

# Multifunctional GBI for the Province of Sondrio

## Regional and local corridors driving the transnational ecological (re)connection



### 1 Why ecological connectivity matters in Sondrio

The Province of Sondrio, located in Lombardy (Italy), is an entirely mountainous territory extending over 3,000 km<sup>2</sup>, with nearly half of its surface above 2,000 m and a maximum elevation of 4,050 m on Mount Bernina. It encompasses the upper basin of the Adda River, its lateral valleys, and the Alpine slopes, which host a rich mosaic of habitats and protected areas of regional and transalpine relevance. Preserving and strengthening the ecological connectivity among these protected sites and the surrounding alpine space is essential to maintaining biodiversity and ecosystem functions. However, the territory is increasingly exposed to pressures from urban expansion, linear infrastructures, intensive agriculture, tourism, and climate change. The ongoing revision of the Provincial Territorial Coordination Plan (PTCP, 2010) provides a strategic opportunity to embed multifunctional green and blue infrastructure, enhancing ecological networks and aligning local planning with regional and Alpine-scale strategies.

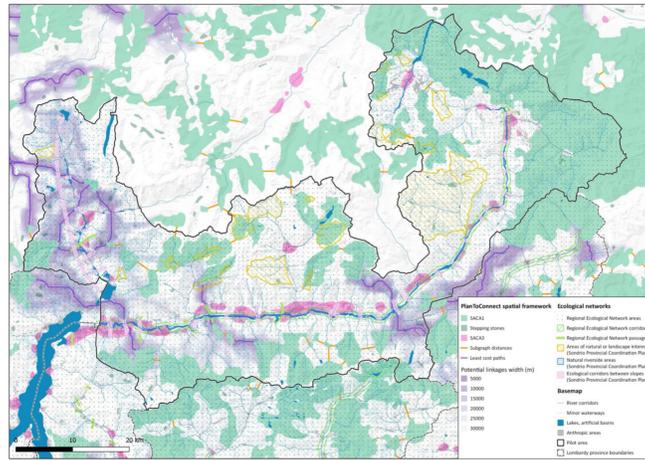


Figure 1 - Sondrio Province ecological framework. Source: developed by FPM - DASIU/Lab PPTe working group

### 2 Project goals

The pilot case adopted a multifunctional approach aimed at enhancing ecological integrity, natural assets, recreational opportunities, cultural values, and landscape quality through an integrated design perspective. Meeting this objective required innovative planning methods that combine evidence-based knowledge with strategic framework design to coordinate and harmonize diverse territorial functions (Arcidiacono et al., 2016). An ecosystem-based model was applied, integrating biotic and abiotic components to strengthen and restore ecological connectivity through a GBI project designed to enhance local knowledge and contribute to the drafting of the Provincial Green Plan currently under revision.

## PlanToConnect

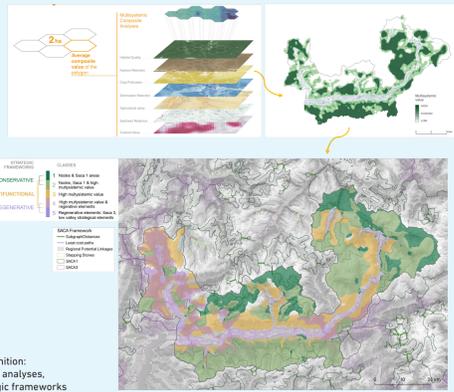


Figure 2 - Strategic framework definition: ESS assessment, Hotspot analyses, Interpretation and strategic frameworks

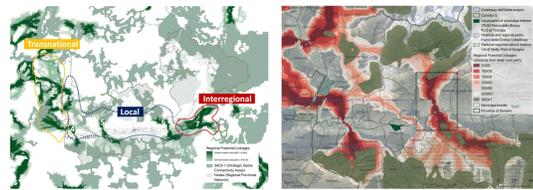


Figure 4 - Regional Potential Linkages' characterisation. Source: developed by FPM - DASIU/Lab PPTe working group

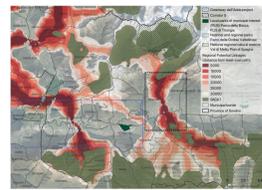


Figure 5 - Pilot corridor context. Source: developed by FPM - DASIU/Lab PPTe working group

### 3 Methodological approach

The ES-based methodology began with the modeling and interpretation of seven ecosystem services across the provincial territory to establish a robust scientific foundation for the GBI strategies. By overlaying biophysical information with both natural and anthropic territorial elements, analyzing threats to ecological connectivity, and mapping protected areas, three strategic frameworks were identified from the outset: *conservative*, *multifunctional*, and *regenerative*. These frameworks were subsequently articulated into sub-strategies and targeted actions for each relevant component of the GBI. Moreover, data on potential regional ecological corridors (Saca framework, AlpBionet 2030) enabled the inclusion of an additional information layer, which played a central role in addressing ecological fragmentation and safeguarding potential connections within the highly urbanized and pressured valley floor.

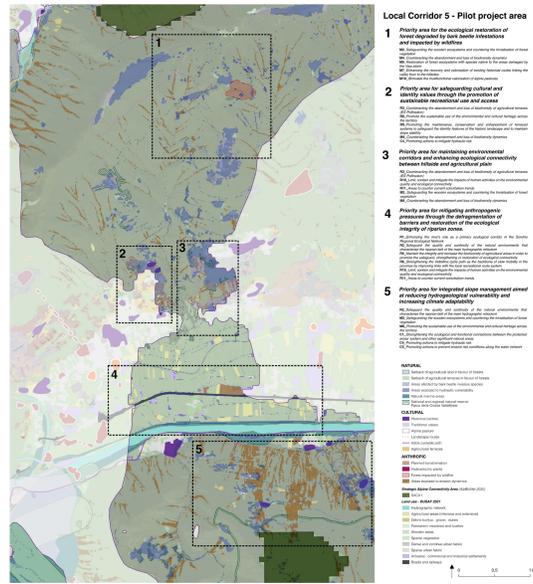


Figure 3 - Corridor 5 GBI Design. Source: developed by FPM - DASIU/Lab PPTe working group

### 4 Pilot design: Corridor 5

Within the strategic design of multifunctional Green Infrastructure (RVB) for the entire province, a specific focus was developed on Corridor 5, located in the Valtellina valley between Morbegno and Tirano. This pilot was selected to ensure continuity with the previous "Greenway of the Upper Adda" project (LIFE IP Gestire, Action C21, and the Adda River Basin Contract), which addressed ecological rehabilitation and public access along the lower valley. Corridor 5 connects Alpine SACA1 cores across a highly anthropized valley floor, supporting ecological defragmentation. Five priority macro-areas were identified: 1) Ecological Restoration of Forests Degraded by Bark Beetle Infestations and Impacted by Wildfires; 2) safeguarding cultural and identity values through the promotion of sustainable recreational use and access; 3) maintaining environmental corridors and enhancing ecological connectivity between hillside and agricultural plain; 4) mitigating anthropogenic pressures through the defragmentation of barriers and restoration of the ecological integrity of riparian zones; 5) integrated slope management aimed at reducing hydrogeological vulnerability and increase climate adaptability.

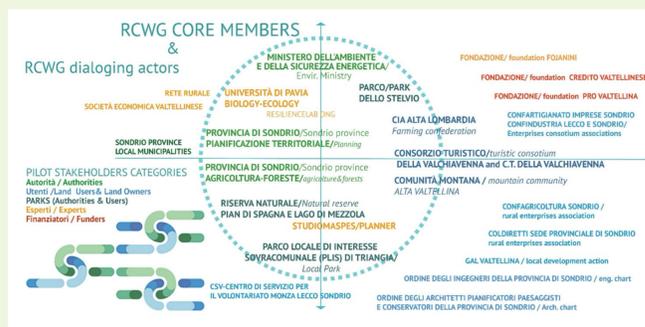
### 5 From vision to statutory plans

The Sondrio province pilot demonstrates how the multifunctional GBI strategy can be embedded across different planning levels. At the provincial scale, the Provincial Territorial Coordination Plan (PTCP)—currently under revision—provides the primary framework for integration. The PTCP already includes a multifunctional ecological network, conceived as both a conservation tool and a driver of territorial regeneration and landscape valorisation. The GBI proposal could strengthen this framework by incorporating the strategic-design guidelines of the pilot and aligning them with broader objectives of ecological connectivity and climate adaptation. At the sub-provincial scale, the Territorial Area Plan (PTRA) for Middle and Upper Valtellina represents a complementary entry point. The PTRA defines its own ecological network, later integrated into the PTCP, and its scope

extends toward Valle Camonica, a key SACA1 connectivity area of Alpine relevance. At the transnational scale, the GBI strategy aligns with the PlanToConnect project, embedding large-scale connectivity axes into local planning instruments. This multi-tiered integration enhances synergies between strategic visions and regulatory frameworks, supporting multifunctionality and connectivity.

Instrument	Member	Address to connectivity in pilot area. Status or necessary	Relevance and content of the integration proposal
Provincial Territorial Coordination Plan (PTCP)	M	Ecological connectivity: Provincial ecological network project integration of currently planned corridors, and of restoration axes on the ecological network and previous corridors. Possible "PTCP" content: integration of corridors.	Priority of the PTCP project: General: diversity of corridors and their connectivity. Provincial: ecological connectivity and landscape quality.
Territorial Area Plan for the Upper and Central Valtellina	V	Ecological connectivity: Provincial ecological network project integration of currently planned corridors, and of restoration axes on the ecological network and previous corridors. Possible "PTRA" content: integration of corridors.	Priority of the PTRA project: General: diversity of corridors and their connectivity. Provincial: ecological connectivity and landscape quality.
Municipal Urban Plan (PTU)	M	Ecological connectivity: Provincial ecological network project integration of currently planned corridors, and of restoration axes on the ecological network and previous corridors. Possible "PTU" content: integration of corridors.	Priority of the PTU project: General: diversity of corridors and their connectivity. Provincial: ecological connectivity and landscape quality.

Table 1 - Overview of spatial planning instruments addressed. Source: developed by FPM - DASIU/Lab PPTe working group



### 6 Governance and stakeholders

Stakeholder engagement in the Sondrio pilot is structured through a multi-level coordination system mainly supported by the Province of Sondrio and regional/national parks. The Regional Connectivity Working Group (RCWG) acts as the core coordination body, bringing together public authorities, farmers' associations, NGOs, businesses, and academic institutions. This structure is complemented by steering committees and river contract experiences, ensuring continuity with existing governance models. A co-design process based on workshops, targeted consultations, and participatory seminars fosters dialogue and knowledge exchange, enabling integration of scientific expertise, local knowledge, and sectoral interests into the strategic design of the multifunctional green-blue network.

### 7 Funding toolbox

The implementation of the Sondrio GBI strategy relies on mobilizing diverse financial resources. Key sources include European instruments (Cohesion Fund, ERDF, Horizon Europe, LIFE, EAFRD/NRDP), national and regional funds linked to landscape restoration, biodiversity, and climate adaptation, as well as innovative mechanisms such as public-private partnerships and Payments for Ecosystem Services.

Connectivity Instrument	Funding Instrument	EU Measure	Description
Restoration and maintenance of riparian zones and riparian corridors	LIFE Programs	EU	EU financial resources to protect, restore and enhance riparian zones, contributing to the improvement of the ecological integrity of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	Philosofia/Action	EU	Philosofia/Action program for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	PRC	EU/Regional	PRC (Provincia Regionale del Sondrio) financial resources for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	LIFE programs	EU	EU financial resources to protect, restore and enhance riparian zones, contributing to the improvement of the ecological integrity of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	Nature Restoration Law	EU/Regional	Nature Restoration Law (2020-2027) financial resources for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	Hydrogeological	Regional	Regional financial resources for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	ERDF/Cooperation	Regional	ERDF/Cooperation financial resources for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	ERDF	Regional	ERDF financial resources for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	Other area fund	Regional	Other area fund financial resources for the restoration and maintenance of riparian zones and riparian corridors.
Restoration and maintenance of riparian zones and riparian corridors	Cooperation	Regional	Cooperation financial resources for the restoration and maintenance of riparian zones and riparian corridors.
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Table 2 - Funding instruments for the GBI implementation. Source: developed by FPM - DASIU/Lab PPTe working group

### 8 Key messages for planners

- An ES-driven strategic framework allowing spatially explicit identification of territorial strengths and vulnerabilities, highlighting climate risks and the need for adaptation measures in the Alpine region.
- Emphasizing the multifunctionality of GBI enables an integrated project that addresses the complex ecological interface between natural/rural and urban environments.
- Broad stakeholder involvement through working groups and participatory workshops improves ownership and knowledge exchange.
- Mobilising several funding sources, from EU programmes to PES, ensures the feasibility of different actions.

### 9 Next steps

The next phase of the project targets key stakeholders involved in co-developing and refining the GBI framework. The primary goal is to provide materials that support local planning decisions, while raising awareness of climate change, ecosystem preservation, and the importance of maintaining local traditions to safeguard environmental, ecological, and social heritage. Future steps include disseminating results, informing PTCP development, and continuing research in multifunctional green-blue networks.

