D4.3 Practice Abstracts

MOUNT RESILIENCE

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List of Acronyms

CC	Climate Change
CCA	Climate change adaptation
EEA	European Environment Agency
ERDF	European Regional Development Fund
EU	European Union

IoT	Internet of Things
KTM	Key Type Measures
NbS	Nature-based Solutions
SAT	Standoragentur Tirol
SME	Small and medium-sized enterprise
UIBK	University of Innsbruck

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Executive summary

As part of WP4 (Communication, dissemination and networking), in particular T4.3 (Dissemination of the results), practice abstracts are intended to disseminate key results in a clear, user-friendly format, not only through the project website but also through other relevant platforms, such as partner websites and newsletters. These will be developed in multiple steps: an initial version at M18 and two subsequent updates at M42 and M52 to complete the initial abstracts with additional data as the project progresses, and to produce those relevant to results delivered in later stages of the project. This will allow early dissemination of first outcomes, while ensuring that all results are captured.

The present practice abstracts document is therefore only a first version of the demonstrators' progress. It showcases the context and solutions explored in the 6 regions and allows for a first snapshot on the concrete solutions debated and envisaged in each demonstrator (hereafter referred to as demo). It draws from WP1 (Support framework for transformation to climate resilience) and WP2 (Regional demonstrators) deliverables submitted since the beginning of the project and in particular D1.1 Conceptual model for climate resilient transformation, D1.2 Regional diagnosis for CCA, D1.3 Climate resilient regional transformation strategies and D2.1 Demo implementation roadmaps.

Relevant parts from those deliverables have been identified in collaboration with WP2 lead partner. The presented sections of the abstracts have been drafted accordingly, while simultaneously considering the future design of the booklet. This was an important part of the process, resulting in a relevant dissemination output both visually and in terms of content.

Additionally, a cross-sectoral and thematic analysis of the solutions explored in each demo has been performed. For this, the typology developed by the European Environment Agency (EEA) has been used: Key Type Measures to report climate adaptation action in the EEA member countries. This served as the basis for clustering the various solutions explored in demos and for elaborating a cross-sectoral table of content.

Titles and thematical scopes of each demonstrator abstract:

- **BULGARIA – Gabrovo**: the demo aims at improving adaptation and preparedness strategies to address the interconnected geographical and climate challenges in Gabrovo. This includes safeguarding the natural environment and enhancing the health and well-being of its residents in the face of worsening climate-related risks.
- **FINLAND – Lapland**: the demo aims at increasing the general knowledge and awareness on climate change and adaptation pathways. To achieve this, the pathway is to help municipalities avoid land-use conflicts and assist regional and local actors in better managing risks.
- **ITALY – Piedmont:** the demo aims at creating a resilient and well-managed system for water use, ensuring a sustainable water supply in Piedmont, crucial for agriculture, drinking water, and energy production.
- **ROMANIA – Sibiu:** the demo aims at enhancing agricultural sustainability and the health of local ecosystems through the restoration of degraded soil.
- **AUSTRIA – Tyrol:** the demo aims at defining a strategy to enhance building energy efficiency and sustainable environmental resource management while simultaneously promoting sustainable tourism.
- **SWITZERLAND – Valais:** the demo aims at developing a climate adaptation strategy (Climate Resilience Adaptation Strategy) to adopt a strategy based on data monitoring, sharing and visualisation to secure water resources, reduce flood risk, and protect natural ecosystems through collaboration, coordinated actions, monitoring, and environmental nature-based solutions at a local scale.

1. Methodology

1.1. Objectives

A practice abstract is a short summary aimed at communicating easy-to-access information to practitioners. These documents provide information, recommendations or practices beneficial for end-users' daily activities. Indeed, they should facilitate networking by connecting project partners with practitioners. Abstracts also help projects share their results in an easily understandable way. Finally, abstracts aim to foster knowledge flows and sharing project results more widely and at a faster pace. At this stage of the project, results are not yet available in MountResilience and it is thus a first version of the abstracts, with updated versions to come.

As part of WP4 (Communication, dissemination and networking) and in particular T4.3 (Dissemination of the results), practice abstracts will be developed in multiple steps: an initial version at M18 and two subsequent updates at M42 and M52 to complete the initial abstracts with additional data as the project progresses, and to produce those relevant to results delivered in later stages of the project. This allows for early dissemination while ensuring that all results are captured.

Thus, the primary objective of the present abstracts is to disseminate the initial working pathways explored by the demonstrators (hereafter referred to as demo). For this, content from previous deliverables (WP1 and WP2) has been selected. The abstracts also offer a cross-territorial and thematic overview of explored solutions to climate change adaptation (CCA) to replicators, and more broadly to interested stakeholders.

For this, the typology developed by the European Environment Agency (EEA) has been used: Key Type Measures to report climate adaptation action in the EEA member countries[1]. This served as the basis for clustering the various solutions explored in demos and notably the cross-sectoral table of content (see below in the layout section).

[1] https://www.eionet.europa.eu/etcs/etc-cca/products/etc-cca-reports/using-key-type-measures-to-report-climate-adaptation-action-in-the-eea-member-countries

KTM	Sub-KTM[17]	Specifications
A: Governance and Institutional	A1: Policy instruments	• Creation / revision of policies • Creation / revision of (implementing) regulations
	A2: Management and planning	• Mainstreaming adaptation into other sectors • Creation / revision of technical rules, codes and standards
	A3: Coordination, cooperation and networks	• Creation / revision of ministerial coordination formats • Creation / revision of stakeholder networks
B: Economic and Finance	B1: Financing and incentive instruments	• Creation / revision of incentive mechanisms • Creation / revision of funding schemes
	B2: Insurance and risk sharing instruments	• Creation / revision of insurance schemes and products • Creation / revision of contingency funds for emergencies
C: Physical and Technological	C1: Grey options	• New physical infrastructure(s) • Rehabilitation, upgrade and / or replacement of physical infrastructure(s)
	C2: Technological options	• Early warning systems • Hazard / risk mapping • Service / process applications
D: Nature Based Solutions and Ecosystem-based Approaches	D1: Green options	• Creation of new / improvement of exiting green infrastructure • Natural and / or semi-natural land-use
	D2: Blue options	• Creation of new / improvement of existing blue infrastructure • Natural and / or semi-natural water and marine areas management
E: Knowledge and Behavioural change	E1: Information and awareness raising	• Research and innovation • Communication and dissemination • Decision support tools and databases
	E2: Capacity building, empowering and lifestyle practices[18]	• Identification and sharing of good practices • Training and knowledge transfer • Reporting on lifestyle practices and behaviours

Figure 1: Key Type Measures to report climate adaptation action in the EEA member countries (ETC/CCA Technical Report 2021/1)

1.2. Audience

Project replicators and potential external mountain stakeholders: although the content of the abstracts is at a limited stage, in terms of concrete results, engaging replicators and external mountain stakeholders through such material is crucial. It gives a first overview of what the project concretely deals with, and specific challenges explored. It has the potential to catch the attention of specific stakeholders facing similar challenges and the following abstracts updates will then further expand on the concrete solutions deployed to allow for replication. Moreover, in view of elaborating their replication plans, this deliverable is important for project replicators to grasp the variety of solutions explored in the project demonstrators so far. In addition, some parts of D1.3 and D2.1 have special references to replicators' challenges. This deliverable therefore aims to highlight those elements in a clear and simple manner to trigger cross-sectoral thoughts and ideas, which can later be further explored in dedicated deliverables.

Local Councils' stakeholders: this group is represented by volunteers and engaged individuals, selected by the demonstrator partners, according to the principles of the quadruple helix. They are giving their time to provide feedback on what MountResilience partners are planning and they will be asked again to provide insights along the way. This visually appealing deliverable serves as a two-way exchange with them: 1) a way to integrate some of their feedback and 2) a presentation of how the project is integrating such interactions. Finally, for non-expert audiences, this deliverable is a dissemination and engagement tool.

Project partners: to ensure the first results of the project are shared among a large consortium involving 46 partners.

1.3. Sources and content

Six separate abstracts have been produced for dissemination. To make the results more accessible, the abstracts will be compiled into a booklet containing contextual information about all topics tackled. It will be possible to consult these abstracts either in the booklet format or separately, in their local languages.

Each of the abstracts includes content extracted from multiple sources:

- Baseline study elements extracted from D1.2 and the context sections of D2.1
- Suggested solutions and adaptation strategies from D1.3
- Implementation of suggested strategies and roadmaps in D2.1

One important element to note is that these abstracts present an **overview of all solutions explored,** even if not selected. This provides interesting elements on the selection process, the participatory aspect through Local Council[2] workshops, and shows the variety of solutions explored. The suggested implementation stages presented in section 2 involve multi-scale (at local, regional and national level) and multi-sectoral (from academia, government, industry and community) partners and stakeholders. Their engagement procedures been elaborated by the authors of D2.1 taking into account an overall framework[3] and not just the objectives of the individual pilot areas, recognizing interconnections and relationships between different systems, and proposing a predefined and shared action plan.

The content showcased in each abstract (see section 2) is the result of a scientific process, including co-creation exercises with local stakeholders. A summary of the process that the demo regions have followed, leading to the material presented in the abstracts, is listed below:

- *Identification of **regional background on climate change (CC)** and associated challenges, defined by early interviews and meetings between scientific project partners and technical demo partners.*
- *Creation of a **database with examples of relevant projects and scientific studies** related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.*

[2] It is an informal working group made up of a core of key stakeholders aimed at facilitating communication, collaboration, and participation among community members, stakeholders, and government representatives. These councils serve as a bridge, enabling quadruple helix actors to voice their opinions, share feedback, and actively participate in local decision-making processes.

[3] Multi-scale, multi-sectoral, and systematic adaptation (Fedele et al, 2019)

- ***Review of existing projects and scientific studies*** *relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.*
- ***Key external local stakeholders*** *from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.*
- ***Feedback was received from Local Councils*** *based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.*
- *The present abstract summarizes the* ***outcomes of the first discussions*** *and lists the most relevant solutions explored, as chosen by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*

This process is detailed in each abstract (see “What has happened so far?” in sections 2.2 – 2.7) to ensure a clear understanding when viewed individually. However, in the final design of the booklet, which will include the six practice abstracts, this information will be integrated only as part of the introduction to improve clarity and avoid repetition.

1.4. Layout and mock-ups

In order to maximise their dissemination potential, the abstracts are packaged in a booklet structured as follows:

- 1 initial double page with key themes and solutions suggested in all demos (transversal outlook). This cluster by topic will ease the dissemination to external audiences and to replicators. This can serve as an index of the deliverable.
- 1 Recto/ verso on each demo including:
    - Baseline study elements
    - Solutions and list of adaptation strategies explored
    - Implementation strategies possible as suggested by horizontal partners in D2.1
    - Lessons learned, as extracted from State-of-the-Art meetings held on a regular basis with demonstrators and replicators, where challenges faced are discussed

Printed versions are foreseen to be shared with targeted audiences.

Figure 2: Mock up version of the cover page of the abstract booklet.

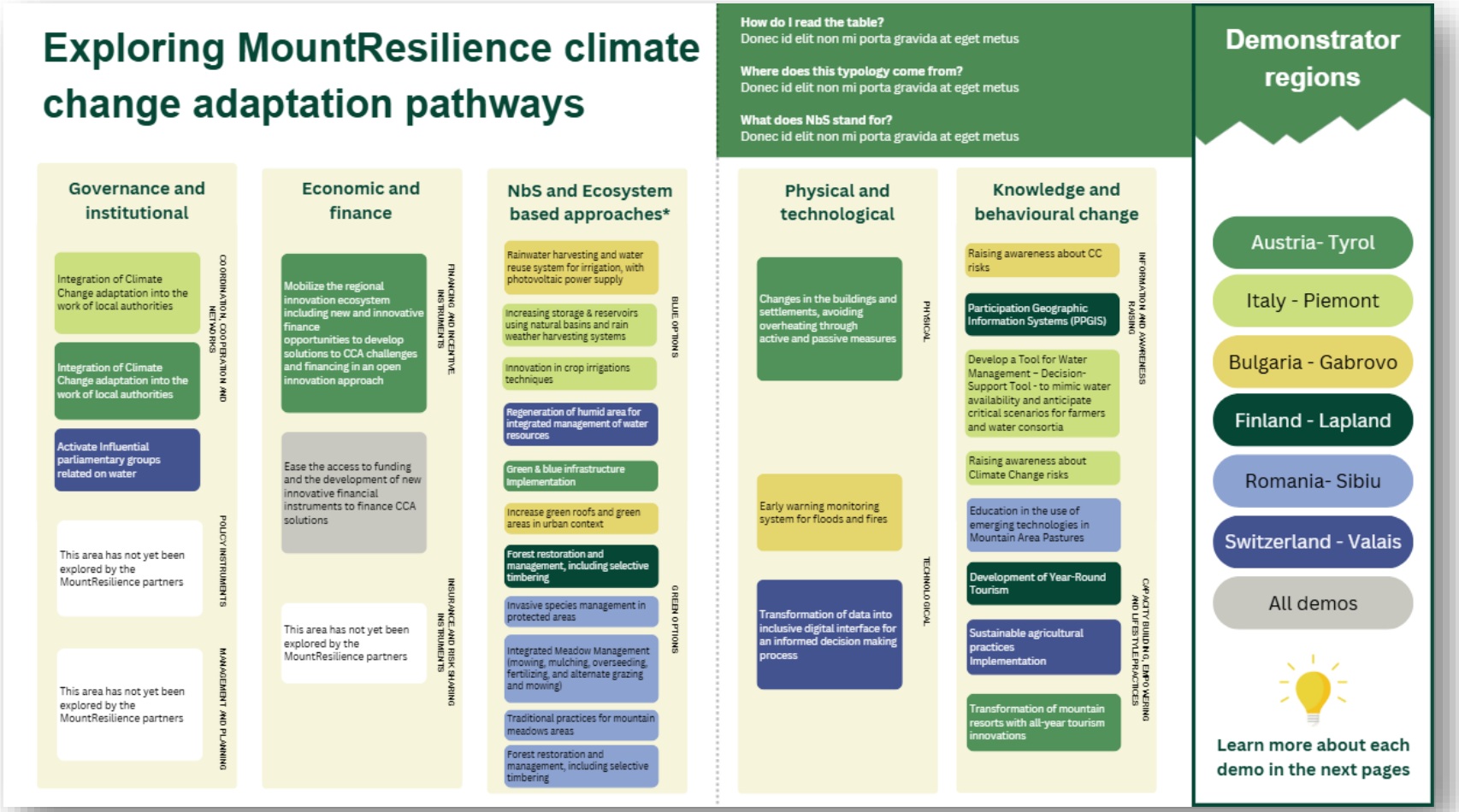

Figure 3: First page 'table of content'.

Figure 4: Mock-up version of one of the demonstrator abstract's pages.

2. Content of the abstracts

2.1 Table of content

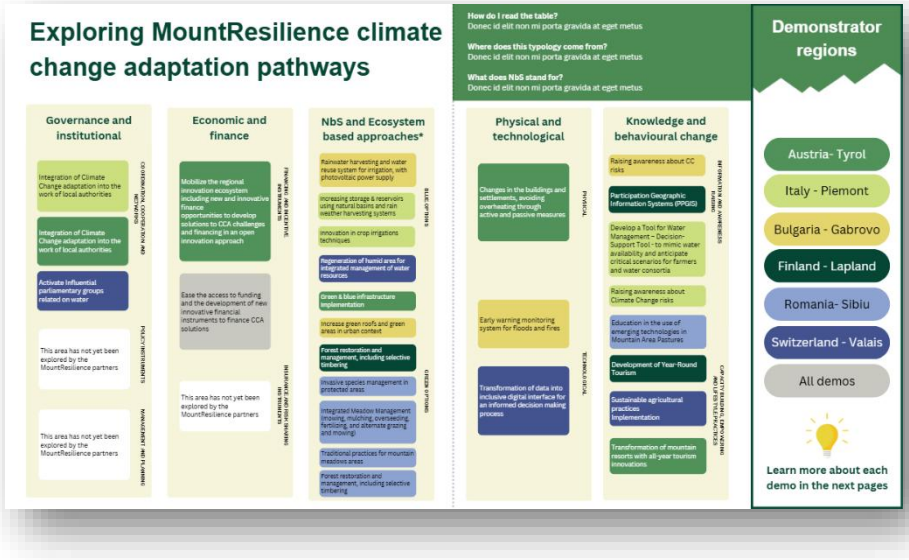

Figure 5; Mock-up version of the table of content of the abstract's booklet.

Below are the sections which will appear on the top right green corner. The rest of the content (text in the coloured boxes) refers to the name of the explored solutions in each regional demonstrator (detailed in the sections below starting from 2.2).

How do I read this table?

In the different columns, you can see coloured boxes which refer to the solutions currently being explored in MountResilience demonstrator regions. They are marked with a distinct colour each for the 6 territories concerned. These solutions are not all going to be put in practice. The regions are still exploring technical solutions to their challenges, and these are all the possible options discussed with the local stakeholders.

Where does this typology come from?

The different columns refer to a classification established by the European Environmental Agency to report on climate adaptation actions. Each category has a subtopic, as shown on the right sides.

What does NbS stand for?

The project's activities focus on NbS (Nature-based Solutions). These solutions involve managing and restoring ecosystems to address societal challenges, benefiting both human well-being and biodiversity. The key for the NbS success is the correct approach for stakeholder engagement, needed to appropriately implement these solutions.

In MountResilience, partners have looked closely at NbS already in place or being explored in other projects. This has given some inspiration to project partners and external stakeholders, for example, for the co-creation exercises. The consulted Solutions Database, including NbS projects and publications, is publicly available on the MountResilience's website.

2.2. Gabrovo (Bulgaria)

Name of the demo	BULGARIA – Gabrovo
Map	Map in D1.2 p14 (see annexes)
Description of the demonstrator location	Gabrovo is a municipality in Bulgaria's North Central Region, covering an area of 556 km² with a population of approximately 65,813. 90% of the total population lives in urban areas. Gabrovo is surrounded by five rivers and extensive forests, over half of which are protected (Natura 2000). The municipality of Gabrovo is a well-developed economic centre within Bulgaria, with a rich industrial tradition. The central location of Gabrovo functions as a transport junction and is part of the trans-European transport corridor 9 (Helsinki - St. Petersburg - Kiev - Bucharest - Ruse - Veliko Tarnovo - Gabrovo - Stara Zagora - Dimitrovgrad with diversions to Greece and Turkey).
Climate change impacts in the region	Bulgaria is particularly vulnerable to CC, mainly through an increase in extreme weather events, such as droughts and extreme precipitation. In overall, temperatures are expected to increase from 1.6°C to 3.1°C by 2050, with more pronounced increases during the summer. Gabrovo's proximity to the Balkan Mountains also influences the local climate. In fact, the Balkan Mountains affect both cold and Atlantic air masses. As a result, the town of Gabrovo experiences both very hot and dry periods, as well as high humidity in the winter season. This exacerbates the effects of CC and increases the risk of droughts, floods and forest fires. For example, high summer temperatures combined with reduced rainfall have already led to droughts.
Goal for the territory	To improve adaptation and preparedness strategies to address the interconnected geographical and climate challenges in Gabrovo. This includes safeguarding the natural environment and enhancing the health and well-being of its residents in the face of worsening climate-related risks.
Challenges and needs (Titles N°1)	**Sustainable water sources for irrigation**

Challenges and needs (Description N°1)	Both the ageing infrastructure and soil sealing contribute to heat stress and other health concerns, particularly for urban residents. Gabrovo would benefit from more green areas. Tap water is used to irrigate the lawns and the trees in city garden areas. However, with the more frequent drought periods, there is more frequent heat stress for trees and lawns. In addition, the city faces the challenge of an inefficient and expensive use of tap water for irrigation.
Explored solutions (Title N°1)	**Rainwater harvesting and water reuse system for irrigation, with photovoltaic power supply**
Explored solutions (Description N°1)	Maintenance and increase of the urban green areas, through sustainable irrigation. The modernisation of the existing irrigation system with rainwater harvesting is envisaged, which could use roofs and retention buildings areas around the green areas. The aim would be to source water from alternatives to the aqueduct network. Having remote control over this system would also be beneficial.
Roadmap (Implementation plan explored)	1. Contracting phase with engineering study (3 months). The studies carried out by the contractor aim to define the geophysical conditions, ensure compliance with national regulations, etc. to eventually develop options for using the water. In this process, cost, policy constraints, technical and operational considerations are taken into account. 2. Design (6 months) by the Designer's company. 3. Implementation (6 months) by a construction company.
Roadmap (Possible outcomes)	Green city parks in the summer, lower bills for irrigation and lower costs for the municipality.
Roadmap (Possible indicators)	Quantity of rainwater used for irrigation.
Roadmap (Funding possibilities)	EU funded projects (like MountResilience).

Challenges and needs (Titles N°2)	**Floods and fires**
Challenges and needs (Description N°2)	Increased flood risk and water scarcity due to long dry periods followed by intensive rainfall. The droughts induce a higher risk of forest fires, heatwaves and cold waves. Both droughts and fires induce infrastructure damage and reduce the quality of life. Eventually, there are also risks for human lives, especially of the most vulnerable (elderly and children).
Explored solutions (Title N°2)	**Early warning monitoring system for floods and fires**
Explored solutions (Description N°2)	Monitoring stations for early alarms in case of floods and fires. This should be done by involving more stakeholders and technological solutions. Eventually, it would aim to reduce the effects of the floods on infrastructures and people.
Roadmap (Implementation plan explored)	1. Conceptualise the integrated system (by external contractors). This requires analysing the areas of higher disaster risk and exploring the possibility to include the existing weather indicators. 2. Design the new system and provide training to the project partners to use it. 3. The municipal staff of the city of Gabrovo will use the information for planning.
Roadmap (Possible outcomes)	Better managed natural risks, increased sense of security.
Challenges and needs (Titles N°3)	**Informing on climate change risks**
Challenges and needs (Description N°3)	The impact of CC on human health has been acknowledged as a significant health risk. In Gabrovo, this risk is particularly acute due to very humid winters leading to higher air pollution and thus urban air quality challenges. In addition, extreme weather events (especially droughts) pose significant health hazards, especially for vulnerable populations such as the elderly.

Explored solutions (Title N°3)	**Raising awareness about climate change risks**
Explored solutions (Description N°3)	Raising awareness about the risks associated with sun exposure and high temperatures.
Roadmap (Implementation plan explored)	1. Selection of channels for raising awareness. 2. Creation of material and organising events focused on raising awareness and educating the community. 3. Support to existing organisations. The solution was not explored in detail. Some participants (local stakeholders) deemed this danger less relevant, indicating a variation in the perceived risk associated with health factors.
Challenges and needs (Titles N°4)	**Vegetation in the city**
Challenges and needs (Description N°4)	Gabrovo is facing the urban heat island effect with consequences on air quality, and this can cause health risks for old people and workers. However, there has been a lack of investment to counter this aspect.
Explored solutions (Title N°4)	**Increase green roofs and green areas in an urban context**
Explored solutions (Description N°4)	Plantation of more trees.
Roadmap (Implementation plan explored)	1. Collection of spatial data for the urban tree cover and translating it into a monitoring tool for regular updates. 2. Making the green infrastructure strategy, based on the spatial data collection, and holding discussions with relevant stakeholders. Options favoured: Greening urban roofs (with an emphasis on residential buildings) and increasing the number of urban green areas.

Roadmap (Possible outcomes)	Better air quality, decrease of temperatures, increased green areas, improved management of the green infrastructure, better quality of life for the population.
Roadmap (Possible indicators)	Area of green roofs built, existing green areas renovated, new green areas built, area of built green zones, number of people who will benefit.
Roadmap (Funding possibilities)	External financing for the roof solutions. EU funded projects (like MountResilience), national/ municipal budget, public – private partnerships, 7.500.000 € for the green areas.
What has happened so far?	• *Identification of regional background on climate change and associated challenges.* • *Creation of a database with examples of relevant projects and scientific studies related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.* • *Review of existing projects and scientific studies relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.* • *Key external local stakeholders from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.* • *Feedback was received from Local Councils based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.* • *The present abstract summarizes the outcomes of the first discussions and lists the most relevant solutions explored, as chosen by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*
Stakeholders involved	Climate change is a multifaceted challenge that cannot be addressed by any single organisation alone; thus, a collective and collaborative approach is essential. In MountResilience, it was considered effective to integrate strong and active stakeholder engagement in addition to the project consortium's partnership, specifically by the quadruple helix approach. This model integrates the efforts of four key actors from

academia, industry, government and community-civil society. The quadruple helix model represents a novel social dynamics framework centred on networking, breaking down barriers between institutions, and fostering integration and cooperation across various social sectors.

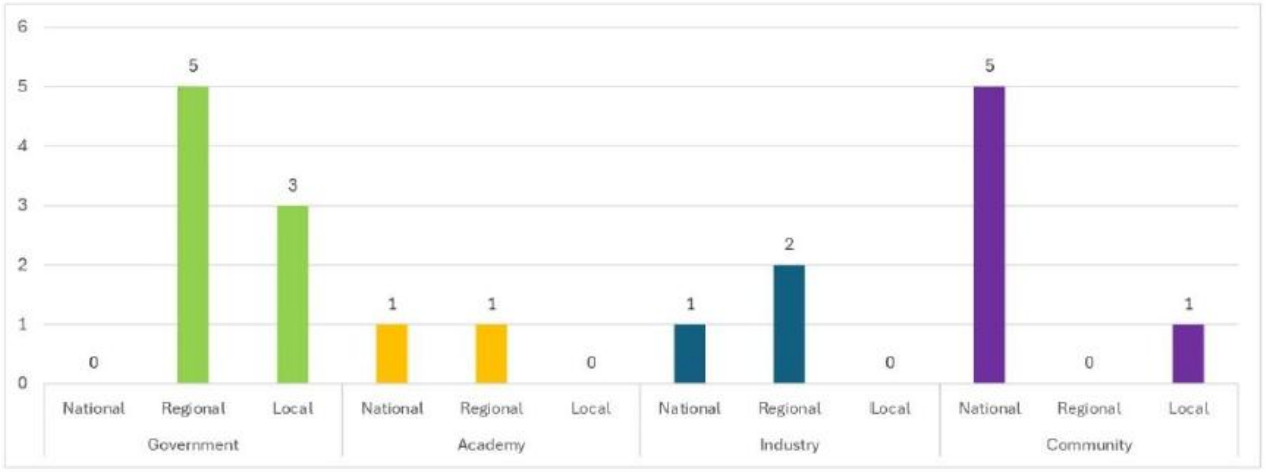

Figure 6: Graphical representation of Gabrovo's selection of external stakeholders (in Local Councils) following a stakeholder map analysis.

While the current stakeholder composition in Gabrovo demonstrates a solid foundation for addressing climate and public health challenges, enhancing academic and local industry participation, as well as strengthening local community engagement, will be key to developing a more comprehensive and effective response.

Lessons learned

- *Gabrovo is facing the challenge of cost considerations for rainwater harvesting and water reuse systems. It makes it harder to plan the details of the construction options. To overcome this, feasibility studies are key.*
- *Gabrovo city found it essential to have external stakeholders (outside the city staff, like ARC fund and the Technical University of Gabrovo) for writing the terms of reference for contractors about establishing the early warning monitoring system.*

- *The demonstrator partners faced technological obstacles for collecting the initial data on tree cover due to seasonal vegetation cover changes. During the winter, it was hard to collect the data and this delayed the process. In addition, the public procurement process was also very long and delayed also the work for exploring the solution on greening the city.*

2.3. Lapland (Finland)

Name of the demo	**FINLAND - Lapland**
Map	Map in D1.2 p31 (see annex)
Description of the demonstrator location	Lapland is the Northernmost region in Finland and most of its population lives on or above the Arctic circle. With a population of 178,530 spread over 1,000,366 km² it is very sparsely populated. The municipalities of Enontekjo and Utsjoki (the two areas involved in the MountResilience project) cover a large area, which has only 0,22 inhabitants per square kilometre. There are few urban centres, such as Rovaniemi, the capital, but most of the region is very rural. A portion of the population belongs to the Sámi, Europe's only indigenous people. Lapland is the coldest region in Finland; its average daily maximum temperature amounts only to 5°C. Along the two municipalities involved in the project, there are fell landscapes, a unique mountainous feature in Northern Lapland, with a very specific biodiversity due to extreme climate conditions.
Climate change impacts in the region	Finland's temperature has already increased twice as much as the average global temperature, since the middle of the 19th century. Some studies suggest that the Arctic area might warm up 3 or 4 times more than the rest of the globe, which makes Lapland very exposed to CC impacts, such as more heat waves, changes in snow cover and snow season duration. Lapland, which covers a third of Finland's land area in the North and the home region of the indigenous people of Sámi in the northernmost part, is especially vulnerable to CC. Most of the province is located north of the Arctic Circle, which is known for the long 6-month winter, nature-dependent livelihoods, tourism and reindeer herding.

Goal for the territory	Increase the general knowledge and awareness of CC and CCA pathways. To achieve this, it is crucial to help municipalities avoid land-use conflicts and assist regional and local actors for better risk management.
Challenges and needs (Titles N°1)	**Data and monitoring climate changes**
Challenges and needs (Description N°1)	With reindeer herding and fishing as the main livelihoods in Northern Lapland, the region is dependent on specific climate conditions, such as sufficient icing of lakes, availability of snow and sparsely wooded areas. CC effects threaten these livelihoods through rising temperatures, changes in precipitation and snow, and other direct and indirect effects. For instance, the quality of winter lichen, the main food source for reindeer in winter has decreased in recent years, due to changes in precipitation and snow regimes. This impact on the availability and quality of pastures has forced herders to supplement with bought fodder, which is not the traditional way and makes reindeer herding less economically viable. Adapting these livelihoods, which are so closely connected to the arctic nature, is one of the main challenges for Lapland.
Explored solutions (Title N°1)	**Public Participation Geographic Information Systems (PPGIS)**
Explored solutions (Description N°1)	Monitoring the impacts of CC through data collection and accuracy. In particular, a PPGIS online collaborative tool will be used to obtain more localised information. Through its participatory characteristic, it aims to increase people's awareness and acceptance of adaptation and solutions. The objective is to foster local communities' involvement as well.
Roadmap (Implementation plan explored)	1. Create a PPGIS online platform considering local needs and future uses. 2. Disseminate the PPGIS tool to foster participation and integration of local knowledge. 3. Create a more permanent PPGIS platform to be updated and used by municipalities in the following years.
Roadmap (Possible outcomes)	Increased knowledge sharing and enhanced community engagement.

Roadmap (Possible indicators)	Number of PPGIS users and increased awareness levels.
Challenges and needs (Titles N°2)	**Tourism in the Arctic**
Challenges and needs (Description N°2)	Lapland's economy relies heavily on tourism, as it accounts for 5.7% of the regional GDP, and 8% of the workforce. Most overnight stays are counted in winter, which is also when most international tourists come to Lapland (50% of tourists are from outside of the country). Tourism is especially important for the creation of jobs outside of urban centres. Generally, tourism has a strong social acceptance in Lapland because it is perceived to bring more benefits than disadvantages. However, tourism is also seen as a barrier to a successful CCA, due to the ecological impacts of over-tourism. In addition, shorter winter seasons, the delayed onset of the snowy season, sudden temperature changes and strong wind and storms are likely to affect the nature-based tourism activities predominant in Lapland. For instance, a lot of international tourism relies on activities with snow, and particularly around Christmas. However, snow can no longer be sufficient, which affects Lapland's reputation as a snow-safe destination.
Explored solutions (Title N°2)	**Development of Year-Round Tourism**
Explored solutions (Description N°2)	Promoting year-round and long-term benefits of touristic activities to reduce seasonal dependency. Encourage businesses, employees, and local communities to take the path of local year-round tourism. Moreover, the efforts could be geared towards heritage and cultural preservation to keep the tourism sector connected to local traditions and culture.
Roadmap (Implementation plan explored)	1. Using participatory methods to map risks and current adaptation solutions, together with local reindeer herders, cooperatives, municipalities and local inhabitants. 2. Idea generation and product development for tourism services. 3. Marketing and sales participatory events.

Roadmap (Possible outcomes)	Diversified tourism offerings and increased economic opportunities.
Roadmap (Possible indicators)	Number of tourists and usage of services.
Roadmap (Funding possibilities)	Businesses, regions, and public support is needed, for example, through projects.
Challenges and needs (Titles N°3)	**Planning and coaching for climate change adaptation strategies**
Challenges and needs (Description N°3)	Although there are current adaptation measures on a national level, the CCA governance on a regional or even local level is insufficient due to lack of funding, clear share of responsibilities and political prioritisation. Additionally, Lapland's climate strategy dates to 2011 and needs some adaptation and additions. For instance, CCA governance on a national or EU level lacks adequate representation of both independent communities, with regards to Sámi culture, and other Lapland communities living in very specific conditions.
Explored solutions (Title N°3)	**Climate change adaptation plans and coaching**
Explored solutions (Description N°3)	CCA plans and coaching for reindeer herders, municipalities and tourism companies.

Roadmap (Implementation plan explored)	1. Mapping climate risks linked to the territory. 2. Herding coaching to local students in Sami educational institutions. 3. Training framework setup (Identifying potential trainers, procurements). 4. Work on adaptation plans for public and private organisations.
Roadmap (Possible outcomes)	Adaptation plans at municipal, company and herder's scales.
Challenges and needs (Titles N°4)	**Habitat preservation and restoration**
Challenges and needs (Description N°4)	The higher temperatures increase the melting of peatland ice, leading to carbon release and habitat loss for distinctive species. Invasive species appear more and more and are threatening the availability of vegetation. The tree line on top of the fells is rising due to increasing temperatures, and especially pine trees seem to spread out. This impact on biodiversity has in turn an impact on local employment, people and culture (especially Sami).
Explored solutions (Title N°4)	**Forest restoration and management, including selective timbering**
Explored solutions (Description N°4)	Maintain habitat type for reindeer protection and carbon sequestration, while avoiding invasive species. Make use of resources in a sustainable manner to continue supporting local economy and livelihood in the longer term.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
What has happened so far?	• *Identification of regional background on climate change and associated challenges.*

- *Scientific partners in MountResilience provided a database with examples of relevant projects and scientific studies related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.*
- *Review of existing projects and scientific studies relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.*
- *Key external local stakeholders from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.*
- *Feedback was received from Local Councils based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.*
- *The present abstract summarizes the outcomes of the first discussions and lists the most relevant solutions explored, as ranked by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*

Stakeholders involved	Climate change is a multifaceted challenge that cannot be addressed by any single organization alone; thus, a collective and collaborative approach is essential. In MountResilience, it was considered effective to integrate strong and active stakeholder engagement in addition to the project consortium's partnership, specifically by the quadruple helix approach. This model integrates the efforts of four key actors from academia, industry, government and community-civil society. The quadruple helix model represents a novel social dynamics framework centred on networking, breaking down barriers between institutions, and fostering integration and cooperation across various social sectors.

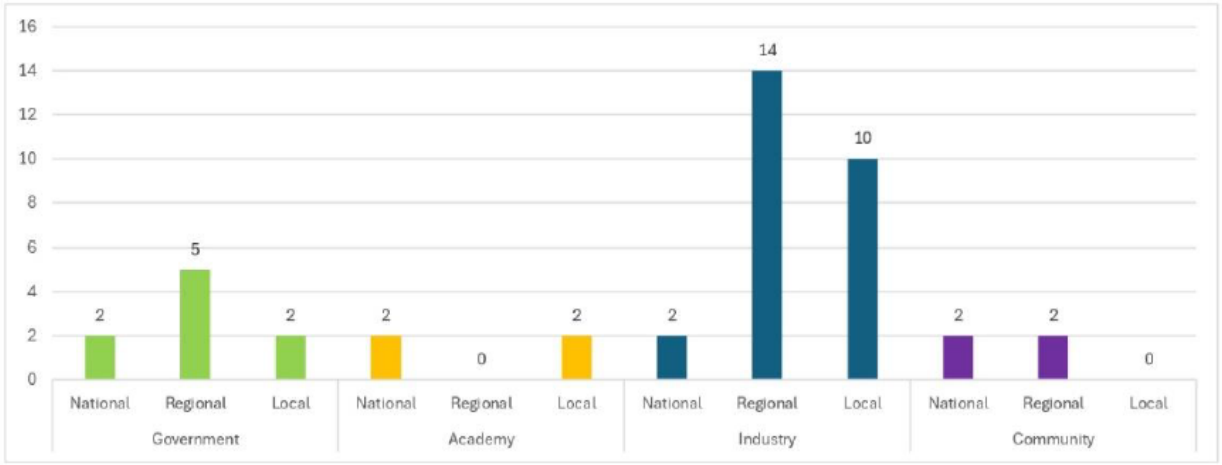

Figure 7: Graphical representation of Lapland's selection of external stakeholders (in Local Councils) following a stakeholder map analysis

While the current stakeholder composition in Lapland demonstrates a strong foundation for addressing the region's climate and socio-economic challenges, enhancing academic engagement and local community representation will be critical for developing a holistic approach that ensures the sustainability of both the environment and the Sámi culture in the face of significant climatic changes.

Lessons learned

- *Face to face meetings between local partners and researchers developing the PPGIS solved a lot of issues.*
- *Municipal elections (and subsequent changes of representatives) delayed the project's process. This is a factor that needs to be considered when planning the project times.*
- *It has been hard to attract local people to workshops (for presenting the PPGIS tool and fostering its wide usage).*
- *There have been difficulties reaching out to the local stakeholders, and especially reindeer herders, because of their seasonal work.*
- *There is a general lack of CCA plans for the tourism sector to get inspiration from, and especially for the Arctic region, indicating that the MountResilience project is pioneer.*

- *Preliminary interviews were important for starting the work on CCA plans and coaching. Following the results from the expert interviews, it can be positively noted that all stakeholder groups are aware of the need for CCA action and willing to change, although the extent of a transformative CCA approach differs. However, it is worth noting that the stakeholders already knew relatively precisely which challenges the region needs to deal with and which approaches are appropriate. What was missing were legal ties to make the decision-makers capable of acting and the knowledge of concrete local actions for individuals.*

2.4. Piedmont (Italy)

Name of the demo	**ITALY - Piedmont**
Map	Map in D1.3 p52 (see annex)
Description of the demonstrator location	Piedmont is an Alpine region in northwestern Italy, formed by 43% of mountainous territory (the Alps and Apennines). Piedmont consists of 31% hilly terrain and is home to 4.34 million inhabitants. Piedmont's climate is influenced by both Continental and Mediterranean regimes, resulting to a unique combination of climatic conditions that contribute to its rich biodiversity and agricultural productivity. The region is home to the Po Valley, which is the largest agricultural area in Italy and responsible for more than a third of the Italian agricultural production. However, there have been major social and economic changes in the region. Over the last 30 years, there has been a drastic decline in the number of livestock farms (−74%), while livestock concentration in larger farms has been trending upwards. This has led to 2-3-times increase in annual nitrate load exacerbating water pollution. Additionally, shift to intensive agriculture has created more abandoned agricultural land, raising concerns on land maintenance and ecosystem management. Besides being Italy's agricultural heartland, Piedmont is also the centre of most Italian industry. The region is in the top 20% of OECD regional economies based on size.

Climate change impacts in the region	Piedmont has experienced an increase of 2°C in daily maximum temperatures over the past 60 years and a 1.5°C increase in minimum temperatures. Data on climate variables demonstrate the increased frequency of extreme weather events: heat waves, intense rainfall and prolonged periods of drought. The territory is already significantly exposed to these effects, causing economic and ecosystem damage, affecting local production systems and the overall health of the population. The main identified climate impact chain for the region deals with the risk of water scarcity and conflicts around water use. The three main climate hazards responsible for this issue are the increase in temperature, decreasing precipitation in summer and the change in precipitation patterns and snowmelt. The latter one is again a key factor impacting the agricultural sector. The Piedmont region faces challenges with snow precipitation patterns, leading to water shortages in summer and increased economic losses in agriculture.
Goal for the territory	Create a resilient and well-managed system for water use, ensuring a sustainable and precise water supply in Piedmont, crucial for agriculture, drinking water, and energy production.
Challenges and needs (Titles N°1)	Water management
Challenges and needs (Description for solutions N°1, 2, 3)	Agriculture plays a significant role in the region both economically and spatially, but it is facing unique climate challenges. The Piedmont region is characterised by water-intensive crops, such as grapevines, orchards, rice and corn. These crops are especially flourishing in the southeastern region, along the riverbeds, as they require a lot of water throughout the year. Therefore, water-related issues significantly impact the region's economy. Due to shifting climate patterns, there is water shortage during the planting season in spring, leading to agricultural yield decline. Moreover, the shortened precipitation period compounded with high nitrate runoff from industrialised agricultural practices and intensified livestock husbandry leads to lower availability of non-contaminated groundwater.
Explored solutions (Title N°1)	**Develop a Tool for Water Management (Decision- Support Tool) to mimic water availability and anticipate critical scenarios for farmers and water consortia**
Explored solutions (Description N°1)	Optimising management among the various organisations and users is crucial for securing efficient water use by farmers, while reducing costs, and ensuring a prompt response during emergencies. Unlike the priorities for using water resources are known, the internal usage methods of each irrigation consortium are defined within complex emergency plans. The fragmentation among the various consortia and territorial bodies remains a significant challenge, despite the

	ongoing process of regional reorganisation of irrigation entities. One of the greatest weaknesses and main source of vulnerability in the region is the lack of cooperation between the stakeholders, when it comes to water management. Investing in technological infrastructure, such as software for the swift and clear management of water usage data and real-time monitoring systems, would be beneficial.
Roadmap (Implementation plan explored)	1. Daily updating (2-3 months) by the farms, irrigation consortium and regional authorities. 2. Data collection: retrieve old data available and install new sensor for monitoring (6 months) by partner University. 3. Sharing data/aims among stakeholders (3 months) by the irrigation consortia. 4. Creation of a model for forecasting available water to distribute (6 months) by the partnered university. 5. Creation of a model of the irrigation network (6 months) by the partnered university. 6. Sharing data among stakeholders weekly/monthly during the irrigation season (1-2 years) by Irrigation consortium, regional authorities, farmers.
Roadmap (Possible outcomes)	Efficient use of water for irrigation, better water management, less water wasted, fewer conflicts between farmers and irrigation consortia, less costs for end users, better cooperation and data sharing.
Roadmap (Possible indicators)	Water availability, water management processes, water use (particularly in irrigation processes)
Roadmap (Funding possibilities)	EU funded projects (like MountResilience).
Challenges and needs (Titles N°2)	Water management
Explored solutions (Title N°2)	**Increasing storage & reservoirs using natural basins and rain weather harvesting systems**

Explored solutions (Description N°2)	Water reservoirs are fundamental for the effective management of the water resources, under abnormal conditions. Specifically, water reservoirs can protect crops during droughts, mitigate the impacts of floods and increase biodiversity, while decreasing the pressure on freshwater and groundwater demand. Engineering solutions, such as the use of dams or abandoned quarries as water reservoirs, as well as natural water retention areas, reforestation, and soil conservation efforts could be effective. More specific techniques, like rainwater harvesting or recycling wastewater and sludge, should also be considered to support agriculture.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
Challenges and needs (Titles N°3)	Agriculture
Challenges and needs (Description N°3)	**Innovation in crop irrigations techniques**
Explored solutions (Description N°3)	Despite a generally high level of awareness regarding water scarcity challenges—especially in agriculture—there is still a pressing need for improved monitoring and optimisation of water usage at the individual level. In conditions of resource scarcity, optimisation is crucial. A plausible solution explored is to encourage farmers to adopt new water-saving irrigation techniques, although some of these are not feasible for certain crops like rice. This practice would reduce water losses along the canal systems, even though some reintegration into the soil can be beneficial for vegetation maintenance in certain areas.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.

Challenges and needs (Titles N°4)	Knowledge related to climate change.
Challenges and needs (Description N°4)	Establishing an effective CCA requires comprehensive knowledge on the potential impacts of CC on various sectors. With prevailing knowledge and action gaps, the need for further awareness building, through education and training, and the active contribution of individuals, together with the dissemination of good practices is crucial for successful CCA implementation.
Explored solutions (Title N°4)	**Raising awareness about climate change risks**
Explored solutions (Description N°4)	Stakeholders' awareness and participation to foster an increasingly conscious and efficient use of water resources. This would mean informing people about risks and encouraging the acceptance and further adoption of sustainable practices. Such awareness-raising would create a solid base for climate action at the local level, particularly by water end-users like farmers.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
Challenges and needs (Titles N°5)	Holistic strategy on CC and biodiversity.
Challenges and needs (Description for solutions N°5)	The risks related to CC have been highlighted above. In addition, the risk of biodiversity loss is directly related to CC and reflects the consequences of agricultural modernisation. For instance, the development of new ineffective irrigation infrastructures could lead to further destruction of biodiversity and conservation efforts in the area. This challenge is further exacerbated by pollution, energy production and tourism-related disturbances. There is therefore a need for local planning on water and biodiversity conservation.
Explored solutions (Title N°5)	**Integration of climate change adaptation and biodiversity into the work of local authorities**

Explored solutions (Description N°5)	The feedback received in local workshops revealed a desire for a stronger bottom-up, partnership-oriented approach and a need to centralise coordination and simplify rule-setting. This translates into the need to develop a comprehensive regional strategy that addresses key economic, social, and environmental aspects, aiming for strong policy coherence. Such holistic planning would also include both community and decision-maker involvement.
Roadmap (Implementation plan explored)	The creation of a working group has been explored as a first step. The main stakeholders involved could be water companies (especially consortia), farmers and agricultural associations, agricultural cooperatives, NGOs, technical institutions, environmental and research organisations, administrative authorities, and individual farmers who will need to directly implement new efficiency practices.
What has happened so far?	• *Identification of regional background on climate change and associated challenges.* • *Scientific partners in MountResilience provided a database with examples of relevant projects and scientific studies related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.* • *Review of existing projects and scientific studies relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.* • *Key external local stakeholders from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.* • *Feedback was received from Local Councils based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.* • *The present abstract summarizes the outcomes of the first discussions and lists the most relevant solutions explored, as ranked by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*
Stakeholders involved	Climate change is a multifaceted challenge that cannot be addressed by any single organization alone; thus, a collective and collaborative approach is essential. In MountResilience, it was considered effective to integrate strong and active stakeholder engagement in addition to the project consortium's partnership, specifically by the quadruple helix approach. This model integrates the efforts of four key actors from

academia, industry, government and community-civil society. The quadruple helix model represents a novel social dynamics framework centred on networking, breaking down barriers between institutions, and fostering integration and cooperation across various social sectors.

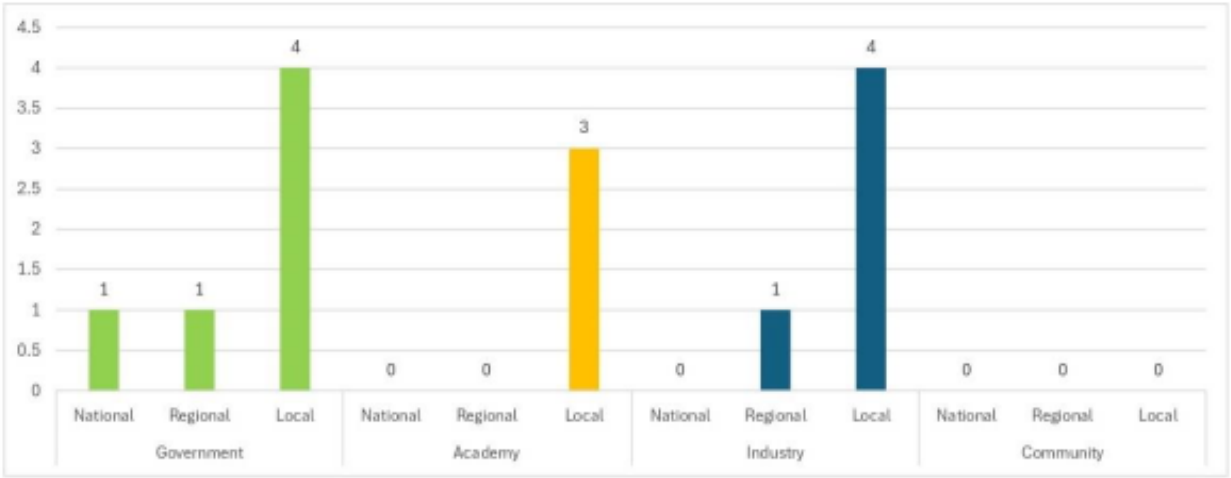

Figure 8: Graphical representation of Piedmont's selection of external stakeholders (in Local Councils) following a stakeholder map analysis

While the current stakeholder composition in Piedmont provides a strong foundation for addressing climate and agricultural challenges, enhancing academic engagement and strengthening community representation are critical steps.

Lessons learned

- *One particularly important issue raised in Local Councils was the difficulty in estimating the costs of large nature-based solutions, such as natural basins.*
- *The demo partners also face difficulty on understanding the security levels of the installed open-air sensors, and their associated costs, related to the kind of data needed and their frequence.*

- *In MountResilience, the Local Councils have been crucial in the process of identifying local challenges related to CC. For instance, water scarcity and drought-related issues were frequently highlighted during the local council meetings, particularly considering that water needs are expected to rise in a business-as-usual scenario.*
- *The project partners are facing the slow processes of public authorities, which hinders the initial ambitions and sometimes delays the calendar for solutions' implementation.*

2.5. Sibiu (Romania)

Name of the demo	**ROMANIA - Sibiu**[4]
Map	Map in D1.3 p75 (see annex)
Description of the demonstrator location	Located in Sibiu County, both the municipalities of Râu Sadului and Cristian are very close to the Carpathian Mountain range. This geographical position has strongly shaped the local activities: agriculture, forestry, animal farming, with a particular focus on sheep breeding. Indeed, it is a region known for its large forests and meadows, pastures and sheepfolds, providing one of the most important pastoral areas in the Carpathians. The area is also characterised by smaller villages, agricultural lands and touristic activities. Today, the Sibiu County population is involved in various economic sectors such as the automotive industry, electronics manufacturing, IT&C, food industry, construction, wood processing, and

[4] The name Sibiu has been preferred to Rau Sadului (as used until now) as it encompasses the two plot areas, which include Rau Sadului and is therefore more accurate geographically speaking

	tourism. Though the region diversified its economy, it remains particularly known for its rich cultural, architectural, and historical heritage (e.g. settled by different ethnicities and home to the Transylvanian Saxons), and is therefore gaining touristic significance in Romania.
Climate change impacts in the region	According to regional climate models, the period from 2021 to 2050 is predicted to bring significant changes to the climate in Sibiu County. Events such as decrease in snow and rain, while more intense and frequent heavy precipitation and droughts are predicted. The Municipality of Sibiu is for instance experiencing droughts of 65 consecutive days with precipitation below 1L/m^2. Additionally, the risk of wildfires remains high under both low emissions and high CO^2 emissions scenarios. The focus of the regional demonstrator is the agricultural challenges caused due to CC. Increased temperatures impact the health and reproductive rates of livestock, and limited water resources can cause heat stress for crops and animals. More frequent extreme events will affect the soil as well, potentially leading to landslides and erosion. Soil fertility is essential for plant growth, better yields and for preserving meadow composition with high nutritional value of grass. Soil restoration can therefore increase livestock farming efficiency, improve animal health, and food quality.
Goal for the territory	Enhancing agricultural sustainability and the health of local ecosystems through the restoration of degraded soil.
Challenges and needs (Titles N°1)	Soil structure.
Challenges and needs (Description N°1)	While some mountain meadow areas require protection due to external pressures and urban expansion, others are facing abandonment, particularly in the depopulated mountain regions. This has several consequences: socio-economic losses, social conflicts and a general degradation of the environment, making it more vulnerable to CC. For the two plots used for the project, stakeholders identified mountain soil degradation as a central issue with cascading negative effects. From impacts on crop and livestock farming to the depopulation of mountain areas, due to lack of income. Additionally, soil degradation can lead to a loss of biodiversity and the disappearance of valuable species. As the region is economically vulnerable and is already facing a decline in

	traditional agricultural and pastoral practices, the goal of the project is to provide immediate, small-scale outcomes on the meadow management, positively impacting the local pastoral-related economy.
Explored solutions (Title N°1)	**Integrated Meadow Management**
Explored solutions (Description N°1)	Sustainable soil management by promoting drought-resistant crop varieties, restoring and preserving degraded soils with traditional practices (like rotational grazing, mowing, mulching, overseeding, alternate grazing, and protection of permanent grasslands). Where conservation agriculture may not be sufficient, the use of natural fertilisers—such as livestock manure or composted plant waste—might improve yield, while carefully managing associated risks. The solution also aligns with promoting biodiversity conservation by increasing crop diversity, re-vegetating degraded areas, preserving natural resources and native ecosystems. Additionally, overseeding would enhance productivity and prevent further deterioration. This would be done through new management technologies (such as drones, remote sensing, and precision agriculture practices) but also include traditional practices use (rotational grazing and water-preserving irrigation systems, for instance).
Roadmap (Implementation plan explored)	1. Scanning and assessment of existing vegetation (2 months) by Râu Sadului Mayoralty, ICDM research (local project partners). 2. Soil analysis (2 months) by Holland Farming (local project partner). 3. Product specifications to achieve targeted results, according to plant needs (type and amount of amendment to be applied) (1 month) by ICDM. 4. Procurement of amendments (1 month) By Râu Sadului Municipality/ Holland Farming. 5. Soil preparation (2 months) by Rau Sadului municipality. 6. Application of amendments (1 month) by Rau Sadului municipality. 7. Monitoring effects (3 years) by Rau Sadului municipality and ICDM.
Roadmap (Possible outcomes)	Higher yields with improved nutritional value, higher grazing capacity of the meadow, improved crop resilience to CC, higher resilience of pastures, reduced soil erosion.
Roadmap (Possible indicators)	Biomass output, biomass composition, number of animals allowed on the meadow.

Roadmap (Funding possibilities)	EU funded projects (like MountResilience).
Challenges and needs (Titles N°2)	Soil management in protected areas.
Challenges and needs (Description N°2)	Methods for regenerating fields that address both agricultural interests and environmental protection.
Explored solutions (Title N°2)	**Invasive species management in protected areas**
Explored solutions (Description N°2)	Support agricultural and pastoral activities by removing anthills, weeds and invasive new species. This in turn protects native plants and natural habitats, reduces fire risks and increases soil quality and value.
Roadmap (Implementation plan explored)	This solution is explored in conjunction with the integrated meadow management, with similar roadmaps and outcomes envisaged.
Challenges and needs (Titles N°3)	Technology and dissemination.

Challenges and needs (Description N°3)	To improve knowledge exchange and local awareness, effective dissemination and understanding are key for the acceptance and adequate implementation of these solutions. One barrier appears to be the scepticism towards non-traditional methods among different groups. However, there does not appear to be significant resistance from farmers, as stakeholders have indicated in interviews that they are open to technological solutions. Targeted dissemination of new technologies, including drones, could help pasture-related stakeholders better adhere and use them.
Explored solutions (Title N°3)	**Education in the use of emerging technologies in mountain pastures**
Explored solutions (Description N°3)	Climate education with training activities for farmers and local communities, focusing on sustainable agricultural techniques and soil management.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
Challenges and needs (Titles N°4)	Tourism and forestry.
Challenges and needs (Description N°4)	Râu Sadului aims to promote its natural heritage and to serve as a significant starting point for rural and outdoor activities, such as hiking. The region is particularly known for its rich cultural, architectural, and historical heritage. However, local economies and livelihoods, especially those dependent on tourism and forestry, are particularly vulnerable to CC.
Explored solutions (Title N°4)	**Forest restoration and management, including selective timbering**
Explored solutions (Description N°4)	The solution has been only briefly explored in Local Council meetings and would aim at maintaining habitat types, biodiversity (while avoiding invasive species) and eventually increase in carbon sequestration.

Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
What has happened so far?	• *Identification of regional background on climate change and associated challenges.* • *Scientific partners in MountResilience provided a database with examples of relevant projects and scientific studies related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.* • *Review of existing projects and scientific studies relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.* • *Key external local stakeholders from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.* • *Feedback was received from Local Councils based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.* • *The present abstract summarizes the outcomes of the first discussions and lists the most relevant solutions explored, as ranked by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*

Stakeholders involved

Climate change is a multifaceted challenge that cannot be addressed by any single organization alone; thus, a collective and collaborative approach is essential. In MountResilience, it was considered effective to integrate strong and active stakeholder engagement in addition to the project consortium's partnership, specifically by the quadruple helix approach. This model integrates the efforts of four key actors from academia, industry, government and community-civil society. The quadruple helix model represents a novel social dynamics framework centred on networking, breaking down barriers between institutions, and fostering integration and cooperation across various social sectors.

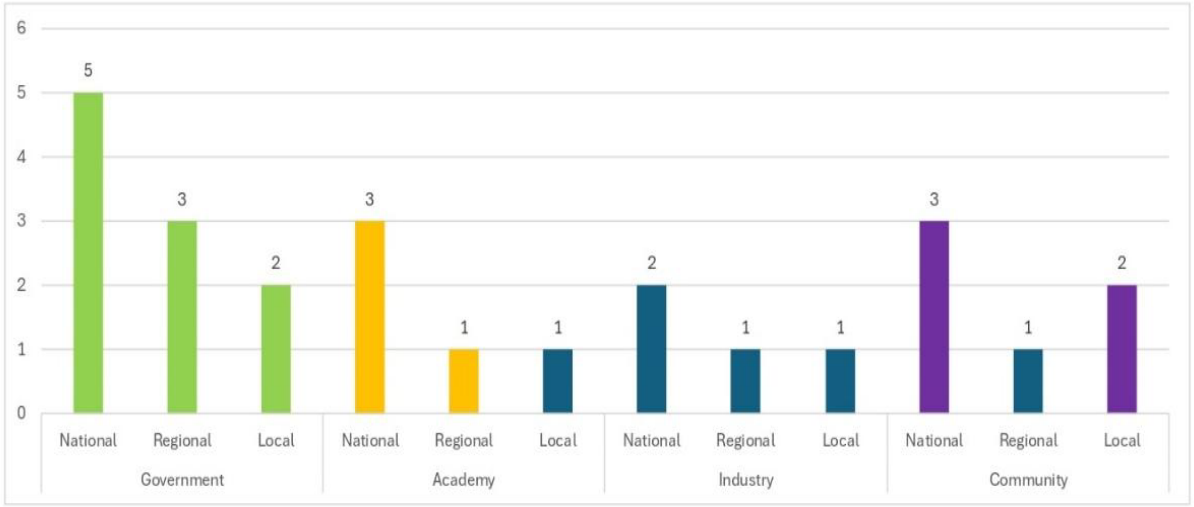

Figure 9: Graphical representation of Sibiu's selection of external stakeholders (in Local Councils) following a stakeholder map analysis

While the current stakeholder composition in Sibiu County provides a foundation for addressing climate and agricultural challenges, enhancing local government engagement, bolstering regional academic participation, and increasing industry involvement at the local level are critical steps. This comprehensive approach will help to ensure that Sibiu County can effectively navigate the impacts of CC, while promoting agricultural resilience and preserving local knowledge and traditions.

Lessons learned	• *The project partners face technological obstacles for data collection. For instance, during winter it was hard for them to collect data due to the vegetation cover. This delayed some of the planned processes.* • *The partners did not expect such lengthy delays in obtaining public procurements to work on the identified plots; clear procedures and timelines are essential when working in protected areas.* • *Parcels identified for implementing the integrated meadow management are at risk of being invaded or crossed by livestock, which could potentially compromise results.*

2.6. Tyrol (Austria)

Name of the demo	**AUSTRIA - Tyrol**
Map	Map in D1.3 p96 (see annex)
Description of the demonstrator location	Tyrol is one of the nine federal states of Austria, situated in the western part of the country, bordering Germany, Italy and Switzerland. Almost two-thirds of Tyrol's area consist of forests (37%) and mountain landscapes (27%), followed by unproductive (25%) and arable land (11%). Only one-eighth of the total area (12,4%) is designated for permanent settlement. Tyrol is also home to the country's two highest mountains and its second-largest glacier. Tourism is an important source of income for the whole region, especially winter tourism, accounting for almost half of the annual stays. The economic dependency on tourism generally increases with the distance from the cities. For instance, in some remote areas, tourism is the only or the main source of income.
Climate change impacts in the region	Since 1900, the temperature in the European Alps has risen by 2°C, particularly at high elevations, which is roughly three times higher than the global average. Climate predictions for the Austrian Alps follow this trend. It is predicted that under the high emission scenario, winter precipitation could increase by 10% and summer precipitation could decrease by over 20%, compared to 1970–2000 levels. This shift will lead to more intense and irregular rainfall, increased rain-on-snow events, and a higher frequency of rapid snowmelt, exacerbating the risk of floods and landslides.

	Global warming will also cause a shift of the snow line (the snowline ascends by approximately 150 meters per degree Celsius of warming), along with changes in the timing and duration of seasons, collectively affecting the distribution of adapted plant and animal species in mountain ecosystems.
Goal for the territory	Tyrol's strategy is designed to enhance building energy efficiency and sustainable environmental resource management, while simultaneously promoting sustainable tourism.
Challenges and needs (Titles N°1)	Reducing overheating in buildings.
Challenges and needs (Description N°1)	Periods of heat lead to impairment of human health and rising mortality. Vulnerable population groups, especially children, the elderly and people with pre-existing health conditions, are particularly affected. Creating resilient buildings is one of the possible pathways. However, current adaptation measures to address heatwaves and the heat island effect in buildings are generally deemed insufficient. Considering the problems associated with traditional buildings, an energy efficiency strategy is explored to reduce energy consumption both for winter heating and summer cooling.
Explored solutions (Title N°1)	**Changes in the buildings and settlements, avoiding overheating through active and passive measures**
Explored solutions (Description N°1)	Aiming for better quality of life and living spaces with less energy consumption, natural cooling systems, such as green or white roofs and green walls are explored. Wherever not feasible—such as in classic Tyrolean wooden buildings—the adoption of modern insulation and energy-efficient ventilation systems is explored. These buildings should ideally use renewable sources (i.e. solar energy and heat pumps) and local materials that preserve traditional architecture.
Roadmap (Implementation plan explored)	1. Collecting data on buildings affected by overheating problems and the causes (3 months) by project partners, municipalities and house owners. 2. Simulation of buildings (i.e. thermodynamic simulation of a primary school researching the efficiency of various active and passive measures) and derivation of measures (2 weeks each) by project partners. 3. Deployment of sensors for monitoring (3 months) by project partners, municipalities, and building owners. 4. Derivation of the results and development of counselling services and information material (implementation phase) by project partners and advertising agency.

Roadmap (Possible outcomes)	Improved knowledge about how to prevent buildings from overheating.
Roadmap (Possible indicators)	Number of consultations; number of requests; number of presentations.
Roadmap (Funding possibilities)	For small projects, energy audits and incentives to aid homeowners and support renovations (subsidised by the Austrian federal government) are available, alongside regional and national grants, bank loans, tax deductions, and incentives for renewable resource use (e.g., solar panels).
Challenges and needs (Titles N°2)	Nature and tourism.
Challenges and needs (Description N°2)	Climate change has significant effects on tourism and especially in Alpine regions. On one side, the retreat of glaciers poses challenges for glacier ski resorts, with shrinking glaciers narrowing or interrupting existing ski slopes, and the need of ski operations that requires ongoing technical adaptation to protect their infrastructure. On the opposite side, the reduction of snowfall in winters has led to increase in demand for glacier ski areas and high-altitude resorts. The tourism industry in valleys dependent on glaciers is threatened, while the attractiveness of alpine glaciers for tourism is diminished. Snow ski resorts are also affected and increasingly reliant on artificial snowmaking, which requires substantial water and electricity. This could lead to maladaptation, due to further demand for water resources and might potentially ignite conflicts over water and energy use. Other activities like hiking and mountain biking, as well as associated infrastructure, such as climbing routes and mountain huts, are negatively impacted by glacier retreat. Additionally, the navigability of Alpine rivers with kayaks and rafts is affected due to low water levels during summer. Tourist resorts need solutions that preserve the region's natural landscapes, while ensuring their sustainable development.
Explored solutions (Title N°2)	**Transformation of mountain resorts with all-year tourism innovations**

Explored solutions (Description N°2)	Expand a year-round tourism offering and focus on sustainable activities (e.g., mountain biking, hiking, wellness, culinary experiences, and culture), to reduce over-tourism pressure. Aim for tourism adaptation with alternatives such as eco-tourism, economic diversification, natural mountain tourism, cultural & experiential tourism, independent of snow. Support artificial snow with high-efficiency snowmaking systems, utilise renewable energy sources, and rely on water sources that do not impact other sectors, such as recycled water. Additionally, support cable car companies with workshops on transitioning.
Roadmap (Implementation plan explored)	1. Case study selection (2 months) through workshops, travel, maybe external analysis/ data. 2. Understanding the social-ecological context (stakeholder, tourism patterns, existing offers, vulnerabilities, needs etc.) (2 months) by UIBK, SAT, case study organisations, tourism associations. 3. Co-development of place-based adaptation measures and/or future scenarios (1 month) by UIBK, SAT, case study organisations, and local stakeholders. 4. Implementation and monitoring concept (6 months) by UIBK, SAT, and case study organisations.
Roadmap (Possible outcomes)	Transformative tourism development strategies, nature-based adaptation measures for ski resorts, nature-based offers, increased year-round tourism through diversification (e.g., hiking, biking, wellness), enhanced environmental conservation, and long-term economic sustainability.
Roadmap (Possible indicators)	Number of development strategies; n° of adaptation measures selected; n° of nature-based offers, n° of workshops; ratio between summer/ winter revenue, n° of year-round jobs, increase in off-season visitor numbers, positive biodiversity impacts (e.g., restored ecosystems)
Roadmap (Funding possibilities)	EU Cohesion Funds and the European Regional Development Fund (ERDF) can be used for large-scale projects, with funds such as Horizon Europe to promote eco-friendly tourism supported by local governments, Tyrolean Government funding and / or private capital.
Challenges and needs (Titles N°3)	Infrastructure robustness.

Challenges and needs (Description N°3)	More frequent and extreme weather events can result in increased danger to life, but also to infrastructures, businesses, and buildings. Floods, debris flows, avalanches and other natural hazards can lead to enormous costs for reconstruction and damage, reinforced by past mistakes in spatial planning and the lack of legally binding regulations.
Explored solutions (Title N°3)	**Green & blue infrastructure implementation**
Explored solutions (Description N°3)	Green areas were identified as having high feasibility and effectiveness. For instance, green areas can protect from heavy weather events (sponge city principle) and address issues such as flooding, heatwaves and avalanches. They can also have other positive effects, such as building cooling effect, reduced health risks and increased biodiversity and life quality. Therefore, reforestation is explored.
Roadmap (Implementation plan explored)	1. Build political will/consensus. 2. Initiate the concept development with a participatory process and consideration that green measures need a lot of time to be effective. 3. Proceed with the examination of legal and infrastructural requirements. 4. Implementation of the measures at test locations and evaluation. 5. Large-scale construction measures and maintenance.
Roadmap (Possible outcomes)	Air and life quality.
Roadmap (Possible indicators)	Temperature, air quality, frequency of use of public squares, number of squares with water access, flow rate in the targeted canal (for data monitoring) during extreme weather events, square meters from grey to green.
Roadmap (Funding possibilities)	The EU LIFE Program and national funds are especially recommended for forest management and natural landscape protection.

Challenges and needs (Titles N°4)	Climate change and decision making
Challenges and needs (Description N°4)	There is currently a lack of awareness and sensitivity among the local population, governments and economic actors. Furthermore, even when high-level political actors and decision-makers recognise the need for CCA, ambitious policies and concrete actions are often lacking, in part due to political barriers.
Explored solutions (Title N°4)	**Integration of climate change adaptation into the work of local authorities**
Explored solutions (Description N°4)	There are multiple solutions to enhance decision-making, such as employing climate coaches, facilitating knowledge sharing among citizens, using questionnaires to gather data, promoting participation, and implementing multi-governance/management plans. The growth of awareness and the involvement of local authorities were identified as highly effective strategies, leading to the recommendation for the installation of citizen councils to discuss environmental issues.
Roadmap (Implementation plan explored)	Possible actions explored include conducting risk and vulnerability assessments; advocacy for a specific orientation of KLAR programmes (national programmes targeting climate issues and financed publicly in Austria); training and communication for administrative staff; public engagement and awareness campaigns; advocacy for a clear consideration of CC in granting subsidies; involving insurance companies in development; monitoring and evaluation.
Roadmap (Possible outcomes)	Sustainable Tourism Practices (promote eco-friendly tourism activities, protect ecosystems, and support sustainable infrastructures); resilience of natural attractions (protect natural sites from climate impacts, e.g., erosion, flooding, and ensuring long-term tourism viability); enhanced Visitor Experiences (improve infrastructure for tourist safety and comfort, even in changing climate conditions); increased local engagement and awareness (engage tourists and communities in climate adaptation/conservation efforts, fostering awareness and responsible tourism).
Roadmap (Possible indicators)	Changes reflected in laws and regulations, implemented projects.

What has happened so far?	• *Identification of regional background on climate change and associated challenges.* • *Scientific partners in MountResilience provided a database with examples of relevant projects and scientific studies related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.* • *Review of existing projects and scientific studies relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.* • *Key external local stakeholders from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.* • *Feedback was received from Local Councils based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.* • *The present abstract summarizes the outcomes of the first discussions and lists the most relevant solutions explored, as ranked by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*
Stakeholders involved	Climate change is a multifaceted challenge that cannot be addressed by any single organization alone; thus, a collective and collaborative approach is essential. In MountResilience, it was considered effective to integrate strong and active stakeholder engagement in addition to the project consortium's partnership, specifically by the quadruple helix approach. This model integrates the efforts of four key actors from academia, industry, government and community-civil society. The quadruple helix model represents a novel social dynamics framework centred on networking, breaking down barriers between institutions, and fostering integration and cooperation across various social sectors.

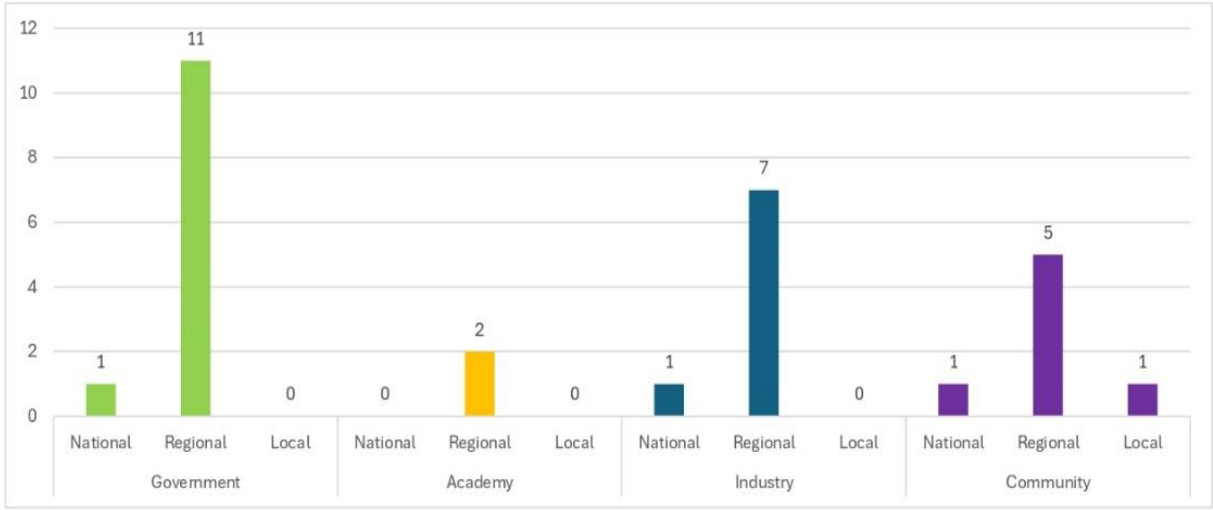

Figure 10: Graphical representation of Tyrol's selection of external stakeholders (in Local Councils) following a stakeholder map analysis

While the stakeholder landscape in Tyrol provides a strong foundation for addressing climate and tourism-related challenges, increasing local industry participation can be critical in the next step. In addition, the strong presence of regional government stakeholders, with eleven participants, highlights a robust commitment to regional governance and decision-making. However, the lack of national and local representation suggests a disconnect that could hinder effective policy implementation.

Lessons learned	• *The exploration phase for the solution on buildings is crucial. For instance, the research in the project goes into various technical directions for finding the most efficient solutions (i.e. gentle cooling with heat pumps; comparison of the different active cooling systems; comparison of different types of solar shading)* • *In parallel, organising awareness-raising campaigns is essential. For instance, workshops about overheating were organised in Tyrolean schools.* • *There are no good practices for NbS in Alpine tourism to take inspiration from for envisaging other tourism models in mountain snow dependent territories.*

	• *In addition, and linked to the previous point, the awareness for NbS in companies/regions is quite low.* • *There were insightful exchanges with the Horizon project MOUNTADAPT in the framework of the green and blue infrastructure solution discussions. The aim of the project is to improve the resilience of health systems to the adverse effects of CC in European alpine biogeographical regions.* • *For the solution on the integration of CCA into local authorities' work, the project partners already conducted surveys among Tyrolean companies, which revealed a high level of uncertainty about CC: more than half of Tyrolean companies have no knowledge of climate risk methods and CCA methods. With this conclusion, the need for further knowledge-building in the different project organisations appears to be a pressing factor to develop tailored services for municipalities and SMEs.* • *In order to start discussing concretely, project partners have decided to hold workshops with different regional administrative units to develop CCA plans.*

2.7. Valais (Switzerland)

Name of the demo	**SWITZERLAND - Valais**
Map	Map in d1.3 p115 (see annex)
Description of the demonstrator location	Valais is the third largest canton of Switzerland, located in the Southwestern part of the country, and it borders with Italy and France. The region is often described as the water tower of Europe. With 80% of Switzerland's ice volume, most Swiss glaciers can be found in Valais. However, it is also one of the driest regions in Switzerland, as it is surrounded by the Bernese and Valais Alps in the North and South, which prohibit precipitation. Contrary to other regions in Switzerland, precipitation is lower in summer than in winter. Most of Valais' land is classified as unproductive land, constituting 53% of the total area, followed by 24% of forested area and 19% of agricultural land. Settlement and urban areas only account for 3,5% of their total area. Most of the arable land is natural pastures, followed by vineyards and orchards. The most important sector of Valais' economy is the industrial sector, accounting for 25% of the cantonal gross added value. However, in terms of employment, the tourism sector represents the most important one and accounts for 15% of total value added. Finally, hydropower plays a big role in the region's economy and water management. Valais, in fact, produces nearly 30% of Switzerland's hydropower energy.

Climate change impacts in the region	In regions of medium altitude (approximately 1,000-2,000 m above sea level), precipitation will increasingly fall as rain, rather than snow. Even at high altitudes (>2,000 m), which represent a large part of the Canton's surface area, rain will increase by 10-20% compared to snow. As summer precipitation decreases, the total amount of available water becomes more limited as well. The main sectors related to water resources are tourism (in particular skiing), hydropower, agriculture and residential areas. To cope with decreasing snowfall and ensure high quality slopes, ski resorts have started using artificial snow, which might be water and energy demanding. For instance, water supply is provided with artificial reservoirs and underground piping systems, resulting in growing environmental costs.
Goal for the territory	Development of a climate adaptation strategy (Climate Resilience Adaptation Strategy) to secure water resources, reduce flood risk, and protect natural ecosystems. Through collaboration, coordinated actions, monitoring, and implementation of environmental NbS at a local scale, water management can happen from source to the end-user. This strategy should be based on data monitoring, sharing and visualisation.
Challenges and needs (Titles N°1)	Data digitalisation and sharing.
Challenges and needs (Description N°1)	According to the Swiss constitution, water management falls into the prerogative of the cantonal level. However, in Valais it is usually the responsibility of the municipalities, as most rivers (apart from the Rhône) are owned by them. Currently, there is no cross-cantonal mechanism for water use management, which has led to conflicts during dry periods. Private companies are currently the only entity in control of water use data, which are unwilling to share to retain high competition. Therefore, there is a general lack of transparent decision making and the benefits and costs of water are unequally distributed. Most adaptive activities have focused on retrospective coping, but there is a need for more proactive and foresighted solutions.
Explored solutions (Title N°1)	**Transformation of data into inclusive digital interface for an informed decision-making process (In-watershed quantitative and qualitative monitoring)**

Explored solutions (Description N°1)	The solution explores different ways of informing stakeholders and users to improve decision-making. For instance, advanced water monitoring, such as remote sensing and IoT sensors will be used for real-time data collection and flood/landslide prevention. This initiative would provide new open-source data as the starting point: solutions were identified for glacier and water continuous monitoring with the use of new and modern technologies, including artificial intelligence. Additionally, this also aims at identifying risks, such as landslides and flooding, and fostering community collaboration and long-term engagement. Finally, it facilitates fast reactions in case of extreme events.
Roadmap (Implementation plan explored)	1. Planning and preparation (6 months) for 30k€ by local government agencies and community stakeholders. 2. Design and approvals (3-6 months) for 20k€ by environmental engineers. Prototyping the digital service (has started already). 3. Implementation of improved decision-making system (12-18 months) for 20k€ by contractors specialised in environmental monitoring and IT; decision-making methodology with stakeholders; citizen information sharing. 4. Implementation of ecosystem service modification towards NbS (3-10 months) for a highly variable cost done by local, regional and national government stakeholders; citizen (voting and behavioural change). 5. Monitoring and maintenance (5 years) for 30k€ annually, carried out by the local government and monitoring teams; stakeholders for decision making; citizen information to drive acceptance and adoption.
Roadmap (Possible outcomes)	Improved water quality in the watershed due to enhanced filtration and reduced runoff, greater community engagement and awareness of watershed management practices, and creation of recreational and educational opportunities for local communities.
Roadmap (Possible indicators)	Monitor key water quality indicators such as nutrient concentrations (e.g., nitrogen, phosphorus), pH level, turbidity, and dissolved oxygen levels; measure changes in hydrological patterns within the watershed, including flow rates pre- and post-restoration.
Roadmap (Funding possibilities)	Local government budgets, state and federal environmental grants, private foundations, community fundraising initiatives.

Challenges and needs (Titles N°2)	Management of water resources.
Challenges and needs (Description N°2)	Water needs are projected to rise in a business-as-usual scenario, particularly in urban areas and livestock farming. This increase will significantly impact economies that are heavily dependent on water availability, particularly in the two most important industries in the region: hydropower and tourism. Currently, there is sufficient water, and the issue is not yet widely recognised by the public. However, there is a significant risk of decreased water availability, which could lead to social divisions and potential conflicts over water usage. Ecosystem restoration is essential to enhance climate resilience.
Explored solutions (Title N°2)	**Regeneration of humid areas for integrated management of water resources**
Explored solutions (Description N°2)	Preserve biodiversity through restoration of aquatic ecosystems, wetlands, and ponds to create wildlife refuges. This would mitigate flood and droughts, while increasing biodiversity and carbon sequestration.
Roadmap (Implementation plan explored)	1. Identification of suitable sites. 2. Design and planning of the restoration process. 3. Implementation of restoration measures. 4. Continuous monitoring of the evolution of the areas.
Roadmap (Possible outcomes)	Reduction of flood and drought risks through water flow regulation and increased biodiversity with healthier aquatic and terrestrial ecosystems.

Roadmap (Possible indicators)	Groundwater levels and water flow in restored areas, as well as the abundance and variety of species (flora and fauna) in the restored areas compared to baseline data.
Roadmap (Funding possibilities)	Funding through government grants.
Challenges and needs (Titles N°3)	Sustainable agriculture.
Challenges and needs (Description N°3)	Water scarcity significantly affects water consumption across various sectors, and particularly agriculture. To cope with the lack of precipitation and water shortages in the summer, inhabitants of the region have developed an irrigation system that has been in use for hundreds of years. Water is channelled from higher altitudes, via meadows and fields, to lower altitudes, also for the irrigation of fruit trees or vineyards. The water is rerouted from streams that are fed by glaciers and meltwater, which means they can provide water throughout summer and autumn, the seasons with the lowest precipitation. This system is also a part of what makes the cultural landscape of Valais so unique. The water use through these traditional channels is regulated through cooperatives, where members have the right to use the water and contribute to their maintenance. Nowadays, there has been a decrease of this traditional way of conducting agriculture.
Explored solutions (Title N°3)	**Sustainable agricultural practices implementation**

Explored solutions (Description N°3)	Adoption of sustainable agricultural practices to alleviate pressure on water resources, while promoting environmental sustainability. Precision irrigation systems and efficient agricultural practices (especially for vineyards and fruit farming) are explored.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
Challenges and needs (Titles N°4)	Water policies.
Challenges and needs (Description N°4)	Despite the projected decline of water resources, current water volumes seem sufficient for today's and for the near future's demand (until there will be meltwater from glaciers). However, the challenge remains the seasonal variability and seasonal shortages. Coordination will be key for successful water management that prevents conflict or shortages in dry periods. However, despite the need for integrated planning and management of water resources, a strong sectoral policy continues to prevail. With increasing tensions and growing cultural divides, numerous political debates occur each year at both federal and regional levels. For instance, every two years, on average, a vote defines the future framework related to CC. The current debate on water is intensifying, with five parliamentary actions already in 2024. There is a risk of major conflicts arising after 2035 due to changes in water legislation, a topic that the Ministry of Defence also prioritises. Several new initiatives are currently underway in parliament. To improve the current situation, greater coordination among policymakers, farmers, and funding sources is deemed essential. Efforts to experiment with new water governance approaches are underway, and the recent appointment of a Cantonal Water Delegate has renewed interest in improving water governance in Valais. However, the focus must be extended beyond this initiative.

Explored solutions (Title N°4)	**Activate influential parliamentary groups related to water**
Explored solutions (Description N°4)	For reaching the goal of sustainable water management, it is required a structured water governance across sectors with transversal decision-makers, who can also prioritise different water uses in emergency situations. This would be supported by advanced water monitoring. Participants (local council) hope that a new national group dedicated to water, like the Local councils created for MountResilience, will address these issues effectively, fostering the best mechanisms, synergies, and relationships to overcome the low interoperability of systems between the 26 Cantons and federal offices.
Roadmap (Implementation plan explored)	This solution has not been explored in more detail.
What has happened so far?	• *Identification of regional background on climate change and associated challenges.* • *Scientific partners in MountResilience provided a database with examples of relevant projects and scientific studies related to the regional challenges, with a specific focus on Nature Based solutions. This database is publicly available on the MountResilience website.* • *Review of existing projects and scientific studies relevant to the challenges of the area. Selection of possible solutions as a basis for the local reflexion in the demo regions.* • *Key external local stakeholders from the quadruple helix mapped and engaged to form Local Councils in each demonstrator.* • *Feedback was received from Local Councils based on tailored exercises to let them participate in a co-creation process. This was a key aspect to ensure the understanding and acceptance of the potential solutions to be funded.*

- *The present abstract summarizes the outcomes of the first discussions and lists the most relevant solutions explored, as ranked by project partners and local stakeholders. It integrates diverse perspectives: scientific insights from project and external researchers, technical expertise from local partners, and opinions from local stakeholders from the quadruple helix.*

Stakeholders involved

Climate change is a multifaceted challenge that cannot be addressed by any single organization alone; thus, a collective and collaborative approach is essential. In MountResilience, it was considered effective to integrate strong and active stakeholder engagement in addition to the project consortium's partnership, specifically by the quadruple helix approach. This model integrates the efforts of four key actors from academia, industry, government and community-civil society. The quadruple helix model represents a novel social dynamics framework centred on networking, breaking down barriers between institutions, and fostering integration and cooperation across various social sectors.

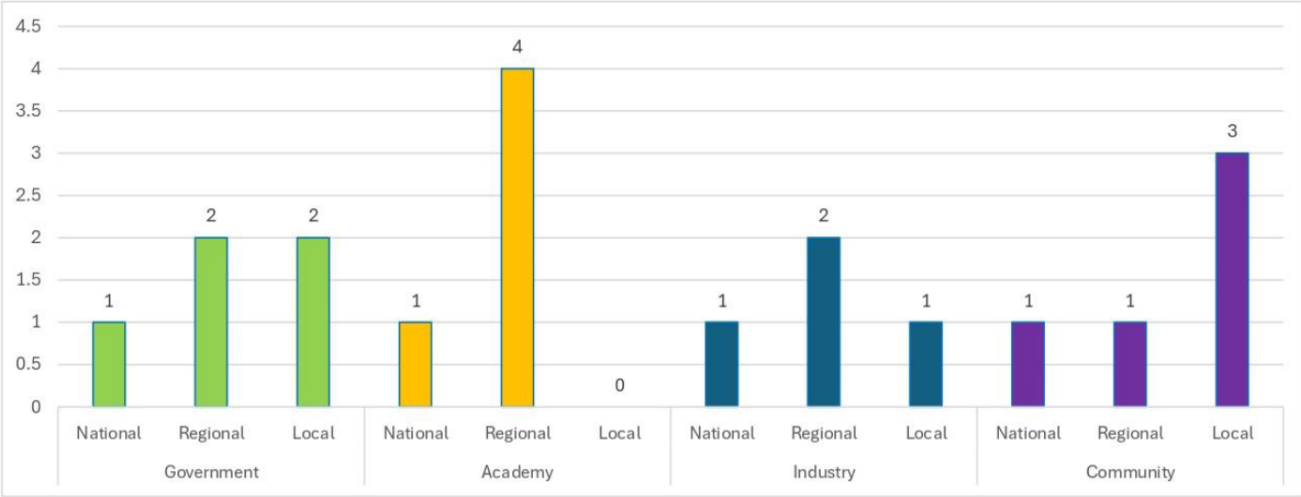

Figure 11: Graphical representation of Valais's selection of external stakeholders (in Local Councils) following a stakeholder map analysis

	While the current stakeholder landscape in Valais provides a solid foundation for addressing water management challenges, increasing national government engagement, expanding academic involvement, and fostering deeper industry participation are critical steps.
Lessons learned	• *Finding new ways to monitor watershed at a reasonable price remains a challenge. However, if expensive sensors are used, then replicability is lowered. Solutions are being explored to overcome this problem.* • *Regional demo partners explored the different perceptions and cultural aspects around water, in addition to the financial ones. To achieve this, efforts have been made to convert data into real/acceptable indicators. They realised that if they were just showing the consumption of water directly to citizens, it could increase the awareness but also make them reluctant. Instead, the approach shifted to measuring the extent to which water needs are fulfilled, allowing for a more constructive discussion.* • *This process of indicator creation is complex for the demo partners because it requires the trust and engagement of stakeholders. Due to this, Valais partners did a lot of research on human perception (extended literature review and state of the art on human engagement, human trust of environmental data, on visual representation, data representation and territory etc.).*

3. Annexes

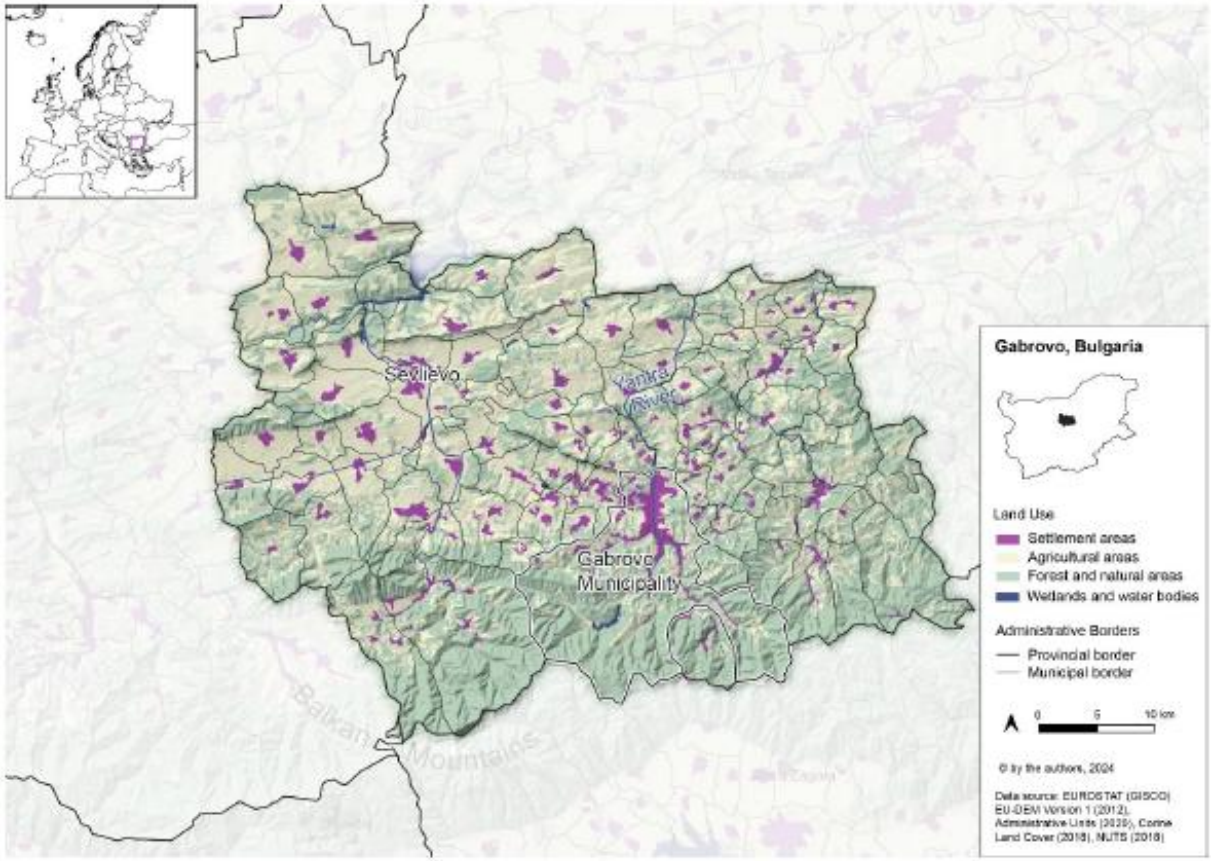

Figure 12: Map of Gabrovo (TU Wien, 2024)

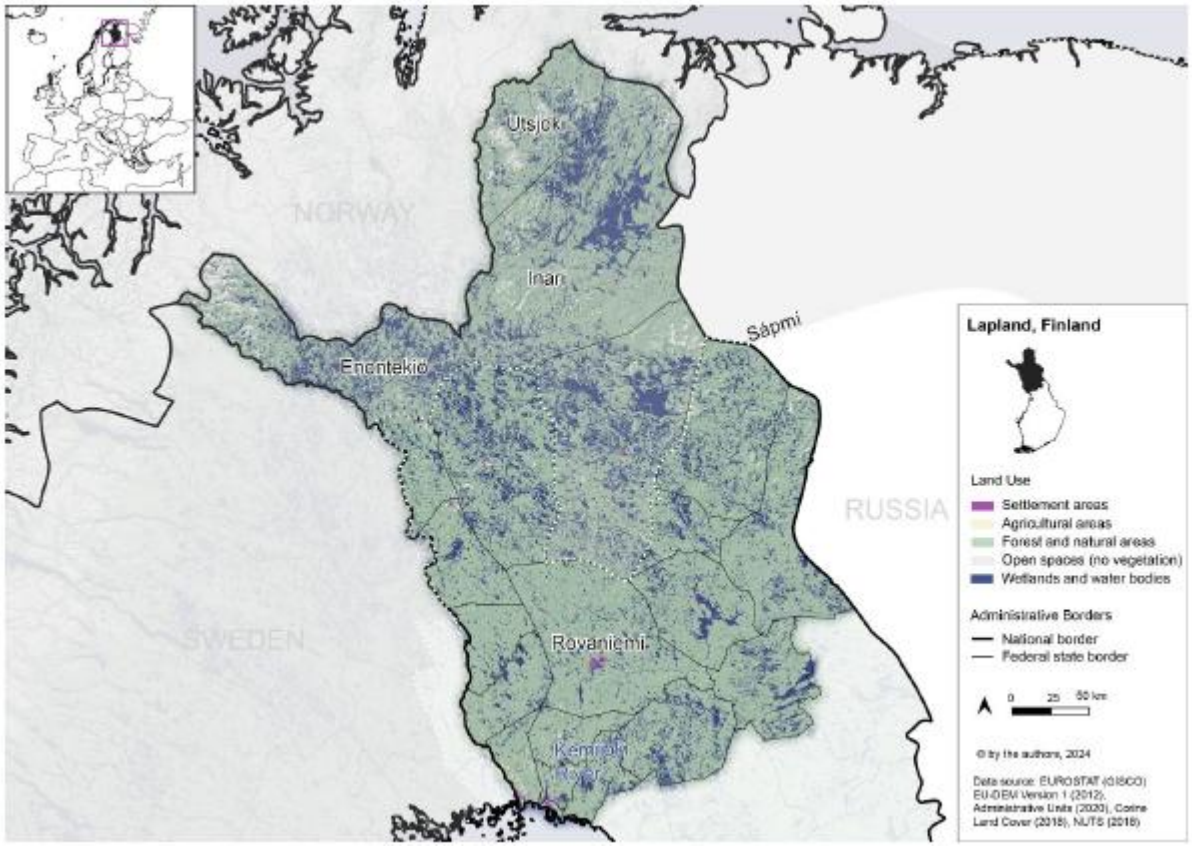

Figure 13: Map of Lapland (TU Wien, 2024)

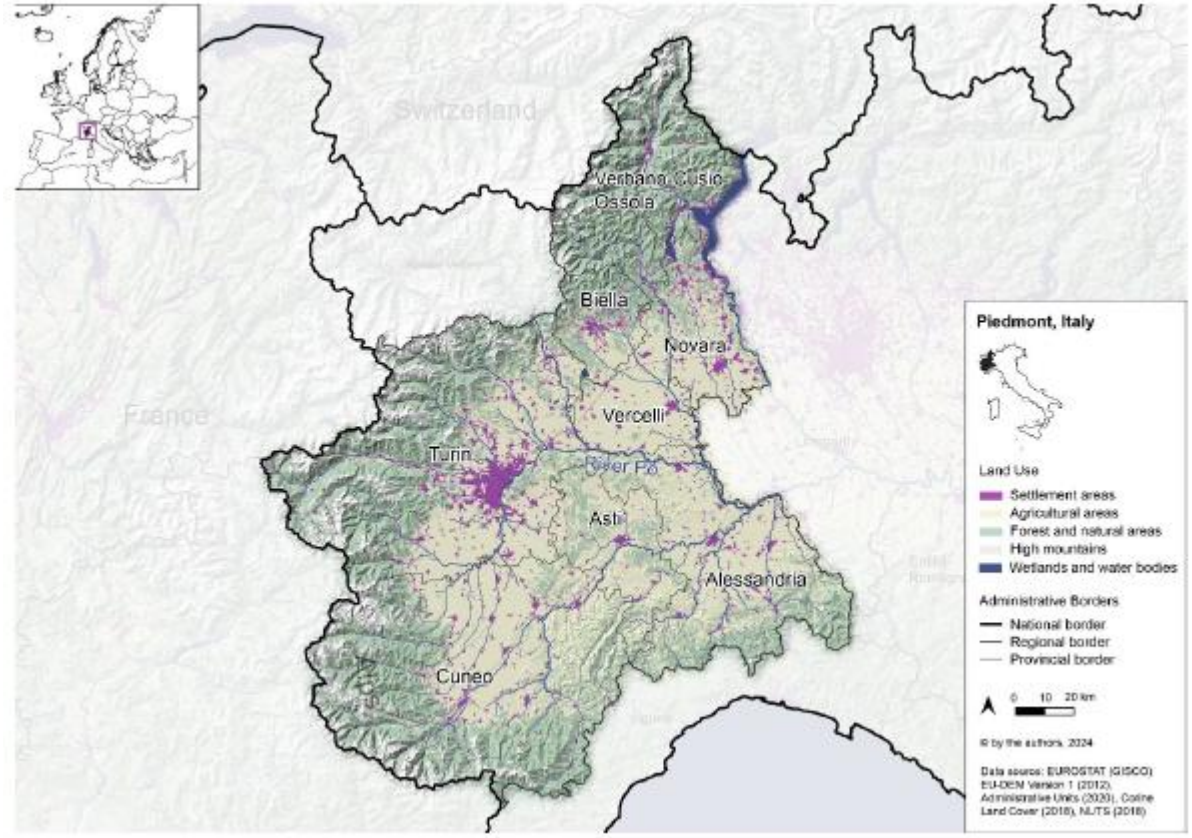

Figure 14: Map of Piedmont (TU Wien, 2024)

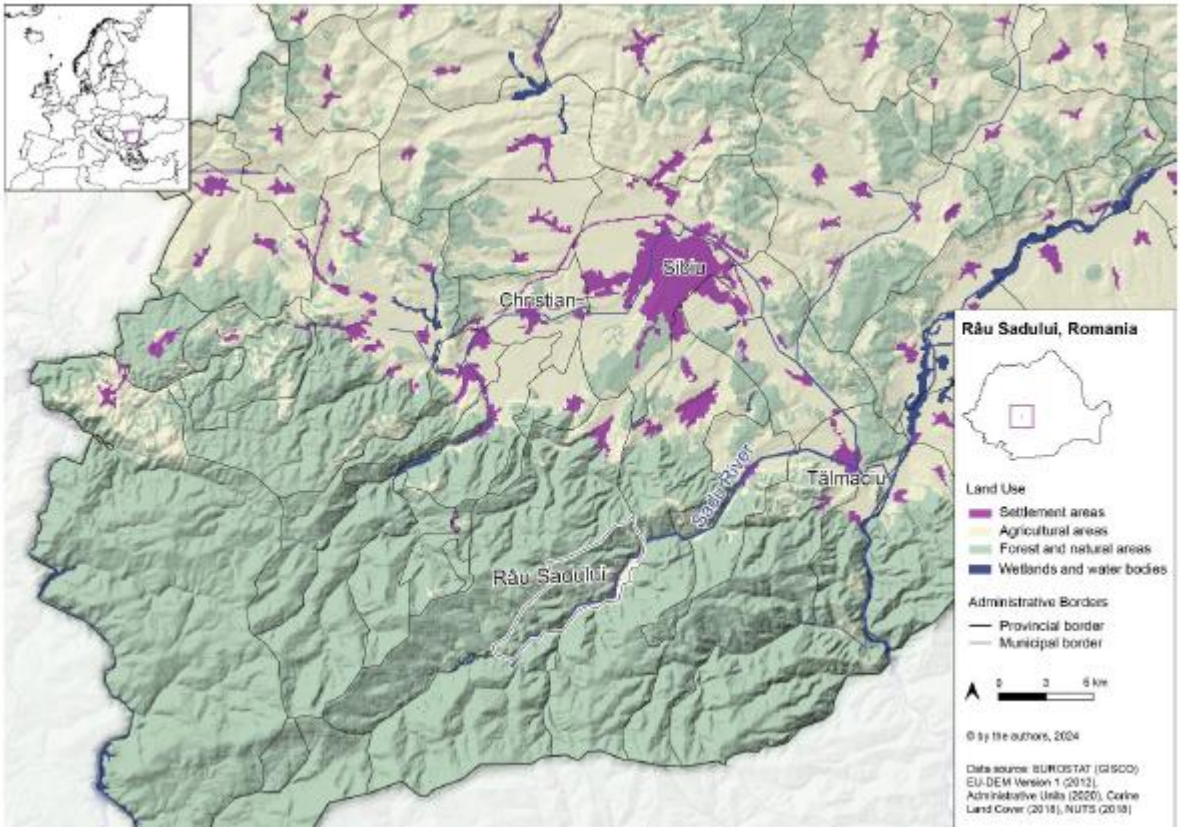

Figure 15: Map of Sibiu (TU Wien, 2024)

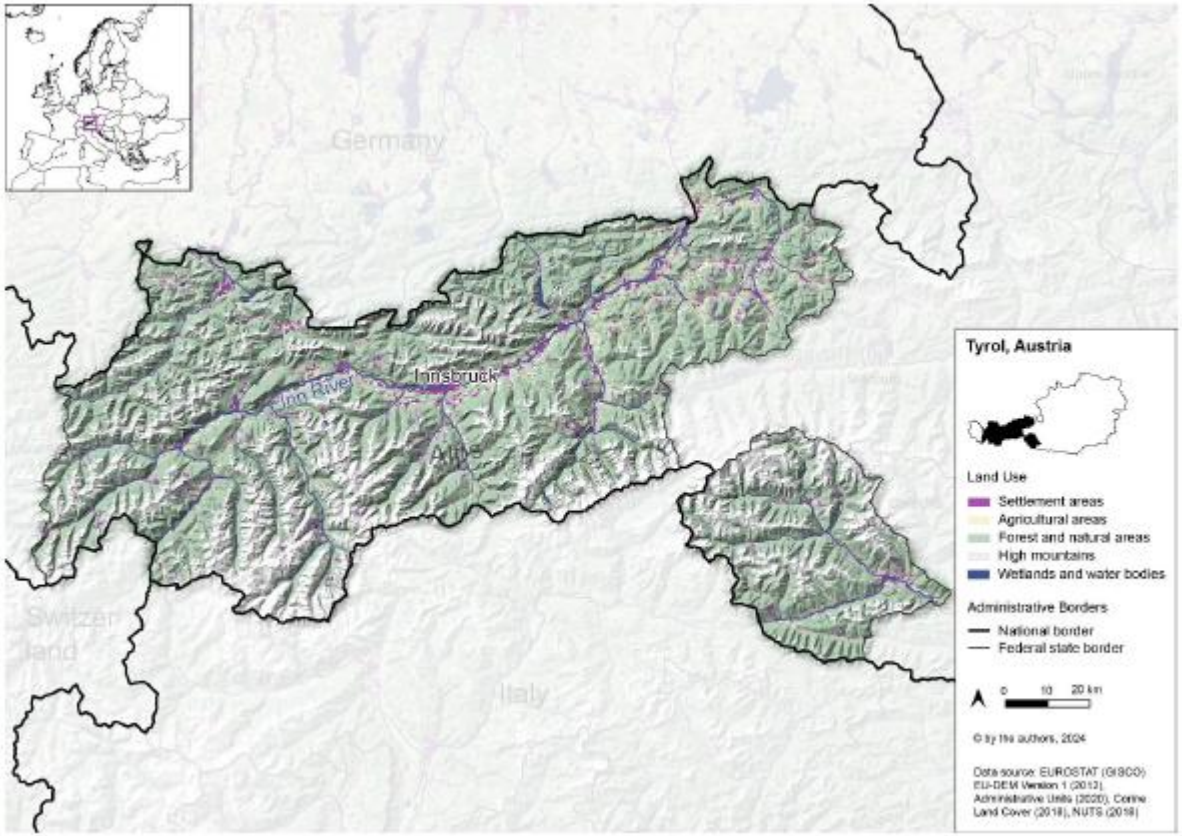

Figure 16: Map of Tyrol (TU Wien, 2024)

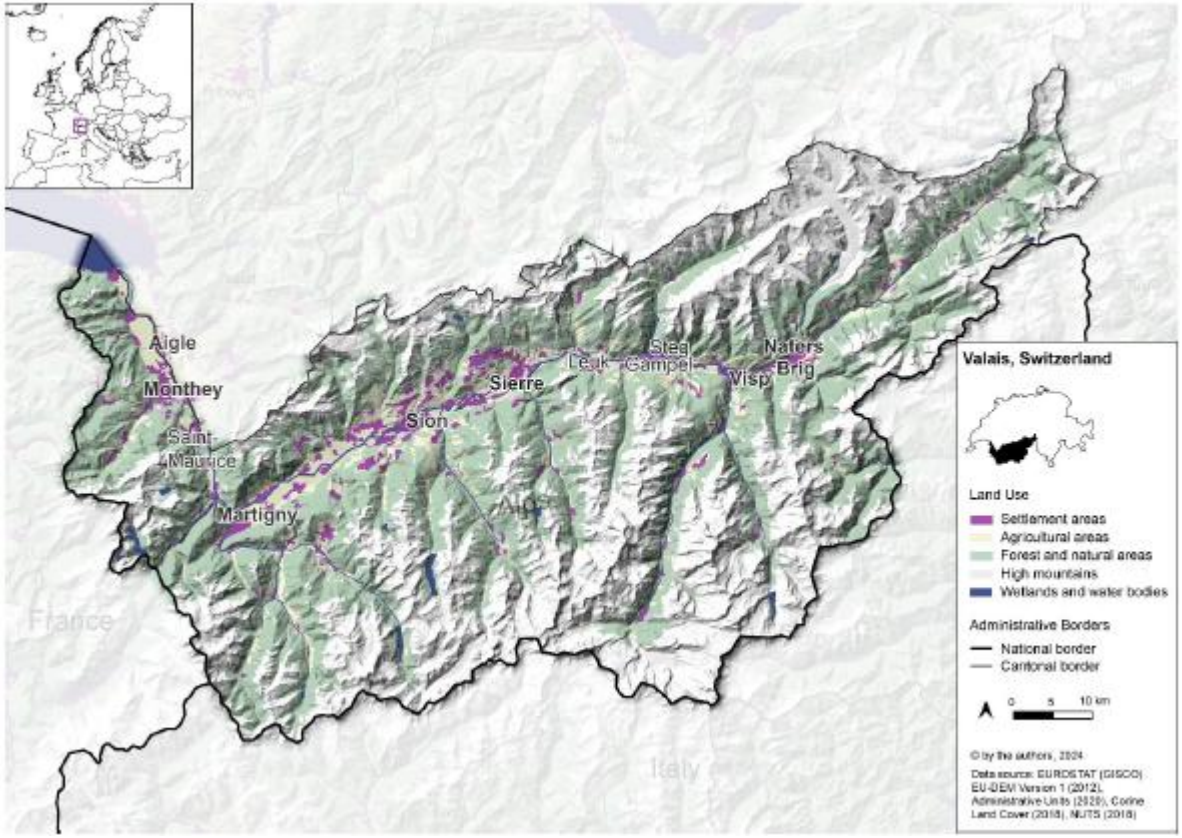

Figure 17: Map of Valais (TU Wien, 2024)