 https://doi.org/10.3390/su142316155
75 https://link.springer.com/article/10.1007/s10113-022-01998-w
76 https://doi.org/10.1659/MRD-JOURNAL-D-15-00071.1
77 https://previous.iiasa.ac.at/web/home/research/researchPrograms/EcosystemsServicesandManagement/rechargegreen/Abschlussbericht-EURAC_kompr.pdf
78 https://doi.org/10.1016/j.rser.2015.04.004
79 https://doi.org/10.3390/w12072011
80 https://doi.org/10.1659/MRD-JOURNAL-D-15-00069.1
81 https://austriaca.at/0xc1aa5576_0x0029e652.pdf

In many Alpine regions, the use of forests for firewood has a long tradition. Although forest biomass for energy production is less polluting than fossil fuels, it has potential impacts on the environment and conflicts with competing interests and the demand for sustainable use of forests.[82] Moreover, the aspect of CO_2 neutrality demands a cascading use of forest biomass. This refers to the efficient utilisation of resources through the use of residues and recycled materials for material purposes, with the aim of extending total biomass availability[83] and facilitating continuous reforestation. The pending revision of the EU's Renewable Energy Directive in 2023 (RED III) consequently strengthens the sustainability criteria for biomass. At the same time, it excludes the use of forest biomass from areas that are of particular relevance for biodiversity. The limits to the use of forests as an energy source have been highlighted in the recent debate at EU level on the continued inclusion of wood as a renewable energy source.[84]

In addition to these energy production challenges, ensuring a reliable energy supply, especially during the winter months, is a particular concern for the Alpine region. Photovoltaic systems, a key component of renewable energy portfolios, may experience reduced efficiency in snowy conditions, raising questions about their reliability in meeting energy demands during peak winter periods. Developing strategies to enhance the resilience of renewable energy systems and ensure consistent energy production throughout the year is essential for meeting the energy needs of Alpine communities while minimising vulnerability to climatic variability.[85]

This has to be seen against a fundamental geographical question: In particular, in terms of water supply, wood delivery and energy storage, the Alpine region serves the functioning of outer Alpine, often metropolitan areas. The question is what the limitations are from a sustainable development perspective.[86]

When discussing energy challenges, the idea of energy self-sufficiency plays an important role. This concept combines adopted consumption patterns and the use of innovative and efficient supply systems (e.g. passive houses[87]). Energy saving and efficiency contribute to CO_2-reduction.[88]

82 https://pure.iiasa.ac.at/id/eprint/12117/1/Energy%20&%20nature%20in%20the%20Alps%20-%20a%20balancing%20act.pdf
83 https://knowledge4policy.ec.europa.eu/glossary-item/cascading-use_en#:~:text=Cascading%20use%20is%20the%20efficient,availability%20within%20a%20given%20system
84 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202302413
85 https://www.gantner-instruments.com/blog/innovation-in-alpine-solar-overcoming-winter-energy-challenges/
86 Bätzing (2015): Die Alpen: Geschichte und Zukunft einer europäischen Kulturlandschaft (p. 366): https://www.jstor.org/stable/j.ctv128fn6r
87 https://www.yourhome.gov.au/passive-design/passive-house
88 https://doi.org/10.1659/MRD-JOURNAL-D-11-00056.1

3.2 The instrumental perspective

In addressing the manifold challenges of green infrastructure as presented above, the links to spatial planning and development are highly relevant. The sectoral fields of GI offer a series of important instruments, and so does spatial planning and development. Understanding and applying the appropriate tools throughout the multi-level system is an ambitious endeavor, as Fig. 17 shows.

	General	Spatial planning & development	Green infrastructure & energy	
			Technical planning (land use & zoning)	Strategic planning (target formulations)
European	– UN 2030 Agenda for Sustainable Development – European Green Deal – 2030 Climate Target Plan – European Recovery Plan – Green Deal Industrial Plan	– Territorial Agenda 2030 – Leipzig-Charter (2007) / New Leipzig-Charter (2020)	– Habitats Directive / Birds Directive (Natura 2000) – Water Framework Directive – *IUCN classification of protected areas** – *UNESCO labels **	– Green Infrastructure Strategy – Biodiversity Strategy 2030 – Roadmap to a Ressource Efficient Europe – Regulation on the governance of the energy union and climate action – EEA strategy on transforming EU land use and the Common Agricultural Policy (2023-27)
Pan-Alpine	– "Alpine Convention (Framework Convention") – EU Strategy for the Alpine Region (EUSALP) – Climate Action Plan 2.0 – Alpine Climate Target System 2050	– Spatial Planning and Sustainable Development Protocol of the Alpine Convention – EUSALP Joint Paper on Spatial Planning – RSA 9: Alpine Towns – *ESPON Alps 2050**		– Soil conservation, mountain farming, mountain forests, energy, nature protection & landscape conservation Protocol of the Alpine Convention – RSA 10: Quality of Life – *Works by OpenSpaceAlps and AlpPlan network on ecological connectivity**
National	– [div.]	– National plans, planning concepts and guidelines – *CIPRA Handbuch Alpine Raumordnung (AT)**	– National plans, planning concepts and guidelines on land use and zoning (e.g. National Spatial Development Strategy, SI; Parke von nationaler Bedeutung, CH)	– National strategies (e.g. national climate and energy plans, national concepts on green infrastructure)
Regional & local	– [div.]	– Plans, planning concepts and guidelines	– Regional plans, planning concepts and guidelines on land use and zoning (e.g. Vorranggebiete Windenergie in BY, Vorarlberger Weißzonen, Alpenplan in BY)	– Regional strategies (e.g. Plan climat de la Région Sud)

*non-litigable context documents

Fig. 17 Relevant documents and strategies for the spatial planning and green infrastructure nexus (FAU, 2024)

The columns differentiate three thematic perspectives:

- **'General'** documents include overarching strategies that do not focus on GI or spatial planning/development as such, even if they do have an impact on these fields. As mentioned in **chapter 2.2**, there are several strategic documents with cross-cutting implications at the European level as well as at the pan-Alpine level.
- The relevant documents and strategies from the point of view of **spatial planning and development** are listed in **2.2**.
- In the field of **green infrastructure**, several documents provide access points. GI must be seen as a cross-sectoral issue (biodiversity, recreation, energy etc.). The overview differentiates between documents with a specific focus on technical planning and those with a strategic approach. In the field of GI, technical planning mainly refers to land use and zoning approaches. In the context of strategic planning, the documents refer mainly to vision-making and target formulations. At the EU level, the 'Habitats and Birds directives' are the key instruments with a rather technical character (resulting in the Natura 2000 network); for blue infrastructure, the 'Water Framework Directive' has to be mentioned.

At national and regional level, a variety of instruments ensure concrete measures and technical implementation. At the pan-Alpine level, technical planning instruments are not established. However, in the field of strategic planning, the multiplicity of target formulations and vision-making documents is numerous. There are several documents focusing on green infrastructure from a vision-making perspective. Pan-Alpine approaches include several protocols of the Alpine Convention (soil protection, mountain farming, mountain forests, energy, nature protection & landscape conservation; not for water), as well as the EUSALP joint declaration 'Alpine Green Infrastructure - Joining Forces for Nature, People and Economy'. In parallel, a number of soft instruments play an important role, mostly in form of reports (such as project results by AlpBioNet and OpenSpaceAlps and the AlpPlan network's position paper on safeguarding ecological connectivity and open spaces in general). At national and regional level, a variety of strategic documents formulate targets and strategic pathways.

Obviously, this compilation is not intended to be complete, but it provides a structured overview of the relevant instruments. The collection of different instrumental formats throughout the governance system has grown over decades, without always having cross-sectoral coordination in mind. The Alpine Spatial Development Perspective aims to contribute towards an integrated strategy. The following sections provide some more background information on the current debates on policy options.

3.3 Sectoral policy options

The current efforts to address challenges regarding green infrastructure in the Alps are various. Simplifying to a large extent, the measures can be classified into four thematic groups, as presented in the following sections.

3.3.1 Ecological connectivity

The Alpine landscape is highly diverse and characterised by a wide variety of specific elements. Natural features such as meadows, forests, pastures, water bodies and elements of human use such as settlements, roads and railways are part of the Alpine area.[89] These infrastructure elements frequently fragment habitats and endangers biodiversity, as mentioned earlier.[90] In this context, area protection plays an important role.[91] The concept of ecological connectivity aims to limit and channel human activities in a way that allows for sufficient exchange between flora and fauna habitats.[92] It is important to note that barriers to ecological connectivity are not only caused by human activities, but also by the Alpine topography.[93]

89 https://www.cipra.org/en/dossiers/13/dateien/341_en/@@download/file/Hintergb_EcoNetw_en.pdf?inline=true
90 https://www.alparc.org/biodiversity-protection-in-times-of-climate-change/biodiversity-and-ecological-connectivity
91 https://www.arl-net.de/de/shop/safeguarding-open-spaces-alpine.html
92 https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/alpine_nature_2030_broschuere_en_bf.pdf#%5B%7B%22num%22%3A262%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C0%2C842%2C0%5D; https://alparc.org/parks2030
93 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/WISO/WISOLandscapeConnectivity_final_version.pdf

The scientific debate defines ecological connectivity as „the degree to which this landscape facilitates or impedes movement between resource patches".[94] In this context, concepts of ecological/habitat/landscape connectivity have become highly relevant in nature conservation. Ecological networks consist of core areas that provide the necessary resources for the relevant species. The idea is that core areas should be complemented by buffer zones and connected by ecological corridors (Fig. 18).[95] [96]

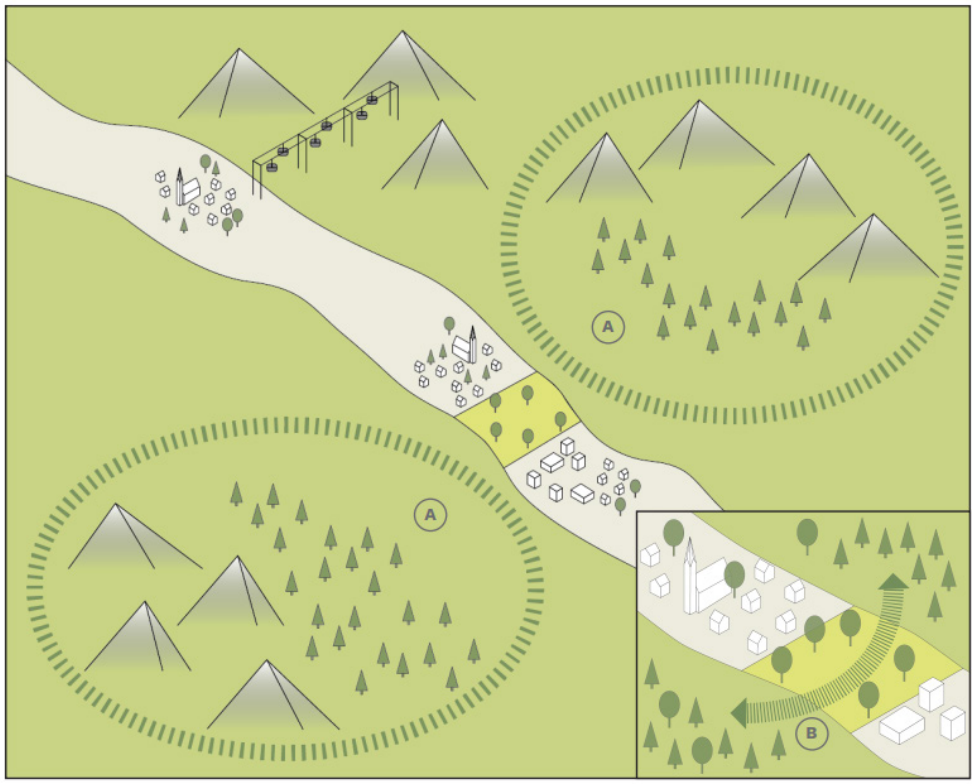

Fig. 18 Large-scale continuous open spaces (A) and small-/mid-scale open spaces (B) (ARL, 2022)

The awareness for ecological connectivity has grown over the last years, in particular in the context of climate and land use change. There is an ongoing debate on the relevance of additional area protection in the Alpine region to improve ecological networks, also in the context of meeting the targets of the EU Biodiversity Strategy for 2030 and the EU Nature Restoration Law.[97] Overall, ecological connectivity is a very popular instrumental concept for nature conservation and biodiversity protection.[98] A series of research projects and studies (e.g. AlpBioNet, OpenSpaceAlps, PlanToConnect, Alpine Park 2030, PLACE report on spatial planning & ecological connectivity) take a pan-Alpine perspective to discuss biodiversity, climate adaptation, and ecological connectivity in the spatial policies of the Alpine countries.[99] Fig. 19 shows a recent approach of mapping ecological connectivity in the Alpine region.[100]

94 https://www.cms.int/en/topics/ecological-connectivity;https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/EcoNet/PLACE_Report_on_Spatial_Planning_and_Ecological_Connectivity.pdf
95 https://www.arl-net.de/system/files/media-shop/pdf/pospapier/pospapier_133.pdf
96 https://journals.openedition.org/rga/808?lang=en
97 https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/alpine_nature_2030_broschuere_en_bf.pdf#%5B%7B%22num%22%3A262%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C0%2C842%2C0%5D
98 https://www.arl-net.de/system/files/media-shop/pdf/fb/fb_007/fb_007_gesamt.pdf
99 https://www.alpine-space.eu/project/openspacealps-2/;https://www.alpine-space.eu/project/plantoconnect/ ;https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/EcoNet/PLACE_Report_on_Spatial_Planning_and_Ecological_Connectivity.pdf
100 https://panorama.solutions/en/solution/alpbionet2030

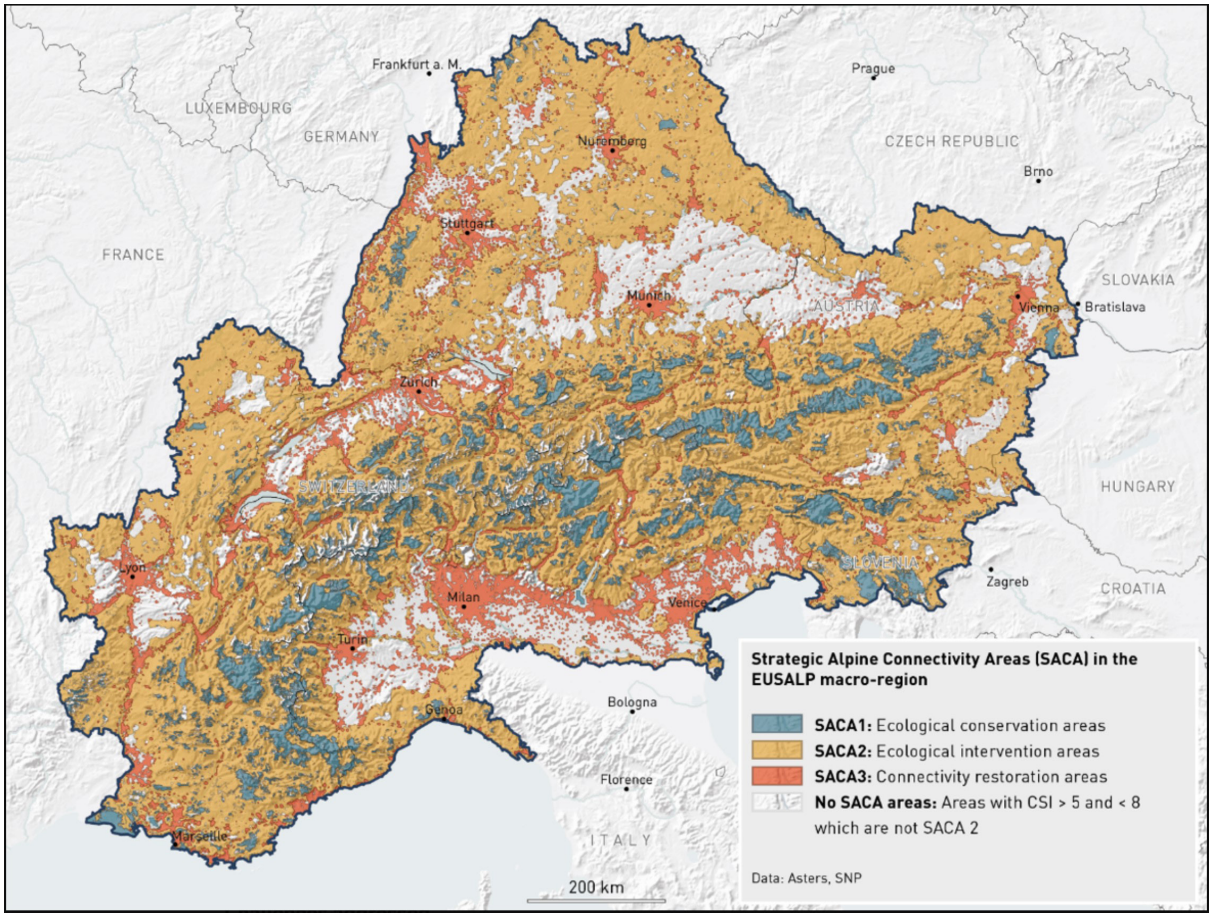

Fig. 19 Strategic Alpine Connectivity Areas (SACA) in the EUSALP macro-region (Alpbionet2030, 2021)

3.3.2 Sustainable agricultural and forestry approaches

In parallel, agricultural and forestry land use is highly relevant in the overall discussion on green infrastructure. In the Alpine region, both the ecological functions as discussed above and the productive functions like agriculture and forestry have to be safeguarded.[101] However, both sectors are facing numerous challenges, like limited availability of arable land due to topography and ongoing land take dynamics. Additionally Alpine farming comes along with specific conditions that make it difficult to compete in a globalised economy (short vegetation periods and topography leading to high labor-intensity/specific machinery).[102]

Multiple policy options can contribute to address these challenges. One can differentiate three categories, namely a) agricultural approaches, b) forestry approaches and c) cross-cutting approaches.

Financial promotion for mountain farming is a very relevant and widely practices policy option. Supporting traditional mountain farming helps to maintain pastures and the involved ecosystem services. In practice, this preserves specific Alpine landscapes, e.g. by sheep farming.[103]

101 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task1_2_ORGANIC_AGRICULTURE_MAMF_2021-2022.pdf
102 https://www.alpconv.org/en/home/topics/mountain-agriculture/
103 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task1_2_ORGANIC_AGRICULTURE_MAMF_2021-2022.pdf

The labeling of Alpine products is another relevant policy option in this context. Territorial brands like European geographical indications and regional formats communicate specific qualities linked to the Alpine origin, often allowing for a stronger economic positioning. In order to line up with the strategies of the European Green Deal, the recent European Common Agricultural Policy (CAP, 2023-2027) is preparing to review the geographical indication and food labelling. The aim is to include more information into the labelling. Another policy option is the strengthening of advertising and marketing measures for Alpine products in general. In particular, mountain products require appropriate promotional strategies, both at the local scale and in the peri-Alpine area as higher pricing is to be reflected in more demanding working conditions and non-constant production yields are reflected in higher pricing.[104]

Moreover, supporting organic farming is seen as a highly relevant policy option. For small mountain farms it is discussed if a modification of EU regulations for organic certification might be necessary. This could address current obstacles regarding the complex control and registration procedures. In addition, group certifications seem to be a possible way forward for small mountain farmers, as they can facilitate the achievement of economies of scale.

In terms of forestry, one of the most popular policy options discussed is providing appropriate governance and financing mechanisms in the Alpine region. More than 40% of the Alpine area is covered by forests, even if most of the wood is exported out of the Alps – not just as a construction material but also as a source of renewable energy. In the Alpine region, forestry is a characteristic feature of the landscape and sustainably managed forests provide protection against avalanches, floods and other natural disasters. Thus, the strategic spatial development of green infrastructure in general is of high relevance for the Alpine region.[105] The EUSALP discusses the goal of making the Alpine region a model region for green infrastructure. Therefore, the respective Action Groups initiate a pan-Alpine multidisciplinary and multi-stakeholder approach to ensure the sustainable provision of ecosystem services and at the same time fostering socio-economic benefits.[106]

As a cross-cutting policy option for both the agricultural and forestry sector, the promotion of regional value chains is widely discussed (see chapter 4.3.5).

3.3.3 Integrated water management

As mentioned earlier, Alpine water resources fulfil a variety of functions, also beyond the inner-Alpine region (fresh water for drinking and industrial purposes, agriculture, leisure and hydropower; see Fig. 20).[107] These uses sometimes compete with each other and with the needs of aquatic ecosystems, while drinking water has the highest priority according to the EU Water Framework Directive.[108]

Within the framework of pan-Alpine water management, the Alpine Convention has installed a water platform based on recommendations of the 2nd Report on the State of the Alps focusing on water and water management issues. In addition, the 'Action Plan on Climate Change in the Alps' illustrates several water-related issues, such as the reinforcement of the implementation

104 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task1_2_ORGANIC_AGRICULTURE_MAMF_2021-2022.pdf; https://www.alpine-space.eu/project/alpfoodway/ ; https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Organisation/thematic_working_bodies/Part_02/mountain_agriculture_platform/PF_Berglandwirtschaft_Vermarktung_de_fin._Version.pdf
105 https://www.alpconv.org/en/home/topics/forests/
106 https://www.stmuv.bayern.de/ministerium/eu/makroregionale/doc/eusalp2017.pdf
107 https://blogs.fau.de/regionalentwicklung/files/2023/11/WP5_EUSALP_FAU.pdf
108 https://www.alpconv.org/en/home/topics/water-management; https://environment.ec.europa.eu/topics/water/water-framework-directive_en

of the 'European Water Framework Directive' and the prevention of water shortages.[109] Even if 'Integrated and Sustainable Water management in the Alps' is addressed in form of an Alpine Convention declaration, there is currently no Alpine Convention protocol on water issues.[110]

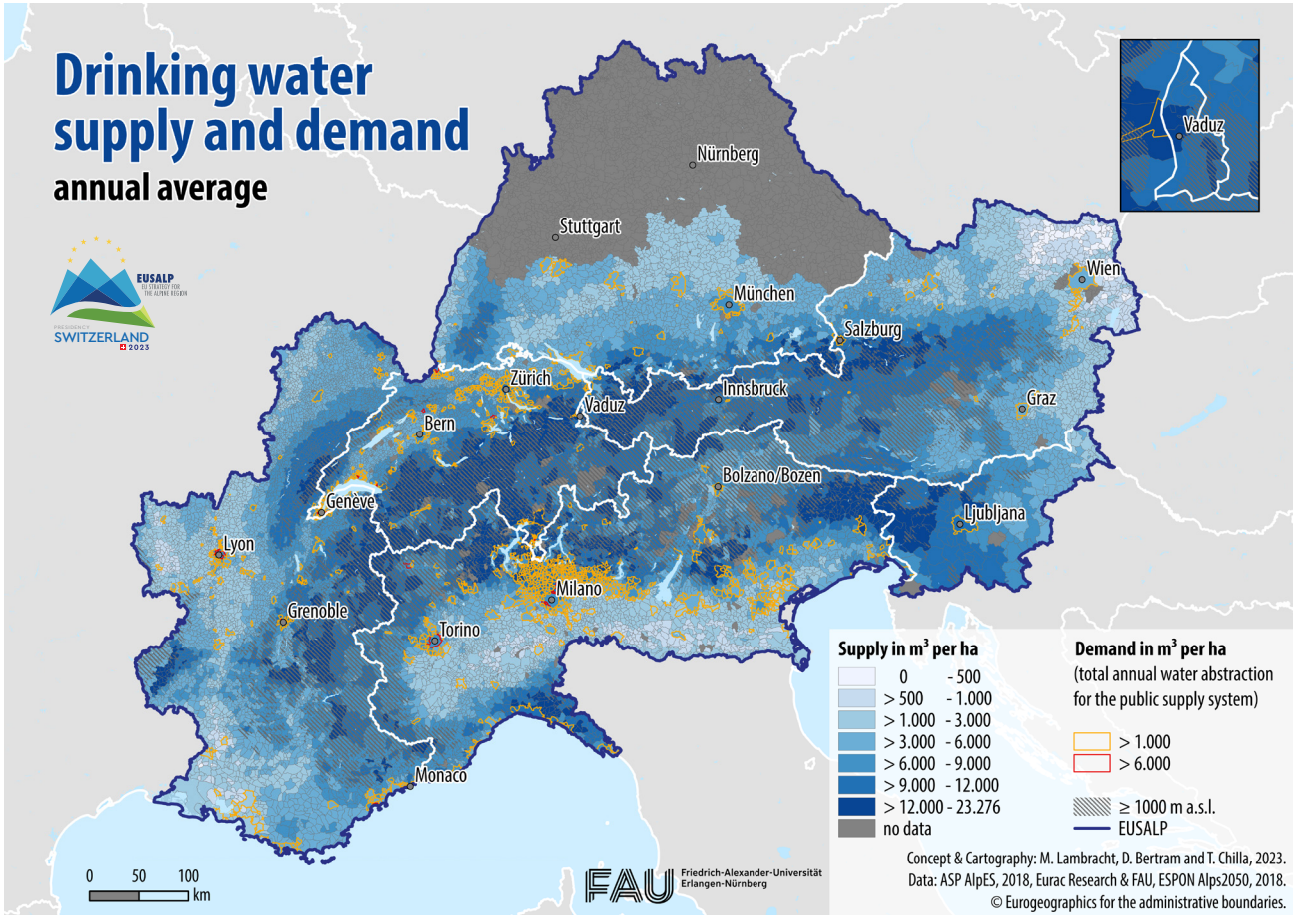

Fig. 20 Geographical patterns of drinking water supply and demand (FAU, 2023)

Given the challenges associated with water management, EUSALP Action Groups have decided to set up a task force. The overall goal is to enhance the transition toward a water-smart society led by stakeholders for a sound management of water resources.[111] The debate on Alpine water resources implies a series of 'soft' measures to strengthen 'upstream-downstream' solidarity. The most promising policy options seem to be promoting integrated water resource management to improve supra-regional and transboundary cooperation regarding natural hazards, water shortages and energy production. This goes hand in hand with continuous monitoring on water resources and water uses to enable evidence-based policy-making.[112]

In terms of aquatic biodiversity, the policy options include the protection of wild river sections, the restoration of degraded rivers and the conservation of biological corridors.[113] Another highly relevant measure is resilient drought management. Over the last years, droughts

109 https://www.alpconv.org/en/home/organisation/thematic-working-bodies/detail/water-management-in-the-alps-platform-2009-2019/
110 https://www.alpconv.org/en/home/convention/protocols-declarations/;https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Water/Facing_droughts_in_the_Alpine_region.pdf
111 https://alpine-region.eu/topics-action-groups/cross-cutting-priorities
112 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Water/Facing_droughts_in_the_Alpine_region.pdf
113 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Water/Facing_droughts_in_the_Alpine_region.pdf

had a significant impact on the Alpine region (especially in 2003, 2015 and 2017). Thus, Alpine drought management has to switch from crisis management to preparedness. There are already several national and regional instruments in place (monitoring and forecasting, see e.g. Alpine drought observatory[114]). The debate here has mainly two dimensions. First, on the technical level, there are gaps in evaluating drought impacts (missing indicators, databases, monitoring and modelling of drought events and water use). Second, at the pan-Alpine level, there is a need for joint quantification of drought situations (e.g. common rules for thresholds). From the policy perspective, integrated pan-Alpine strategies seem to be most relevant to make different sectors (drinking water supply, agriculture) more resilient against droughts. As concrete measure the literature suggests for example investing in alternative water sources (e.g. rainwater harvesting, wastewater and greywater re-use)[115], enhancing planning of water availability or promoting crops diversification to make farming more adaptable to extreme situations.[116]

As a cross-cutting policy option on integrated water management, the transboundary perspective seems to be the most prominent in recent research and policy briefs. For example, national river basin management plans often lack a transboundary perspective. Thus, an Alpine-wide framework for climate-proofing water management systems and coordinated approaches to deal with droughts and floods seems to be highly relevant.[117] In this respect, the cross-border perspective has to be implemented in water(shed) management, tools and methods for drought management, flood risk-management and conservation strategies for Alpine rivers.[118] The implementation of the Alpine Climate Target System 2050 plays a key role in achieving this measure, as water is one of the topics covered by this pan-Alpine instrument.[119]

3.3.4 Sustainable energy solutions

The Alpine debate on energy policy is currently dynamic as illustrated in particular in the 'Renewable Alps vision' of the Alpine Convention.[120] In general, one might differentiate three main directions:

First, a pan-Alpine knowledge transfer on a more harmonised energy transition is discussed on several levels, both in policy and scientific debates. A prominent example are national mechanisms to further develop renewable energies that differ in Alpine countries. Interreg projects on energy issues can contribute to an Alpine-wide knowledge transfer on energy transition. For example, the Interreg Alpine Space project ALPGRIDS comprised seven pilot projects in Austria, France, Germany, Italy and Slovenia and aims to increase uptake of renewable energy sources in the Alps.[121]

Second, the adoption of green and low carbon hydrogen is a widely-discussed policy option, contributing to the REPowerEU strategy. Embedding hydrogen in regional policies and projects in pilot areas supports the development of an Alpine hydrogen sector. Alongside the Alpine value chain (production, storage, transport, distribution and uses for mobility and

114 https://ado.eurac.edu/
115 https://www.eea.europa.eu/publications/water-resources-across-europe/file
116 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Water/Facing_droughts_in_the_Alpine_region.pdf
117 https://alpineclimate2050.org/climate-action-plan-2-0/water/
118 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Water/Facing_droughts_in_the_Alpine_region.pdf
119 https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Topics/watermanagement/Report_water_conference_Annecy_EN.pdf
120 https://www.alpconv.org/fileadmin/user_upload/Publications/Towards_Renewable_Alps_2017.pdf
121 https://ec.europa.eu/regional_policy/en/projects/Slovenia/alpgrids-local-grids-for-reliable-renewable-energy-in-the-alps

industries) investments in hydrogen infrastructure are discussed by several studies (e.g. production of fuel cells, electrolysis, hydrogen refueling stations, etc.).[122]

Decarbonising the transport sector is another important argument. Policy options aim at a modal shift from road to rail and other soft modes and alternative propulsion systems. Several studies imply that the Alpine region lags behind in the use of renewable energy sources in transport and mobility.[123]

3.4 Policy options from the spatial perspective

3.4.1 Cross-sectoral and cross-border coordination

It is obvious that spatial planning has an important role to play in the implementation of GI. Area protection, just as an example, has to be fixed in regional plans, and land use planning can connect ecological habitats.

In doing so, the cross-sectoral coordination is the main purpose of spatial planning. Understanding and balancing the competing needs is a complex challenge – for example, nature conservation vs. tourism, renewable energy production vs. biodiversity, transport infrastructure vs. ecological networks, etc. Concretely speaking, this requests communicative long-term processes that – finally – result in binding jurisdictional measures. The example of land-take is a currently sensitive topic, as both, soil-protection and affordable housing are important societal needs. Combining these two objectives in municipal planning, in the end, is not easy to reach.

In parallel to the vertical challenge in the multi-level system, the horizontal challenge is cross-border cooperation. Effective measures require collaborative efforts across political boundaries in order to implement protected areas or habitat restoration. For example, when open spaces are not continued across borders, this might disrupt ecological connectivity.[124]

3.4.2 Strategic integration of pan-Alpine objectives

Even if pan-Alpine spatial approaches do not have a mandate for technical planning, they provide strategic orientation (see Fig. 17). For example, the Alpine Convention protocols dealing with green infrastructure provide rather general objectives on the pan-Alpine level (e.g. on mountain forests, energy, and nature protection). The implementation, however, is the task of domestic authorities.

Against this background, it is important to reflect on the integration of general goals from the pan-Alpine level in domestic spatial planning and development. This setting can be illustrated with the example of ecological connectivity. Strategic orientation is provided by large-scale initiatives (such as the EU Green Infrastructure Strategy, the Biodiversity Strategy 2030, the Alpine Convention protocol on mountain forests). At lower institutional levels, the objectives have to be transposed in regional or municipal plans (e.g. with zoning techniques). This process has to combine top-down and bottom-up approaches. In doing so, it has to take into account the

122 https://alpine-region.eu/topics-action-groups/cross-cutting-priorities
123 https://alpine-region.eu/topics-action-groups/cross-cutting-priorities
124 https://doi.org/10.1659/MRD-JOURNAL-D-20-00016.1

specific spatial contexts and competing needs (e.g. transport infrastructure vs. ecological networks).[125] This is of particular relevance in the Alpine region with its many borders and diverse territories (see again Fig. 17).

In this situation, it can be helpful to provide spatial differentiation in a visual, cartographic manner – not as binding plans but as illustration and inspiration. A concrete example is the 'Strategic Alpine Connectivity Areas'.[126] At the pan-Alpine level, the Alpine Spatial Development Perspective can provide a vision in a spatially differentiated way, on a strategic level and in a cross-sectoral and cross-border manner.

3.5 Towards vision making

The feedback procedure on the topic of Green Infrastructure was a two-step approach. The main participatory element was a written feedback loop. Furthermore, the working group discussed the paper in the framework of an online meeting (February 2024) as an exchange in presence was not possible. A series of editorial changes has already been implemented in the report at hand. The more conceptual feedback is summarised in the following arguments and will enrich the upcoming formulation of an Alpine Spatial Development Perspective:

- Regarding land take, spatial specificities between peri-Alpine lowlands ('interface territories') and inner-Alpine mountain areas have to be addressed in more detail.
- The multi-functionality of Green Infrastructure must be taken into account in more detail. GI has social, landscape and economic importance. For example, mountain agriculture with its grasslands is fundamental for biodiversity, but also for tourism.
- The expansion of renewable energy systems in the Alpine region is closely linked to the need to upgrade or build new power lines. This kind of infrastructure often has a cross-border and trans-Alpine dimension and undergoes challenging planning processes.
- Water resources for energy production need to be discussed in the context of droughts and climate change. Other potential conflicts with water use, particularly in the context of hydrogen add complexity to the issue.
- The issue of competing land uses, e.g. for energy production, may lead to the need to define areas for potential and priority uses (cp. the German concepts of ‚Vorrang-' and ‚Vorbehaltsgebiete').

This feedback will be taken into account and further addressed as the Alpine Spatial Development Perspective continues to evolve.

125 https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/alpine_nature_2030_broschuere_en_bf.pdf
126 https://alparc.org/alpbionet2030

4 Linking spatial and economic development

4.1 Challenges: Economy in the Alps

4.1.1 Starting position: 'Drop height'

Some of the Alpine economic activities are linked to the territorial specificities of the region: Highly successful sectors include hidden champions in the hydropower sector, in the cableway and outdoor equipment industries and others. The high share of tourism in the summer and winter months is specific to the Alpine region, as is the prominence of the wood and timber sector. Of course, not every development is specific to the Alps, such as the IT sector in many Alpine cities or the financial sector in Ticino. In this context, Alpine economic success is based on a mountain-specific combination of traditional and endogenous potentials that are integrated into the global functioning.[127]

The Alpine region can be described as an – overall – economically strong mountain area that is integrated into the global economy. Fig. 21 shows that the GDP (Gross domestic product) growth in the Alpine region from 2008 to 2018 is significantly above the European average.[128] It is striking, that the economic growth of recent decades has not been limited to large cities, but also includes small and rural settlements.[129]

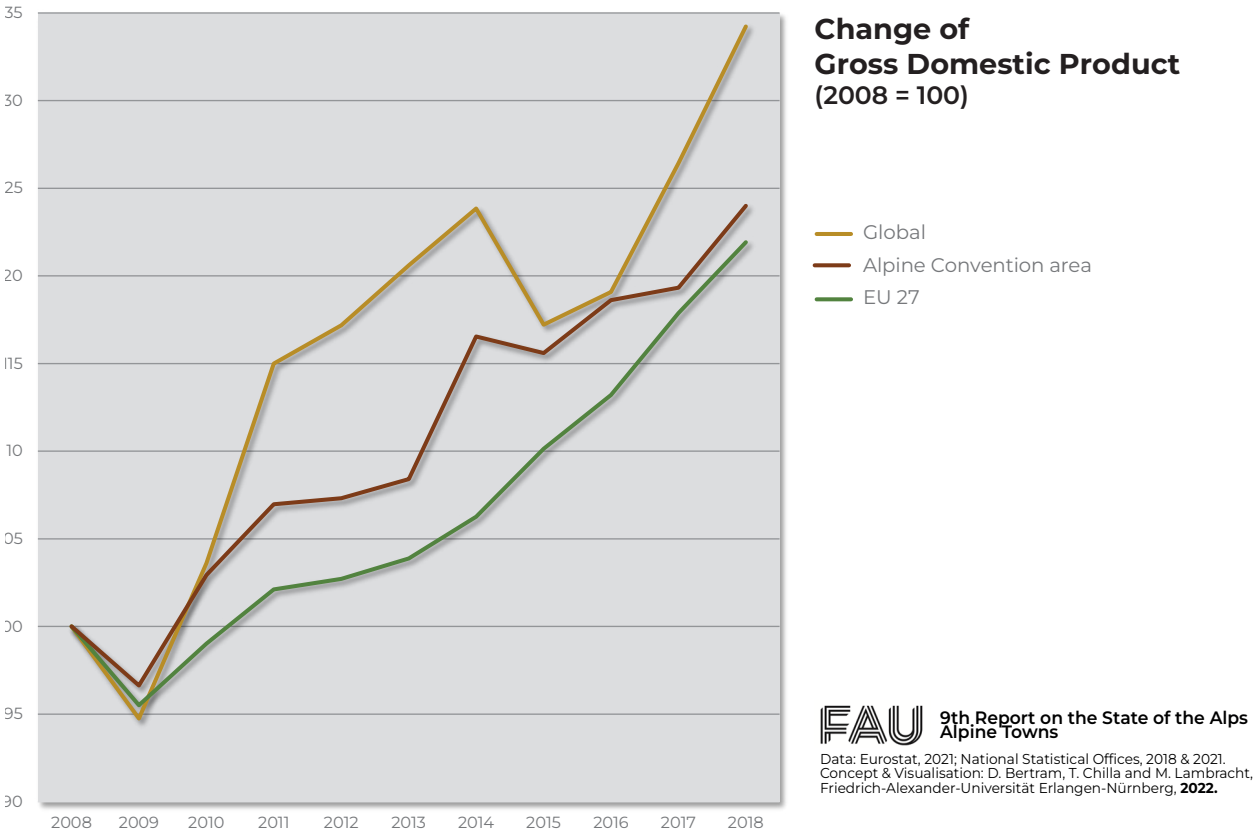

Fig. 21 Gross domestic product change 2008-2018 (RSA9, 2022)

127 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
128 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
129 https://bia.unibz.it/esploro/outputs/report/ESPON-Alps-2050-Inception-Report/991005773246201241?institution=39UBZ_INST#file-0

The successful path of the recent years, based on innovation and positive path dependencies, has created a remarkable 'drop height' for future economic development. The role of large companies is also a risk for the region and its employees if they do not adapt to future trends. Even if the Alpine region can be considered as economically strong, it faces massive challenges in terms of topography and transport infrastructure, demographic change, lack of critical mass, and environmental and sustainability issues. Even if the overall development is positive, one must not neglect a high territorial diversity across the Alpine region, including rather weak inner peripheries in several states.[130]

4.1.2 Topographic challenges for infrastructure

The Alpine region shows heterogeneous land use patterns, with dense urban agglomerations along the valleys and depopulation in some remote areas. The limited share of habitable land increases the competition between different demands (such as settlement, transport and tourism infrastructure, energy production, agricultural infrastructure, agricultural production, environmental protection or measures to adapt to climate change), leading to conflicts over land use.[131] This limited availability of land could become a challenge for economic development in the future. Strategic land use planning is essential for sustainable economic development.

Accessibility is also a challenge for sustainable economic development, especially in mountainous regions with their topography. The Alps are an important transit area in the center of Europe.[132] Transport is creating both, new opportunities and threats for local communities. Freight transport in particular generates high external costs in terms of pollution, noise or congestion. On the other hand, freight transport is essential for the economic development.[133] Furthermore, intra-Alpine, regional accessibility is of major importance, as the organisation of services of general interest (schools, retails etc.) largely depend on individual and public transport qualities.

Digitalisation also comes along with infrastructure challenges in the Alps. Fig. 22 shows the download speed in the Alpine region at the local level (2022).[134] Download speeds vary considerably across the Alps. This exemplary indicator illustrates the scope for improvement in many areas.[135] The further development of digitalisation is particularly important in terms of economic connectivity, the region's attractiveness for remote working and sustainable development. Digital infrastructure is rarely managed on a cross-border basis but strongly linked to national perimeters, as the map shows. The high number of national borders in the Alps plays a role as barriers to infrastructure provision. However, digitalisation is one of the key prerequisites for a successful economic development. It is highly relevant to avoid the so-called 'digital divide', e.g. extreme differences in the economic, social and spatial dimensions.[136]

130 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
131 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Soil/Long-term-action-plan_soil-protection.pdf
132 https://airies.wikiplus.net/attach.php/6a6f75726e616c5f32372d32656e67/save/0/0/27-2_02.pdf
133 https://www.sciencedirect.com/science/article/pii/S221053951930135X#s0010
134 https://www.researchgate.net/publication/375446358_Mapping_the_Scene_Cartographic_sketches_linked_to_the_EUSALP_cross-cutting_priorities?channel=doi&linkId=654a3eeb3fa26f66f4e2650b&showFulltext=true
135 https://www.researchgate.net/publication/375446358_Mapping_the_Scene_Cartographic_sketches_linked_to_the_EUSALP_cross-cutting_priorities?channel=doi&linkId=654a3eeb3fa26f66f4e2650b&showFulltext=true
136 https://link.springer.com/referenceworkentry/10.1007/978-0-387-93996-4_107

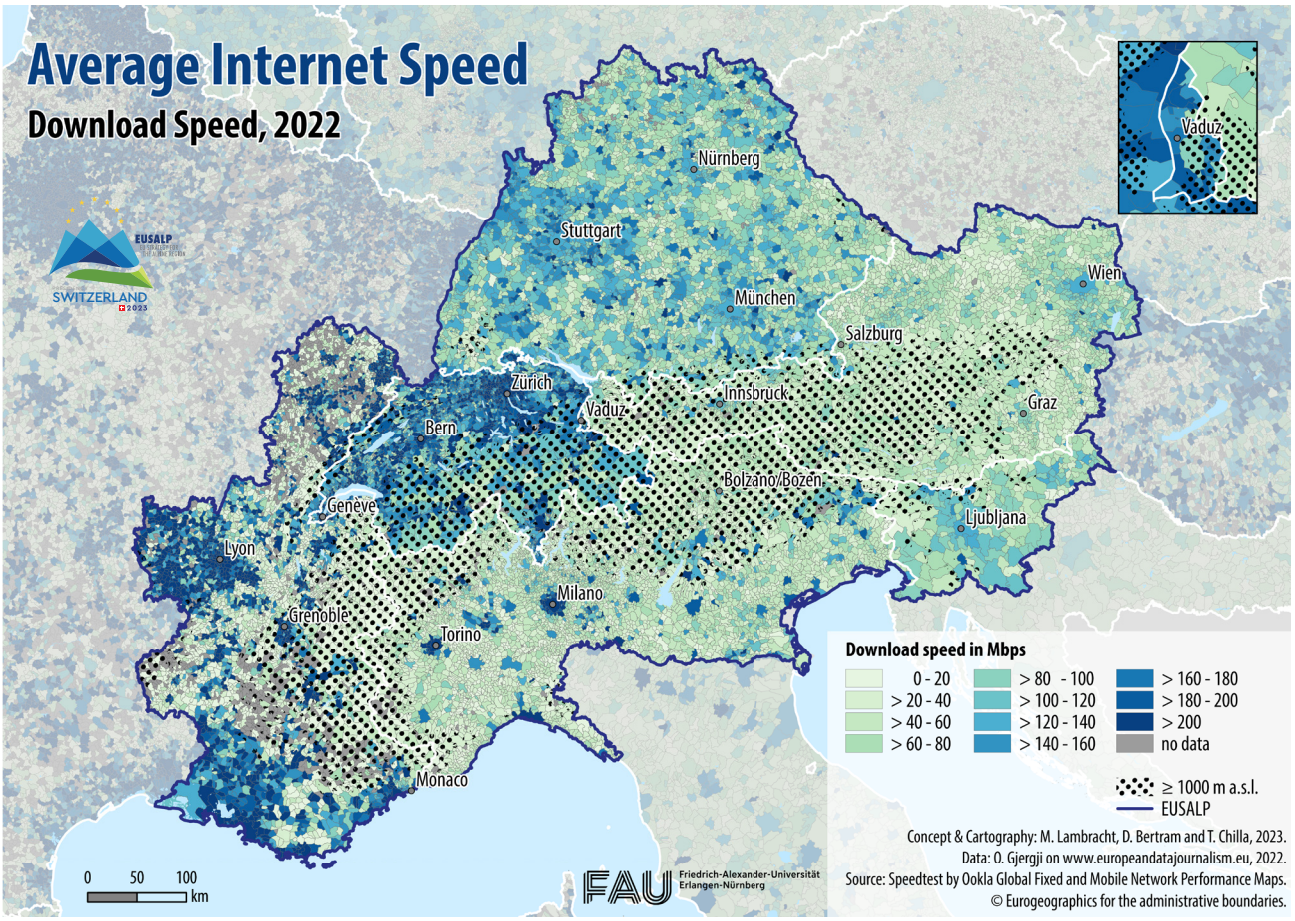

Fig. 22 Average download speed at municipal level (FAU, 2023)

4.1.3 Demographic challenges

The overall demographic trend of the Alpine population is positive, with higher growth rates in most cities and towns than in rural areas (Fig. 23).[137] Nevertheless, the fine-scale development patterns show a high diversity.[138] People tend to live in well accessible mountain valleys with access to jobs, education, healthcare and other social services.[139]

However, the demographic change is also a key challenge from the economic perspective. The dynamics of aging create a critical situation for the future, especially when young, highly educated people leave their home towns in search of further education and career opportunities. These highly educated people rarely return to the inner-Alpine areas.

In areas of demographic decline, the number and share of the working population tends to fall, putting pressure on labour markets. In shrinking regions, this comes along with infrastructure challenges as shifting demand and higher costs (demand for medical and elderly care, closure of kindergartens, schools). Studies from several Alpine countries show that the potential of (domestic, Alpine and international) migration is large, especially in communities affected by

137 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
138 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA5_EN.pdf
139 https://www.alpconv.org/en/home/topics/population-and-culture/#:~:text=Only%20150%20years%20ago%2C%20the,healthcare%20and%20other%20social%20services.

out-migration, skills shortages and ageing populations.[140] The economic performance of the Alps is at stake if regions affected by skills shortages are unable to overcome them.

Amenity migration and remote work can be a large potential in particular for attractive regions. These inhabitants can stabilise regional demand and, to a lower extent, bring entrepreneurial dynamics. This can even apply in the rather critical case of second homes as "multi-local lifestyles can be considered a major opportunity for the Alps if new inhabitants are willing to take responsibility for both regions and their development".[141]

Real estate markets are a major determinant for demographic mobility. Adequate and affordable housing capacities can be an important argument for the attractiveness of a region for potential labour force and inhabitants. In highly urbanised regions, the shortages on the real estate market and the high price level can be a bottleneck for economic attractiveness of the involved regions. The demand for housing in rural areas of the Alps must be seen in a differentiated way. Particularly in municipalities with good commuting facilities to cities such as Innsbruck, Munich, Salzburg or Vienna, population increase is widespread.[142] In contrast, areas of depopulation in higher distance to metropolitan cores are often in risk of downward spirals.

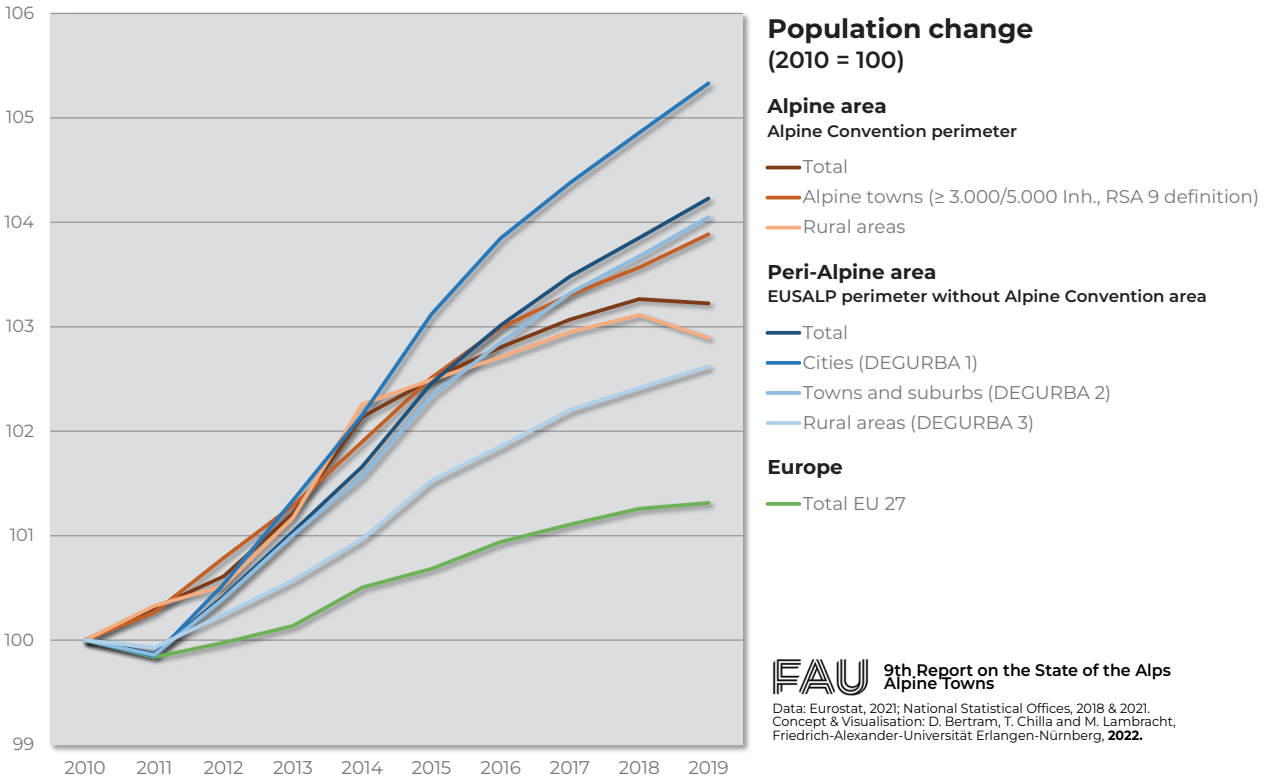

Fig. 23 Population change in 2010-2019 in Alpine and peri-Alpine areas (RSA9, 2022)

140 https://bioone.org/journals/mountain-research-and-development/volume-38/issue-3/MRD-JOURNAL-D-17-00070.1/Migration-by-Necessity-and-by-Force-to-Mountain-Areas/10.1659/MRD-JOURNAL-D-17-00070.1.full; https://bioone.org/journals/mountain-research-and-development/volume-36/issue-4/MRD-JOURNAL-D-16-00042.1/Amenity-Migration-in-the-Alps--Applying-Models-of-Motivations/10.1659/MRD-JOURNAL-D-16-00042.1.full
141 https://www.researchgate.net/publication/242544321_Zweitwohnungen_im_Alpenraum
142 https://doi.org/10.4337/9781803927695.00009

4.1.4 Critical mass

Critical mass is amongst the most Alpine specific challenges. As the Alpine region is of rather rural character with a series of accessibility issues, it is not trivial to develop economies of scale in competition to peri-Alpine metropolitan areas. Regional demand is comparably modest, and interacting on global markets tends to be at least slightly more difficult. Infrastructure costs in the Alpine region are not only higher due to topographic reasons. They also face the critical mass argument, as major investments are more profitable with a high number of potential users.[143]

This is in particular true as big players of the global economy have large opportunities of critical mass and as market complexities (protectionism, price increases due to geopolitical conflicts) can put the Alpine markets under high pressure. On the one hand, specialisation and innovation are an important prerequisite for a competitive economic development in the future. However, a simple 'think big' strategy is insufficient in the context of the region's fine-scale spatial structure.

This is true from an economic point of view, but it also links to a cultural argument: The Alpine identity – with its fine differentiation across the Alpine Arc – is characterised by rather small-scale patterns and often rural contexts. The cultural heritage comes along with creative resources, both tangible and intangible, with a recognised social value. A pure orientation on economies of scale can question these sources.[144] Globalisation brings both opportunities and challenges. On the one hand, it can promote the Alpine region to a wider audience, potentially supporting tourism and economic development. On the other hand, globalisation can lead to cultural homogenisation, where unique local traditions and identities are overshadowed by global trends.[145] With regard to the agricultural sector in the Alps, challenges of critical mass are most obvious. Due to topography, climate conditions, and landscape protection, it is hardly possible to compete on the international market if not referring to particular Alpine qualities.[146]

The comparably successful path of recent decades needs to be transferred into future contexts.[147] This has to be based on endogenous development, innovation, and further developing positive path dependencies.

4.1.5 Environmental and sustainability issues

The relevance of climate change is particularly relevant for the Alps due to the pace of temperature rise, but also to changes in the seasonal cycle of precipitation, global radiation, humidity and precipitation extremes.[148] Against this background, a reduction of greenhouse gas emissions is of great importance. There is a huge debate about how to transform the economy in a more sustainable way.[149] A series of fields has to be addressed, including the Alpine production sector and tourism which are important parts of the Alpine economy.

143 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
144 https://www.interregeurope.eu/sites/default/files/inline/TO6_Policy_Brief_on_Cultural_Heritage_in_Mountain_Regions_04102021.pdf
145 https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1748&context=libphilprac
146 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task1_2_ORGANIC_AGRICULTURE_MAMF_2021-2022.pdf
147 https://alpinetowns.alpconv.org/wp-content/uploads/2022/10/rsa9-part-1-facts-maps-and-scientific-debates.pdf
148 https://doi.org/10.1016/j.scitotenv.2013.07.050
149 https://www.taylorfrancis.com/chapters/edit/10.4324/9781315800462-3/achieving-sustainability-reform-transformation-william-rees; https://www.jstor.org/stable/27283990?seq=3

The Alpine economy faces sustainability challenges related to energy and resource (water, soil) consumption and waste management. The area is characterised by an energy system that is heavily dependent on fossil fuels and the involved higher CO_2 emissions.[150] The water consumption for agriculture, households, tourism, and production are challenged by drought episodes and a reduction of the amount of stored water and glacier melting. The use of water needs to be managed carefully to prevent conflicts of usage and to keep the water ecosystems functional.[151]

It is also important to consider the environmental impact of land take and soil sealing for businesses, housing, transport, and production facilities. Regarding soil degradation in the Alpine region, intensively farmed areas are common in wide valleys and on easily accessible slopes. This type of farming has negative impacts due to the use of fertilisers, grading, and drainage. Furthermore, pollution from agricultural runoff and wastewater discharge can degrade water quality, affecting both aquatic ecosystems and human health.[152]

The debate on so-called ecosystem services is closely linked to resource consumption. The Alpine ecosystem provides a wide range of non-monetary services, including fresh water, CO_2 storage, fertile soils, landscape attractiveness etc. There is a rich debate on how to address the monetary value of these functions from an economic perspective.[153]

The transport sector, which is closely linked to economic activities, has an enormous environmental impact. The morphological shape of the highly populated valleys leads to a high concentration of emissions.[154] Moreover, the rising volume of freight and passenger traffic on road and railways results in high noise levels in the narrow Alpine valleys.[155] The growing economic integration across Europe comes along with higher rates of freight transport in the mountain regions, as they are important transit areas between major economic centers.[156] When talking about emissions and noise, it is also important to mention that the landscape quality of the Alps is under threat. Ecological connectivity has increasingly deteriorated due to construction activities related to settlement and transport infrastructure as well as agricultural use.[157]

It is true that a series of positive effects come from tourism in the Alps and its overall economic relevance is considerable, also through its function as diversification potentials for small farms. But environmental and societal challenges pressurise the tourism sector in the Alps, sometimes linked to overtourism. The seasonality differs across the Alpine region with winter and/or summer peaks, posing challenges for infrastructural capacities (Fig. 24).[158] A large number of tourists is not always a positive factor. From an economic point of view, it has an important influence on price increases due to growing demand, land conversion for tourism services, or temporal employment.

150 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA6_en_short.pdf
151 https://alpineclimate2050.org/climate-target-system/water/
152 https://wwf.panda.org/discover/knowledge_hub/where_we_work/alps/problems/agriculture/
153 https://www.sciencedirect.com/science/article/pii/S2212041612000071; https://link.springer.com/chapter/10.1007/978-3-658-42136-6_87
154 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Transport/Transport_Annex4_IT_Air-quality-sustainable-mobility.pdf
155 https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Topics/transport/AlpineConvention_TransportWG_ExternalCostsNoise_112018_web.pdf
156 https://transport.ec.europa.eu/system/files/2020-07/2020-alpine-traffic-observatory-key-figures-2019.pdf
157 https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/alpine_nature_2030_broschuere_en_bf.pdf#%5B%7B%22num%22%3A262%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22XYZ%22%7D%2C0%2C842%2C0%5D
158 https://www.alpconv.org/fileadmin/user_upload/Publications/25maps.pdf

From an environmental point of view, it highlights an overuse of natural resources and occupation of natural open spaces. Undoubtedly, tourism needs a sustainable destination management, in particular in sensitive environmental areas.[159]

In conclusion, the Alpine economy faces environmental and sustainability challenges, driven by factors such as rising touristic demand, climate change, and resource exploitation. Alpine economies need to develop the capacity to adapt to threats such as water scarcity, heat stress, pressure on carbon-based industries, etc.

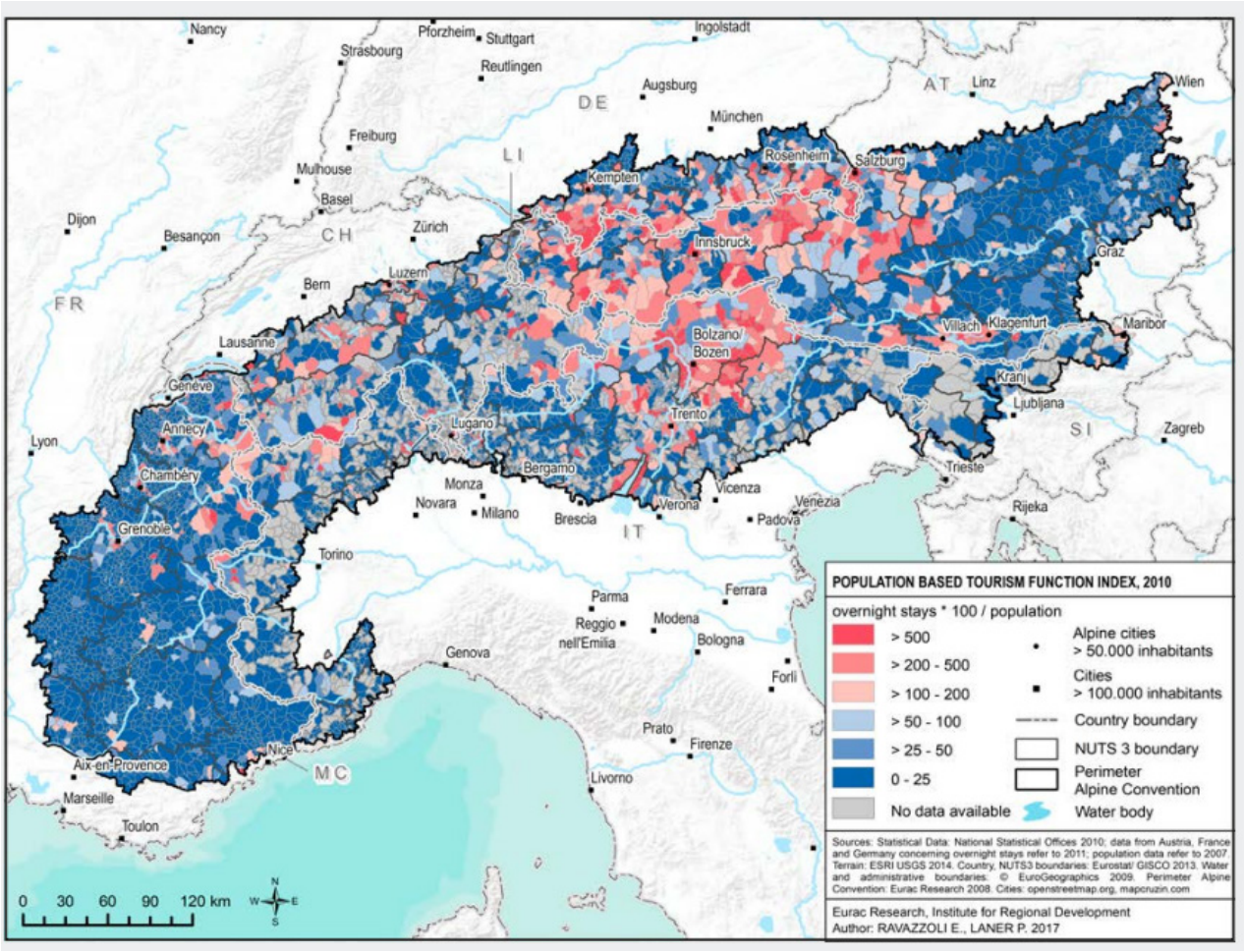

Fig. 24 Population based tourism function index (Eurac Research, 2018)

159 https://journals.sagepub.com/doi/full/10.1177/1354816620932007

4.2 The instrumental perspective

In addressing the manifold challenges of the Alpine economy, a series of policy fields and instruments are of high relevance. This includes both, the sectoral options of economic development and the instruments of spatial planning and development. Applying and combining the appropriate tools throughout the multi-level system is an ambitious endeavor, as Fig. 25 shows.

	General	Spatial planning & development	Economic development
European	– UN 2030 Agenda for Sustainable Development – European Green Deal – 2030 Climate Target Plan – European Recovery Plan – Green Deal Industrial Plan	– Territorial Agenda 2030 – EU Soil Strategy 2030 – Leipzig-Charter (2007) / New Leipzig-Charter (2020) – Cohesion policy	– European Economic Security Strategy – Circular Economy Action plan – SME Strategy – European Industrial Strategy – Europe 2020 Strategy – Horizon Europe – Research and innovation strategy 2020-2024 – EUs common agricultural policy (CAP)
Pan-Alpine	– "Alpine Convention (Framework Convention") – EU Strategy for the Alpine Region (EUSALP) – Climate Action Plan 2.0 – Alpine Climate Target System 2050	– Spatial Planning and Sustainable Development Protocol of the Alpine Convention – EUSALP Joint Paper on Spatial Planning – RSA9: Alpine Towns – *ESPON Alps 2050**	– Mountain Farming Protocol of the Alpine Convention – RSA 3: Sustainable Rural Development and Innovation – RSA 6: Greening the Economy in the Alpine Region – RSA 10: Quality of Life – *Declaration of the XVI Alpine Conference on Fostering a Sustainable Economy in the Alps** – *Action Programme for a Green Economy in the Alpine Region (Alpine Convention)** – *EUSALP AG1 Research and innovation work plan 2023-2025** – *EUSALP AG2 Economic development work plan 2023-2025**
National	– [div.]	– National plans, planning concepts and guidelines – *CIPRA Handbuch Alpine Raumordnung (AT)**	– e.g. National Circular Economy Strategy DE – e.g. New Regional Policy (NRP) & agricultral policy CH – e.g. Fachkräftestrategie DE – e.g. Agrarumweltprogramm ÖPUL 2023 AT – e.g. International Strategy on Education, Research and Innovation CH
Regional & local	– [div.]	– Plans, planning concepts and guidelines	– e.g. Gewerbegebiete, industrial areas… – e.g. RIS3 in Bolzano/Bozen – e.g. Agriturism in the Italian Alps

**non-litigable context documents*

Fig. 25 Relevant documents and strategies for the spatial planning and economic development nexus (FAU, 2024)

The columns differentiate three thematic perspectives:

- **'General'** documents include overarching strategies that do not focus on economy or spatial planning/development as such, even if they do have an impact on these fields. As mentioned in **chapter 2.2**, there are several strategic documents with cross-cutting implications at the European level as well as at the pan-Alpine level.
- **Spatial planning and development** strategies and documents are the same as those described in **chapter 2.2**.
- In the field of **economic development**, several documents provide access points. At the EU level, the European Economic Security and the European Employment Strategy have to be mentioned. At the pan-Alpine level, there are several documents, which include on target formulations and vision-making. Pan-Alpine approaches include several declarations of the Alpine Convention (Declaration on Fostering a sustainable economy in the Alps, Declaration Population and Culture of the Alpine Convention). From its early years on, the Alpine Convention has underlined the importance of endogenous potentials. At the national and regional levels, a variety of instruments ensure concrete implementation. A series of strategic documents formulate objectives and strategic pathways play an important role.

Obviously, this compilation is not intended to be complete, but it provides a structured overview on the relevant instruments. The table shows the incremental character of both, the spatial and economy related policies. The collection of different instrumental formats throughout the governance system has grown over decades. The following sections provide some more background information on the current debates on policy options.

4.3 Policy options from the economic perspective

The challenges introduced above are addressed in manifold ways. Simplifying to a certain extent, the measures can be classified into five thematic groups. The following sections go more into detail.

4.3.1 Green and circular economy

A number of approaches seek to achieve a more sustainable economy. In particular, the green and circular economy concepts aim to promote sustainability and address environmental challenges. Whilst both terms are often used in a rather synonymous way, they go back to distinct concepts. Green economy focuses on minimising environmental impacts and resource use without compromising economic growth. Optimising production processes towards sustainability, whilst building on efficiency and innovation are in the focus, in particular regarding energy, transport, industry and agriculture.[160] This can improve human well-being and social equity, which also includes health aspects as environmental conditions affect the quality of life.[161] The RSA 6 Greening the Economy in the Alpine Region focused on four key topics regarding green economy: Energy-efficient and low-carbon economy, resource-efficient economy, ecosystem services and a natural capital-based economy and last, economy supporting quality of life and well-being. Within the RSA 6, circular economy was part of resource efficiency.[162]

Circular Economy focuses on redesigning the current linear economic model, which is based on the 'take-make-dispose' principle, into a closed-loop system where resources are kept in use for as long as possible. Circular economy aims to minimise waste generation and maximises resource efficiency by promoting strategies reducing, refuse, reusing, recycling and remanufacturing. These concepts often overlap, with initiatives in one area contributing to the other.[163] The circular economy is one of the key concepts for achieving a sustainable Alpine economy.[164] The Alpine Convention`s Action Programme for a Green Economy postulates a multi-level governance approach. It calls for an energy efficient and low carbon economy, resource efficiency and an ecosystem and natural capital-based production system.[165] Nature-based solutions contribute to a greener and more circular economy. They refer to actions to protect, sustainably manage and restore natural or modified ecosystems that effectively and adaptively address societal challenges while providing benefits to human well-being and biodiversity.[166]

160 https://www.atlantis-press.com/article/125971476.pdf
161 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA6_en_short.pdf
162 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA6_en_long.pdf
163 https://www.atlantis-press.com/article/125971476.pdf
164 https://alpine-region.eu/topics-action-groups/cross-cutting-priorities
165 https://www.alpconv.org/fileadmin/user_upload/Publications/green-economy-action-programme_2019.pdf
166 https://www.thebritishacademy.ac.uk/publications/nature-based-solutions-and-the-green-economy/#:~:text=Broadly%20speaking%2C%20nature%2Dbased%20solutions,%2Dbeing%20and%20biodiversity%20benefits.%E2%80%9D

Both discussions are rather young and mainly on a conceptual level. Concrete implementation measures remain on a geographical or sectoral context. Nevertheless, they can be seen as cross-cutting postulates for the economic policies in general and also for the following fields.[167]

A number of debates beyond the green and circular arguments are questioning the need for growth more fundamentally. The discussion on degrowth (post-growth) argues that the only way to minimise CO_2 emissions, resource consumption etc. is to question economic growth as such. A shrinking economy is supposed to use fewer resources and energy, whilst supporting well-being and ecology.[168] This argumentation is linked to the beyond-GDP-debate that criticises to over-focus on this indicator. GDP does not measure all economic activities (e.g. private family care) and does not express externalities of the environment and the society. When formulating developing goals, a too narrow economic growth orientation is considered to question sustainability objectives. The 'Beyond GDP initiative' aims to develop a more comprehensive approach to measuring prosperity and well-being. Adequate indicators are needed to address global challenges such as climate change, poverty, resource depletion, health and quality of life.[169]

4.3.2 Innovation

Innovations are a key to sustainable economic development. Place-based innovation builds on the unique characteristics, resources and needs of a specific geographic area or community.[170] Also, social innovations can help solve local challenges by creating novel ideas for improvement.[171] The EU Smart Specialisation Strategy (3S) is amongst the most prominent formats in classical innovation policy. Starting point of smart specialisation strategies are the resources and skills linked to a region. 3S approaches identify and promote the endogenous potential of a region in order to foster an innovative environment. Some regions may not have the appropriate resources to foster innovation. These regions can learn from other places and work together on smart specialisation. In the Alpine area, the 3S-activities facilitated interregional cooperation in policy areas of economic growth and innovation, mobility and connectivity, environment and energy, and the cross-cutting policy area of governance and institutional capacity.[172]

EUSALP, with its Action Group 1 on 'research and innovation', aims to achieve balanced development and connectivity, an effective innovation ecosystem, and enhanced competitiveness through innovative approaches. These include the promotion of research and innovation, development of an effective research, and innovation ecosystem in the Alps and the support small and medium enterprises.[173] These strategies aim at economic growth and social prosperity.[174]

167 https://link.springer.com/content/pdf/10.1007/s43615-022-00175-9.pdf
168 https://www.weforum.org/agenda/2022/06/what-is-degrowth-economics-climate-change/
169 https://environment.ec.europa.eu/economy-and-finance/alternative-measures-progress-beyond-gdp_en
170 https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwicguOL8reGAxWWQfEDHYu1CVsQFnoECBIQAQ&url=https%3A%2F%2Fpublications.jrc.ec.europa.eu%2Frepository%2Fbitstream%2FJRC120695%2Fplace-based_innovation_ecosystems_comparative_analysis_pdf.pdf&usg=AOvVaw39wq9xAC-4OCwJ0hHa-rQS&opi=89978449
171 https://bioone.org/journals/mountain-research-and-development/volume-43/issue-1/mrd.2022.00023/Social-Innovations-and-the-Mountain-Economy--The-Case-of/10.1659/mrd.2022.00023.full
172 https://s3platform.jrc.ec.europa.eu/alpine-region#fragment-89005-hekg
173 https://www.alpine-space.eu/wp-content/uploads/2022/12/EUSALP_policybrief_2021_en.pdf
174 https://alpine-region.eu/about/strategy

An important focus lies on 'cross-areas complementarity networks', which include the establishment of cooperation agreements emphasising specialisation and division of labour.[175] Furthermore, cluster management aims at the strategic coordination of networks, which are geographic concentrations of interconnected companies and institutions in a particular field. These clusters often include businesses, suppliers, academic institutions, and other entities that are thematically linked.[176] A prominent example is Silicon Alps.[177]

A more alternative approach reflected on so-called 'slow innovations'. It refers to the unique characteristics of innovation (potential) in more peripheral regions. This concept is about how innovators in peripheral regions often rely on their technical and scientific knowledge. They typically experience fewer interactions with external actors, such as suppliers or partners, due to geographic location or a lack of established networks. 'Slow innovators' strategically seek out information and knowledge, to develop an innovative and stable economic environment.[178]

Collaborative innovation approaches – be it 'slow' or 'fast' – contribute to a more innovative environment. However, these approaches are often handled on a domestic level without exploiting the potential across regional borders.[179]

4.3.3 Skilled labour strategies

Tackling the shortage of labour force requires a multi-track approach. One strategic approach aims a reduction of barriers for intra-Alpine labour market migration e.g., to increase information flows. Second, an international recruitment of skilled workers and their integration in the labour market can help to minimise the shortage.[180] Third, the investment in education and training programmes can ensure that the local workforce is prepared for the future needs. For the Alps, an easier recognition of qualifications across borders is an important step.[181] Fourth, enhancing the connection between young people and the local Alpine labour markets can limit outmigration to the large metropolises. This can be achieved by raising awareness amongst young people about opportunities available in mountain businesses and traditional occupations.[182]

Alpine destination marketing can also help to attract skilled workers from outer Alpine areas. New formats aim at the combination of remote work and recreation. For example, the project 'Coworkation Alps' establishes 'creative hotspots' in the Alpine region, supporting the experience and knowledge exchange between professionals and businesses. This can open up opportunities for the regions: new ideas, high skilled workers, creative potential, and inspiration can activate regional development and create an attractive environment. The Alpine region is framed as a place of creativity. It remains to be seen to what extent peripheral areas can exploit their potential and turn their perceived locational disadvantage into a locational advantage.[183]

175 https://re.public.polimi.it/bitstream/11311/1221173/1/2018_Capello%20Cerisola_Economia%20Marche.pdf
176 https://eujournal.org/index.php/esj/article/view/5138
177 https://www.silicon-alps.at/
178 https://epub.oeaw.ac.at/0xc1aa5576%200x003b582d.pdf
179 https://www.alpine-space.eu/wp-content/uploads/2022/06/s3-4alpclusters-final-publication-interactive.pdf
180 https://www.dw.com/en/germany-to-change-immigration-laws-in-attempt-to-attract-skilled-labor/a-65169420
181 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/SPSD/Assessment_study_Cross-border_Cooperation.pdf
182 https://alpine-region.eu/topics-action-groups/detail/labour-market-education-and-training
183 https://www.coworkation-alps.eu/der-verein/vision-mission.html

4.3.4 Sustainable tourism

A number of strategies and policy options have been developed with the objective of promoting more sustainable forms of tourism in the Alps. Rather soft instruments, such as visitor management and the work of rangers[184], aim to balance recreational activities and nature conversation in the Alpine region.[185] Declarations, incentive programs, stakeholder activation, and consumer communication can help to create a sustainable tourism environment. These instruments are embedded in a juridical framework. The implementation of existing legislation, such as zoning in sensitive areas, can help promote more sustainable tourism practices.[186]

From an economic perspective, diversification of the tourism sector has a high potential, in particular in times of climate change. Diversified tourism offerings throughout the year can ensure economic development and a secure source of income and employment. Diversification can minimise the dependence on specific weather conditions as it is the case for skiing and mountaineering. Furthermore, split stays and all-season-offers can increase the flexibility and by that can stabilise the economic basis throughout the year.[187] Mountaineering villages ('Bergsteigerdörfer') are an important tool for balancing tourism and sustainability issues. They aim to increase local added value by focusing on its endogenous potential, without relying on heavy infrastructure and aiming for minimal ecological impact.[188]

Tourism development in many Alpine destinations relies significantly on the work force and products of Alpine farmers.[189] In particular the combination of tourism and agriculture has proved to be mutually positive, e.g. agrotourism in Italy.[190] It promotes sustainable tourism and agriculture by fostering a connection between consumers and producers, encouraging environmental stewardship, providing additional income for farmers, and supporting local traditions and biodiversity.[191]

The collection and dissemination of knowledge and data on sustainability are the basis for the exploitation of the mentioned potentials. Best practice of Alpine tourism solutions can be monitored and disseminated. Alpine tourism destinations can benefit from sharing good practices and data.[192] Sustainable tourism can profit from improved data availability of sustainable tourism indicators. Moreover, cross-border cooperation and stakeholder engagement are seen as an open potential.[193]

4.3.5 Mountain agriculture

Mountain agriculture is a rather small economic sector which is – at the same time – of key relevance for tourism, ecology, landscape conservation, food production etc. Against this background, the protection of geographical origin is a strategy to preserve and support mountain agriculture.[194] These protection schemes and marketing platforms are established at different levels.

184 https://www.alpinium.bayern.de/bewahren/besucherlenkung/index.html
185 https://www.naturerlebnis.bayern.de/lenken_gestalten/best_practice/besucherlenkung_alpen/index.html
186 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA4_EN.pdf
187 https://www.alpconv.org/fileadmin/user_upload/Topics/Measuring_tourism_sustainability_of_mountain_destinations_in_the_Alps_2021_en.pdf
188 https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA4_EN.pdf
189 https://www.sciencedirect.com/science/article/pii/S2213078021000414
190 https://www.arl-net.de/system/files/media-shop/pdf/ab/ab_034/ab_034_gesamt.pdf
191 https://www.researchgate.net/publication/343401302_Agritourism_Activity-A_Smart_Chance_for_Mountain_Rural_Environment%27s_Sustainability
192 https://www.alpconv.org/fileadmin/user_upload/Fotos/Banner/Topics/tourism/IV_Report_GP_tourism_FINAL.pdf
193 https://www.mdpi.com/2071-1050/9/2/226
194 https://www.fao.org/faolex/results/details/en/c/LEX-FAOC118307/

The EU labelling aims to protect specific products to promote their unique characteristics, linked to their geographical origin as well as the underlying traditional heritage. The Geographical Indication allows consumers to recognise quality products, while helping producers to market their products more effectively. The Geographical Indication comprise PDO (protected designation of origin for food and wine) and PGI (protected geographical indication for food and wine).[195] 'Speck of l'Alto Adige/Südtiroler Speck' or 'Vorarlberger mountain cheese' are examples of protected Alpine products.[196] The Geographical Indication is contributed by the EU indication 'mountain product' for agricultural products made in difficult conditions such as mountainous areas.[197] In Switzerland ‚Berg- und Alpprodukte/Montagna e Alpe' is present.[198] Regional labels can also have a protective and marketing purpose, such as Allgäu®[199] and regio-garantie[200] (see Fig. 26).[201] These regional indications are particularly relevant for products that do not have an official PGI or similar formal recognition.

Organic farming and its certification is an opportunity for mountain farmers to qualify their food and products as environmentally friendly and respectful of the environment and its balance. Austria and Italy have significantly higher shares of organic farming than the EU average.[202] The small-scale structure of some Alpine farms makes it difficult to overcome the critical mass for certification standards. Group certification seems to be of particular interest for organic mountain farmers whose small economic size does not always justify the costs associated with individual controls and individual mandatory certification. This group certification is one way and is recommended to achieve economies of scale.[203]

Fig. 26 Examples of mountain labels

Generally speaking, labelling formats include rather formal certification procedures and general marketing in different combinations. Marketing is a crucial aspect for mountain products and their communication to consumers. Labels can link a product to a certain place via slogans, symbols or narratives etc. The place of origin is framed as a part of a specific product quality.[204]

195 https://agriculture.ec.europa.eu/farming/geographical-indications-and-quality-schemes/geographical-indications-and-quality-schemes-explained_en
196 https://agriculture.ec.europa.eu/farming/geographical-indications-and-quality-schemes/geographical-indications-food-and-drink_en
197 https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=CELEX%3A32014R0665
198 https://www.blw.admin.ch/blw/it/home/instrumente/kennzeichnung/berg-und-alp.html
199 https://b2b.allgaeu.de/marke/markenstrategie
200 https://www.schweizerregionalprodukte.ch/de/regio-garantie/
201 Sources from left to right: https://b2b.allgaeu.de/marke/markenkommunikation; https://www.schweizerregionalprodukte.ch/de/regio-garantie/; https://www.clcv.org/infos-sur-vos-produits/produit-de-montagne-et-montagne; http://www.trentinoagricoltura.it/Trentino-Agricoltura/Prodotti/Prodotto-di-montagna
202 https://www.europarl.europa.eu/topics/en/article/20180404STO00909/the-eu-s-organic-food-market-facts-and-rules-infographic
203 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task1_2_ORGANIC_AGRICULTURE_MAMF_2021-2022.pdf
204 https://www.mdpi.com/2071-1050/15/3/2666

Given the overarching relevance of mountain farming for landscape preservation, tourism, food production etc, funding and subsidies are a prominent policy options.[205] This is particular true for small farms, which are not economically viable. The Common Agricultural Policy (CAP) plays a crucial role in EU mountain areas by providing financial support, promoting sustainable practices and contributing to social cohesion. This EU policy framework helps regions by facing the challenges in maintaining farming activities that can also have a stabilising effect on demography.[206] Regional programs like 'Bayerisches Bergbauernprogramm'[207] complement each other, and beyond the EU, also the Swiss Agricultural policy provides important instruments.[208]

Company networking, cooperation and integration are tools to foster Alpine value chains at the business level. The main objective is to enlarge value creation in the region beyond the rather low economic scope of raw materials in agricultural and forestry. Fig. 27 shows the horizontal and vertical dimensions of value creation.[209]

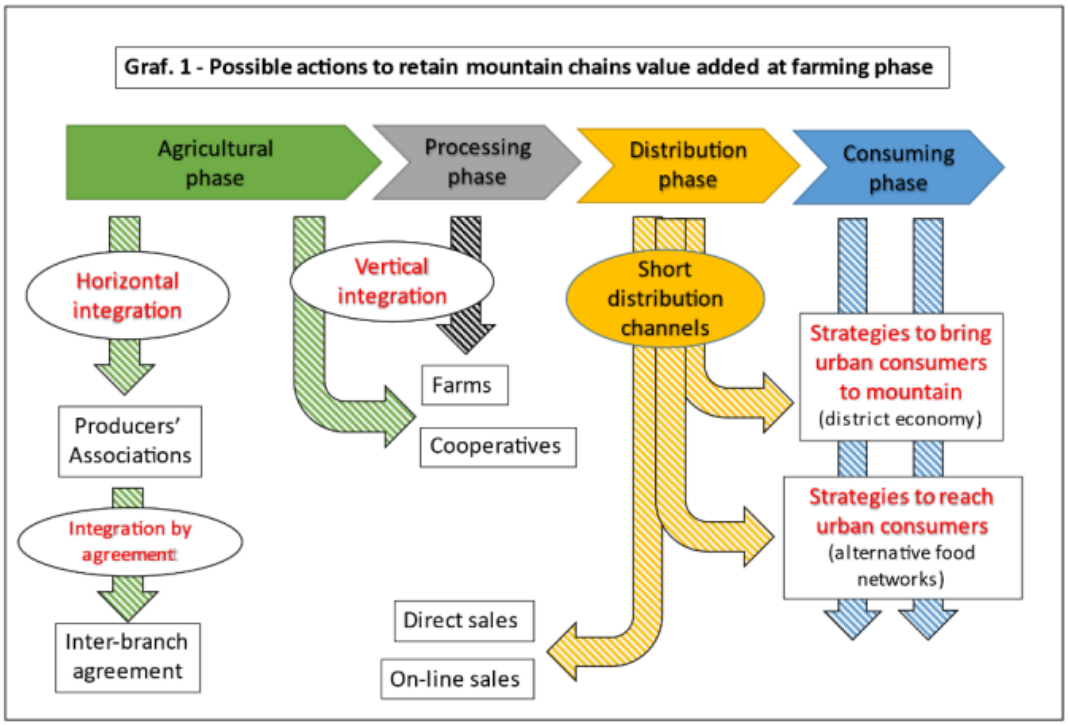

Fig. 27 Possible actions to retain mountain value-added chains at farming phase (Alpine Convention, 2022)

The horizontal dimension refers to the integration of companies at the same level in the value chain to achieve economies of scale. Vertical integration refers to cooperation between companies at different stages of production or distribution. Integration processes strengthen the position of the agricultural and forestry sector. Short distribution channels between producers and consumers can achieve higher margins and can contribute to sustainability with less 'food miles'. Alpine value chains are often promoted at the domestic level, but less at a cross-border scale which could also increase the added value to producers.[210]

205 https://www.sciencedirect.com/science/article/pii/S2213078021000414
206 https://eu-cap-network.ec.europa.eu/publications/policy-insight-importance-mountain-development-eu_en
207 https://www.stmelf.bayern.de/foerderung/bayerisches-bergbauernprogramm-bbp/index.html
208 https://www.blw.admin.ch/blw/en/home/politik/agrarpolitik.html
209 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task_3_VALUE_CHAINS_MAMF_2021-2022.pdf
210 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/MAMF/MAMF_Report_task_3_VALUE_CHAINS_MAMF_2021-2022.pdf

4.3.6 Location factors and policies

The aim of economic policy is to increase or maintain the attractivity of places for businesses and citizens. In order to ensure or strengthen competitiveness in the long term, a good location policy is needed. This requires well-positioned research and innovation facilities, efficient infrastructure (rail, energy, and transport), a sufficient number of skilled workers and a competitive tax system. Moreover, an effective social system and an efficient public sector play an important role.

There is quite a consensus that locational assets have to be ensured across the different territories. However, it is more controversial to what extent economic policies shall support certain sectors or industries[211], e.g. regarding hydrogen production.

Affordable housing (4.1.3.) has increasingly become a location factor. In some regions, employee housing has been experiencing a comeback in recent years. It offers additional potential and attractive solutions for affordable housing.[212] In Austria, the 'job with a flat' model is becoming increasingly important as a means of attracting and retaining talent.[213]

Also, soft location assets play an important role for locational decisions[214]: They are intangible factors that enhance the attractiveness and competitiveness of a place to live, work, and invest. Unlike hard location assets, which include physical infrastructure, soft location assets are more concerned with the cultural environment, social capital and amenity aspects of a location.[215] The Alpine regions have different strengths and weaknesses, and it is important to build on these assets to ensure sustainable regional development.[216]

4.4 Policy options from the spatial perspective

4.4.1 Land use policy

As indicated in the table above (see Fig. 17), the spatial perspective in economic development differs largely across the multi-level system. At the pan-Alpine level, strategic approaches prevail, whereas the domestic levels are most relevant with regard to binding regulatory frameworks and implementation. This includes land use policy that results in exact spatial prescriptions for types of use – e.g. zoning of protected areas, definition of new housing areas, etc. The policy option of compensation can be done monetarily or by restoring or enhancing other natural areas.[217]

Land use policy is currently a sensitive issue, as both land protection and affordable housing are important societal needs. The Alpine Convention's Spatial Planning and Sustainable Development Protocol underlines "that protection of the environment, social and cultural promotion and economic development of the Alpine territory are all objectives of equal importance, and that therefore it is necessary to find an appropriate, durable balance among them". An important orientation of the objectives for a further spatial perspective is Article 1.[218]

211 https://www.bmwk.de/Redaktion/DE/Artikel/Industrie/eine-gute-standortpolitik.html
212 https://www.gdw.de/pressecenter/pressemeldungen/bezahlbares-wohnen-wird-zum-standortfaktor/
213 https://www.diepresse.com/18473915/das-modell-job-mit-wohnung-gewinnt-an-bedeutung
214 https://www.bmaw.gv.at/Themen/Wirtschaftsstandort-Oesterreich/Standortpolitik.html#:~:text=Standortpolitik%20ist%20Teil%20der%20Wirtschaftspolitik,Wettbewerbsf%C3%A4higkeit%20eines%20Wirtschaftsraumes%20zu%20formulieren.
215 https://doi.org/10.1080/1331677X.2019.1590217
216 https://doi.org/10.1659/MRD-JOURNAL-D-15-00061
217 https://www.lfu.bayern.de/natur/kompensationsverordnung/index.htm
218 https://www.alpconv.org/fileadmin/user_upload/Convention/EN/Protocol_Spatial_Planning_EN.pdf

The role of land use policy is to moderate and balance competing needs 'on the ground'. This necessarily requires communicative, long-term processes that ultimately lead to binding jurisdictional measures. As mentioned earlier, most pan-Alpine documents are non-binding with the exception of the Alpine Convention and its Implementation Protocols (for the ratified contracting parties) as intergovernmental treaty.

Across the multi-level system, a series of documents formulate objectives of minimised or even zero net land take[219] (EU Soil Strategy 2030 with the aim of 'no net land take by 2050'[220]). At the same time, the implementation process is challenging, and the balancing with requests for more residential and commercial space is an ongoing concern. High levels of land take led to concerns of ecological connectivity, protected areas, and open spaces. These issues are politically organised within domestic perimeters even if the functional linkages cross these borders, calling for local, regional and pan-Alpine cooperation across borders.[221]

4.4.2 Sustainable infrastructure development

Classical infrastructure is of central to economic development, in particular in form of transport, energy, and digital networks. These infrastructure layers are subject to fundamental transition processes and they are key topics of spatial planning and development.

Currently, a pan-Alpine knowledge transfer for a more harmonised energy transition is being discussed. Energy efficiency as an important aspect of decarbonisation reduces greenhouse gas emissions. In public enterprises, energy agencies can improve efficiency through trust-building, information, and technical support.[222] It is suggested that the Alpine region shows an uneven development of hydrogen mobility, with some areas advancing more rapidly than others.[223] The introduction of green and low-carbon hydrogen as a sustainable energy source is a prominent policy option. Green hydrogen can mitigate CO_2 emissions and foster the transition to low-carbon transport. Decarbonisation of the transport sector is an important issue to promote a more sustainable infrastructure development in spatial planning.[224] Modal shift from road to rail and other soft modes are well-known policy options. Coordinated and harmonised activities in the Alpine countries can contribute to a sustainable transformation in the energy and transport sector.[225]

Promoting digitalisation in the Alps is a key policy field for a sustainable economic development. Broadband and satellite infrastructure are the basis for regional and global economic integration.[226] Moreover, digitalisation comes along with huge sustainability potentials, in particular by reducing mobility needs and more efficient production processes. The use of cutting-edge technologies and the promotion of e-services are key elements in achieving a more digital environment.[227] At the same time, geographical and social 'digital divides' have to be avoided, in order to guarantee accessibility to digital infrastructure and solutions for all.[228] It is important to provide support to local communities and economic players in their efforts to become digitally advanced and independent.[229]

219 https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/SPSD/CDR_ACTS_IP_SP1_3_Land_Saving_Targets_Summary.pdf
220 https://www.eea.europa.eu/en/analysis/indicators/net-land-take-in-cities
221 https://www.alpine-space.eu/wp-content/uploads/2022/12/EUSALP_policybrief_2021_en.pdf
222 https://ec.europa.eu/regional_policy/en/projects/Slovenia/alpgrids-local-grids-for-reliable-renewable-energy-in-the-alps; https://www.alpine-space.eu/wp-content/uploads/2022/12/EUSALP_policybrief_2021_en.pdf
223 https://www.alpine-space.eu/wp-content/uploads/2024/03/D.1.6.1-Guidelines-on-how-to-update-and-develop-H2-and-mobility-strategies.pdf
224 https://www.alpine-space.eu/project/h2ma/
225 https://www.alpine-space.eu/wp-content/uploads/2022/12/EUSALP_policybrief_2021_en.pdf
226 https://www.uni-stuttgart.de/en/university/news/all/6G-mobile-communications-tested-in-the-Alps-for-the-first-time/
227 https://alpine-region.eu/topics-action-groups/detail/connectivity-and-accessibility
228 https://alpine-region.eu/about/strategy
229 https://alpine-region.eu/topics-action-groups/cross-cutting-priorities

4.4.3 The strategic role of spatial structuring

Economic and spatial development are all closely interlinked. This is particularly true for the spatial organisation of settlement systems.[230] For example, it is important avoid an over dense concentration, which can lead to congestion and overload in the central areas. On the other hand, an overly dispersed organisation leads to inefficiency and unnecessary mobility. The optimal planning principle in this context is decentralised concentration, which allows for efficient links between the main areas of activity. This means defining development and infrastructure corridors, functional links and protected zones. Even if - in practice - planning has to deal with existing structures, it can still influence future development.

Ambitious planning not only anticipates cross-sectoral dynamics, but also formulates strategic objectives and long-term priorities. This applies at all scales - most obviously at the urban and regional level. Furthermore, the transnational scale of the Alpine region is an important layer. Reflecting large scale economic flows, axes and gaps means to further develop the spatial organisation also on the pan-Alpine level. Increased spatial knowledge, intensified exchange and aligned vision making can help to achieve a sustainable and resilient economic development. The Alpine Spatial Development perspective can contribute by further concretising cross-sectoral potentials.

230 https://alpinetowns.alpconv.org/

4.5 Towards vision making

As shown, the challenges of economic development and spatial planning and development in the Alps are diverse, as are the guidelines and policy options. The Alpine Spatial Development Perspective will align the different elements towards a common vision, including thematic, geographical and procedural aspects. The feedback loop was organised in the format of an interactive workshop. The Working Group on Spatial Planning and Sustainable Development reflected on this chapter in a joint meeting (July 2024, Innsbruck; see Fig. 28).

Fig. 28 Participative mapping in the workshop of the Alpine Convention working group 'Spatial Planning and Sustainable Development' (Photos: Hannah Paul)

The discussion on the Alpine economy is relatively recent in comparison to the discourses on transport and environmental issues. Given the multifaceted nature of economic development, the workshop participants were requested to develop a legend suitable for economic vision making. They were divided into five groups and engaged in a brainstorming session, during which they develop the following proposals. Fig. 29 illustrates the explorative character of the workshop results.

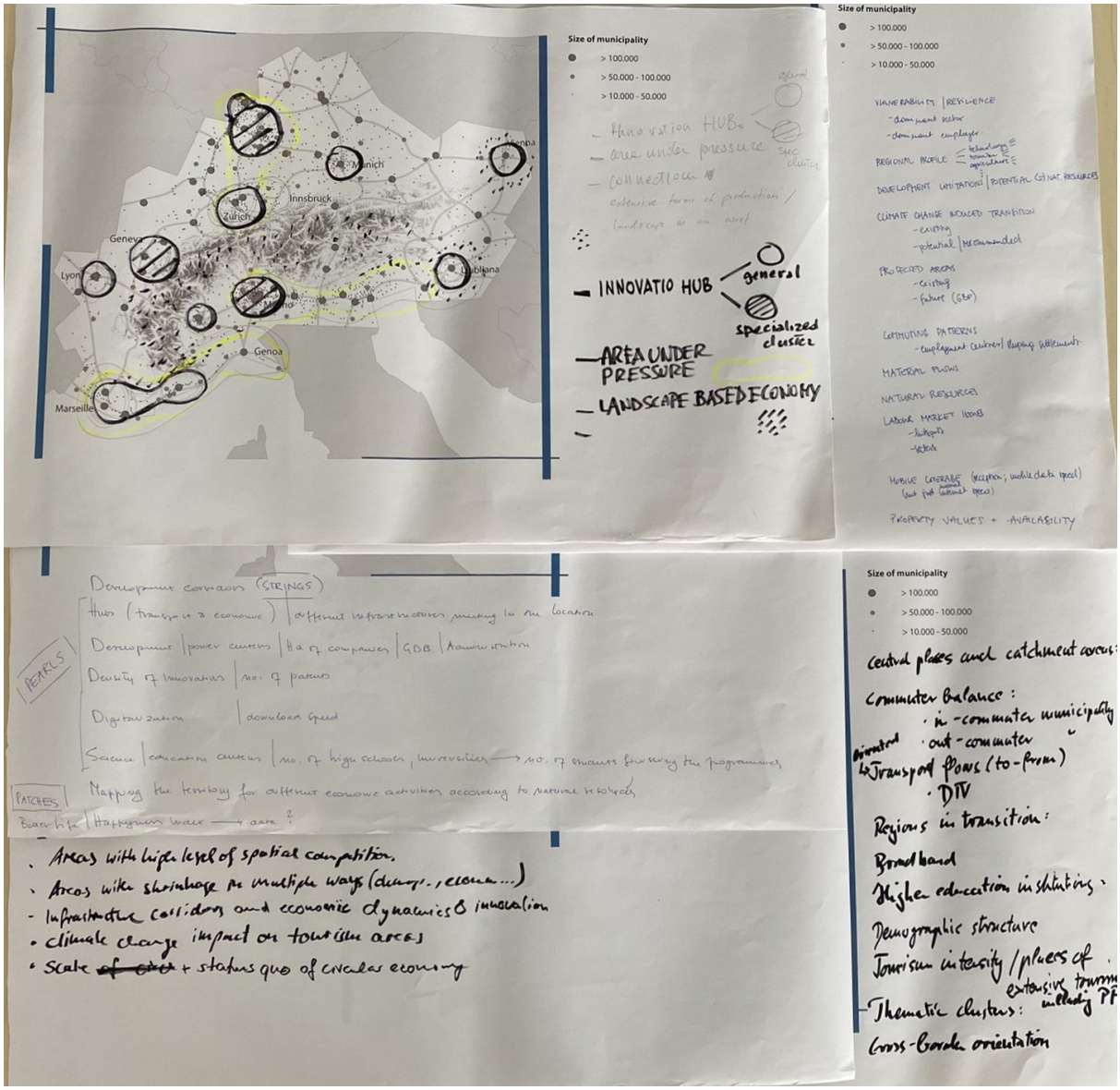

Fig. 29 Results of the participatory legend development (Photos: Hannah Paul)

A map and its legend normally contain lines, points and areas. One workshop group referred to the VASAB logic and defined 'strings', 'pearls' and 'patches', which is the wording of the VASAB vision maps. In relation to lines or 'strings', material or commuting flows were suggested and development/infrastructure corridors were proposed as important patters for Alpine economy. Hubs were mentioned by different groups, covering a wide range of concentration patters including businesses, transport, innovation and tourism.

Most proposals argue along thematic lines, which can be grouped under the following headings. Digitalisation, including mobile coverage or broadband availability, is a prominent topic. Sectoral differences and dominant economic sectors are proposed, including technology, agriculture and tourism. Further proposals include:

- Major employers
- Scale and status quo of circular economy
- Landscape based economy
- Tourism intensity (including impact of climate change)
- Regions in transition
- Labourmarket issues (hotspot/sectors)

A socio-economic perspective should include the demographic structure, education levels and information on quality of life. Environmental issues were also part of the discussion with indicators like natural resource availability, the vulnerability/resilience of a region, climate change induced transition and existing and future protected areas. The last thematic group contains so called conflict zones, which include areas under pressure, demographic and economic shrinking areas, areas with development limitations or areas with a high level of spatial competition.

The draft legends and their topics obviously have a large potential to contribute to further Alpine Spatial Development Perspectives. Some of the themes will be explored in greater depth in the next mandate phase.

5 Outlook

This report synthesises the initial phase in the development of spatial development perspectives for the Alpine region. So far, it is necessary to address prominent sectoral issues of the Alpine region's debate. In the coming steps, the sectoral perspectives of transport, GI, and economy have to be completed, and an integrated reflection has to provide a cross-sectoral vision.

The upcoming formulation of the Alpine Spatial Development Perspective (ASDP) will be an incremental process including a broad range of stakeholders and representatives. The mandate phase of the Working Group on Spatial Planning and Sustainable Development for the period 2025-2026 will continue this process.

The ongoing work on the Alpine Spatial Development Perspective will contribute to a deeper analytical understanding and further concretise the spatial dimensions and perspectives. The territorial and sectoral results will provide critical reflections on advancing sustainable spatial development. Spatial visions will be mapped and developed through detailed cartographic representation. The ASDP results aim at broad acceptance after incorporating feedback loops and participatory elements. Additionally, a concretised political process will be established to guide the development of an Alpine Spatial Development Perspective.

The spatial dimension of sustainable development means to promote a cross-sectoral and cross-border approach. This perspective is a key to achieve harmonious sustainable development.

Federal Ministry
for Housing, Urban Development
and Building

ALPENKONVENTION
CONVENTION ALPINE
ALPSKA KONVENCIJA
CONVENZIONE DELLE ALPI

FAU Friedrich-Alexander-Universität
Erlangen-Nürnberg