

# TRANSNATIONAL COLLABORATION REPORT ON ECOLOGICAL / ECONOMIC VALUATION OF FOREST ECOSYSTEM SERVICES

D.2.3.2

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**Alpine Space**

Forest EcoValue

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Interreg Alpine Space Programme 21-27

Carbon neutral and resource sensitive Alpine region

SO2.2: Promoting the transition to a circular and resource efficient economy

**Forest EcoValue:**

**Supporting multiple forest ecosystem services through new circular/green/bio markets and value chains**

Project ID: ASP0100005

## List of the Forest EcoValue project partners

- PP1. Finpiemonte SpA – Regional financial and development agency / **Coordinator** [FINPIE] PP2. Lombardy Foundation for the Environment – Fondazione Lombardia per l’Ambiente [FLA]
- PP4. National Research Institute for Agriculture, Food and Environment – Institut National de Recherche pour l’Agriculture, l’Alimentation et l’Environnement [INRAE]
- PP5. Slovenia Forest Service – Zavod za Gozdove Slovenije [ZGS]
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## 1. Introduction

According to the application for the Forest EcoValue project this report is on lessons learnt in living labs from activity 2.2 and activity 2.3, about good practices, DO's and DONT'S deriving from the transnational collaboration among PPs in the Pilot Action as well as with EUSALP and AC WG MF. Also, the transnational exchange between project partners on their experiences in the living labs will be addressed.

According to this objective this deliverable represents the summary on the activities related to biophysical and economic assessment carried out in the Living Labs and lessons learnt from the different living labs, the main weaks and success factors and a reflection on the action which institutions within EUSALP and Alpine Convention might take on board.

## 2. Project overview

Forests of the Alpine Space play a key role in climate change mitigation and resilience, providing multiple ecosystem services (ES) and environmental and social benefits such as CO<sub>2</sub> absorption, air pollution reduction, biodiversity enhancement, and protection against natural hazards. However, they are threatened by abandonment, climate change, and territorial degradation, which progressively reduce natural resources and the provision of forest ES (FES). Maintenance costs of Alpine forests are high, and public funds and traditional wood value chains are insufficient to cover them. Economic valuation and payment schemes for FES are widely discussed but rarely successfully applied.

The Forest EcoValue project addresses this challenge by developing innovative, sustainable business models for forest management and maintenance, supporting new bio-based value chains and ES markets, and involving different sectors, public and private actors, and citizens. Restoring and maintaining healthy forests has been recognised as a source of value for the Alpine region, while also creating business opportunities and green jobs for Alpine communities.

The project focuses on a subset of FES from the following categories:

- **Provisioning** (e.g. biomass, raw materials, chemicals) with a specific focus on non-timber forest products, and on the production of woody biomass for energy, integrated into circular energy markets.
- **Regulating** (e.g. biodiversity, natural risk reduction, CO<sub>2</sub> absorption) concretely working on carbon and biodiversity credits, natural risk management through protective forests, and innovative environmental finance instruments such as green bonds and reverse auctions.
- **Cultural** (e.g. recreation, habitat experience, health) particularly enhancing recreational and tourism services and spiritual and cultural services.

These services have been explored and tested within Living Labs (LLs) across five countries, located in different Alpine territories and representing diverse ecological and socio-economic contexts:

- **Italy – Valle Tanaro, Piedmont:** The LL in Valle Tanaro explores innovative approaches to valorising chestnut groves, promoting non-timber forest products, developing carbon and



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biodiversity credits, and fostering experiential activities linked to forest and rural heritage.

- **France - Haute-Savoie:** Grand Annecy and Thonon LLs focus respectively on two aspects 1) recreational ecosystem services, enhancing the value of forests through the sale of experiences such as ecotourism, outdoor activities, and educational programmes 2) enhancing the value of water regulation services through a public-private partnership.
- **Slovenia - Karavanke Mountains, municipality Tržič:** The Slovenian LL addresses natural risk management with a focus on torrent control, advances solutions for wood biomass supply chains and promotes sustainable tourism and recreational use of forests.
- **Austria - Province of Styria:** The Styrian LL concentrates on biodiversity and habitat provision and carbon sequestration and storage through innovative financing mechanisms such as reverse auctions.
- **Germany - Tegernsee Valley, Upper Bavaria:** The German LL explores spiritual and cultural services, such as forest cemeteries with biodegradable urns, while also fostering habitat and biodiversity conservation through collaborative public-private partnerships.

Accordingly, the project is aiming to:

- Map and analyse the Alpine Space forests delivery capacity of FES;
- Identify and estimate the economic potential, define business models and FES market frameworks;
- Test the models/tools developed by the consortium in pilot LLs involving local players;
- Compare results at transnational level, identifying obstacles and facilitating factors;
- Analyse the need for innovative policies to foster forest maintenance, FES markets, and new value chains;
- Elaborate refined transferable tools/models and policy proposals to enable new markets and value chains and ensure the expected FES.

Throughout the project, a continuous participatory process is carried out within the Living Labs. Stakeholders' active involvement in these labs is essential for co-designing and testing models and tools, ensuring that the innovative approaches are rooted in local realities. In parallel, public events and capacity-building workshops have strengthened engagement, supported knowledge transfer, and provided regular updates on project activities. This participatory and long-term approach, tested across the five territories, is paving the way for refined, transferable tools and policy proposals that can unlock new markets and value chains while safeguarding the provision of ecosystem services in the Alpine Space.

Project duration: 36 months

### 3. Overview of Living Labs

#### 3.1 Austria

The Austrian Living Lab adopted an approach that allowed to involve private forest owners from the entire state of Styria, Austria's most forest-rich state, boasting a forestation rate of 61.4 %. Due to the heterogeneous geography ranging from floodplains and wine regions at 200 m above sea level to high alpine areas up to 3,000 m, the forest composition is very diverse. This includes typical riparian forests in the south with poplar, willow, alder, and oak, to lower acid soil areas with beech-oak forests with fir and sweet chestnut in the east, to spruce, beech, pine, fir, ash, sycamore in the mid-altitudes, and up to larch and stone pine in the high mountains. 65 % of the forest is coniferous, 27 % is mixed forest, and 8 % is deciduous forest. 17.2 % of the forest area is a protection forest. Thanks to legally mandated reforestation and sustainable usage, the forest area is increasing, thus acting as an important CO<sub>2</sub> sink.

Styria is unique in Austria for its "dynamic forest typification," which allows even laypeople to select climate-adapted tree species, thereby enhancing stability as well as biodiversity. 22.9 % of Styria's forests are owned by large forest owners (more than 1000 ha), 55 % are owned by small forest owners (less than 200 ha), and ca. 9 % is owned by the Austrian Federal Forests Corporation. The forest is responsible for 1/6 of Styria's economic output. Styrian forests provide a range of important ecosystem services, including timber provision, CO<sub>2</sub> sequestration and habitat maintenance – three FES in focus. To facilitate transnational comparability and practical use of the assessment results the assessment was carried out in three districts, where most applications to participate in the Living Lab came from, namely Bruck- Mürzzuschlag, Murau and Weiz.

#### 3.2 France

The Grand Annecy Living Lab is located in the Haute-Savoie department of the Auvergne-Rhône-Alpes region and encompasses the city of Annecy and 33 surrounding municipalities, covering approximately 515 km<sup>2</sup> in the northern French Pre-Alps. Centred on Lake Annecy (27 km<sup>2</sup>), the territory forms a transitional zone between the Geneva basin and the alpine valleys, with elevations ranging from about 396 m in valley areas to more than 1,500 m on surrounding massifs. The geomorphology is shaped by Mesozoic limestone and marl formations, with Quaternary alluvial and glacial deposits in depressions and valley floors. Soils vary from alluvial and lacustrine substrates near the lake to shallow, calcareous soils on steep slopes. Groundwater levels fluctuate seasonally, from shallow aquifers in valleys to deeper karstic systems in the limestone mountains. The climate is montane, with a mean annual temperature of ~9.5 °C and annual precipitation of 1,600–1,650 mm.

Land use is structured around an urban core along the northern lakeshore, embedded within a broader matrix of agricultural zones and extensive forested landscapes. Forests cover roughly 23,000 ha, with ownership almost evenly split between public and communal forests managed by the National Forestry Office (ONF; 42 %) and private forests supported by the National Centre for Forest Ownership (CNPF; 58 %). Key forested massifs include Semnoz-Val Laudon, Tournette-Veyrier, and Parmelan-Glières.

Forest stands occur between 400 and 1,900 m and span three major vegetation belts. Deciduous species dominate lower elevations (oak, beech, chestnut, hornbeam), mixed and coniferous stands prevail in the montane zone (fir, spruce, beech), and spruce-dominated subalpine forests extend to higher altitudes. Deciduous forests represent approximately 65–70 % of forest cover, conifers 25–30 %. Stands are typically

mixed-aged and two-layered, with natural forests comprising 70–80 % of the area. Average growing stock reaches 300–350 m<sup>3</sup>/ha, with an annual increment of 6–7 m<sup>3</sup>/ha and harvest rates below this threshold. Climate impacts, particularly drought-induced bark beetle outbreaks, have increased deadwood quantities and led to a decline in spruce monocultures. Current management emphasizes natural regeneration, species diversification, continuous cover, and selective harvesting adapted to slope conditions.

The region contains numerous protected and conservation areas, including national nature reserves (Roc de Chère, Bout du Lac), several Natura 2000 sites (totalling ~10,000 ha), 41 Sensitive Natural Areas (ENS), and 55 ZNIEFF sites. Forests also provide essential natural hazard mitigation functions by stabilizing steep slopes and protecting settlements from rockfalls and landslides. Grand Annecy is a major outdoor recreation destination, offering hiking, cycling, skiing, and water sports, supported by an extensive trail network (552 km) and ski areas such as Semnoz and Glières, alongside environmental education initiatives aimed at balancing recreation and conservation.

### 3.3 Germany

The German Living Lab is situated in Upper Bavaria, south of Munich, encompassing four administrative districts within a climatically diverse region spanning from Alpine Foothills to Northern Limestone Alps (591 m to 1328 m above sea level). It comprises 441.17 ha of forest, managed by two distinct entities: the Archdiocese Munich and Freising, and a private forestowner.

The heterogeneous topography and moist-continental climate lead to diverse forest compositions, from spruce-dominated stands to multi-layered mountainous mixed forests of spruce, beech, and fir, reflecting the area's natural communities. Ownership is split between the Archdiocese, a large ecclesiastical organization emphasizing ethical and sustainable management with economic, ecological, and social pillars, and a private owner who actively integrates sustainable timber production with social, ecological, and recreational functions, fostering community and cultural initiatives.

The Living Lab is committed to sustainable forest management, focusing on continuous timber production while providing crucial ecosystem services like carbon sequestration, habitat maintenance, and extensive recreational opportunities. A significant portion of the area is under various protection statuses, including Landscape Conservation Areas, Natura 2000 sites, and numerous biotopes, with a strong commitment to biodiversity through programs like the Contractual Nature Conservation Program "VNP Wald" and Climate-Adapted Forest Management "Klimaangepasstes Waldmanagement". A distinguishing feature is the considerable presence of protective forests, particularly in the private owner's area, safeguarding against natural hazards such as avalanches, slope fractures, and landslides, highlighting the critical role of forest in regional safety.

### 3.4 Italy

The Italian Living Lab is located in the south of the Piedmont region, bordering Liguria and France. It is identified as Forest Area 13, encompassing the Langa Cebana hills, Mongia, Cevetta, and Upper Tanaro valleys, with Alta Valle Tanaro being the largest in terms of surface. The LL covers 67,264 ha and includes 30 municipalities. Land use is characterized by extensive forest cover, primarily in mountainous areas, while hillside regions are predominantly dedicated to agriculture, featuring vineyards and hazelnut orchards. The area exhibits a Sublitoraneo rainfall pattern, with summer minimums and autumn maximums, alongside a secondary peak in spring. Solid precipitation is common between January and March, and snow cover typically persists for 3-4 months annually, with late snowfall being a frequent phenomenon. Elevations vary significantly, from sites along the Tanaro riverbed to peaks reaching 550 m

a.s.l. in the north. The Tanaro Valley's complex geological structure, shaped by Alpine polyphasic deformation, results in diverse soil types, ranging from shallow and undeveloped in disturbed areas to deeper and well-developed soils. Forest covers 61% (41,358 ha) of the total LL area. Deciduous species overwhelmingly dominate, comprising approximately 88% of the forest cover, while conifers account for around 12%, largely due to mountain belt reforestation efforts. Key forest categories include Chestnut, Beech, and Downy Oak. Significantly, extensive chestnut stands, covering 18,812 ha, show a notable proportion of dead biomass (around 50%). More than 17% of the pilot area falls under various protected statuses, including Nature Conservation Areas, Banned Forests, Landscape Protection Areas, and several Natura 2000 sites, such as fractions of the ZSC/ZPS Alte Valli Pesio e Tanaro and natural parks like Parco del Maragoeis. For natural hazard protection, 14% of the forest cover is managed as direct protection forest, predominantly beech coppice. While avalanches pose a less urgent risk, forest management plays a crucial role in mitigating frequent mudslides and floods. Recreation and tourism in the LL leverage the accessibility of its forests, the rich heritage of the valley and mountain chain, and its strong agronomic and culinary traditions. Hazelnut and chestnut orchards are iconic features that attract visitors, especially from Liguria and Piedmont. Major recreational activities include hiking and cycling, supported by 169.157 km of regional cycling tracks, with a growing agrotourism sector. A unique educational asset is the Forestry School of Ormea, the only Italian public high school offering professional apprenticeships in forestry.

### 3.5 Slovenia

The Slovenian Living Lab (LL) is situated in the Municipality of Tržič, northern Slovenia, covering 15,500 ha. With a significant forest cover of 73 %, the area also features agricultural land in its lowlands and alpine pastures. Home to approximately 15,000 residents across 35 settlements, Tržič boasts a varied topography, ranging from the Karawanks mountain range, with peaks up to 2,133 m, down to river-glacial terraces at 424 m. The alpine climate is characterized by high annual precipitation, averaging 1,400 mm and exceeding 1,700 mm in higher elevations, and diverse geology resulting in a variety of soil types. Forest management for the LL's 11,290 ha of forest (72.7 % of the total area) is overseen by the Slovenian Forest Service (SFS), with local units and district foresters. Private forests constitute the majority at 85.5 %, fragmented among over 2,000 owners with an average property size of 0.5 ha, complemented by state (9.7

%) and municipal (4.7 %) ownership. The forest composition is predominantly Norway spruce (60 %) and European beech (21.4 %), with mixed forests accounting for 63.6% of the stands. The average growing stock is 401 m<sup>3</sup>/ha, with an annual increment of 7.87 m<sup>3</sup>/ha. Management adheres strictly to close-to-nature principles, prohibiting clear-cuts and emphasizing natural regeneration through irregular shelterwood and group selection systems, with rotation periods typically ranging from 120 to 160 years. Significant

challenges include insufficient active management of protective forests (16.5 % of the total forest area), which impacts their stability and vitality, and the vulnerability of historical spruce

monocultures to windthrow and bark beetle attacks. Beyond timber production, the LL provides crucial ecosystem services. Hunting is regulated by the SFS and is legally mandated for forest owners, reflecting a holistic ecosystem approach. Over 86 % of the forest area is designated as Natura 2000 sites, and the Dovžan Gorge is a prominent natural monument. The region is a popular destination for recreation and tourism, particularly for hikers, cyclists, and ski tourers, benefiting from its natural beauty, diverse attractions, and proximity to major cities like Ljubljana.

## 4. Forest ecosystem services in the Living labs

This chapter gives an overview of the forest ecosystem services which have been assessed in the Living Labs from a biophysical and economic perspective. The chapter presents after an overview first the different forest ecosystem services, then the business models and finally draws some conclusions from a transnational perspective.

### 4.1 Overview assessed Forest Ecosystem Services

The table below provides a short overview of the forest ecosystem services which have been selected according to the local conditions and were assessed in all living labs. The ecosystem services are grouped according to the international classification system in provisioning, regulating and cultural services. In total eleven, six provisioning, three regulating and two cultural ecosystem services have been assessed.

Table 1: Presentation of a short overview of Forest Ecosystem Services in the Living Labs.

Forest Ecosystem Service	AUSTRIA	FRANCE	GERMANY	ITALY	SLOVENIA
<b>Provisioning ecosystem services</b>					
Provision of timber wood biomass	X	X	X	X	X
Provision of fire wood biomass	X	X	X	X	X
Provision of fuel wood biomass				X	
Provision of Non-Wood Forest Products (NWFP)				X	
Provision of forest spring water		X			
Provision of habitats for wild plants and animals	X	X	X	X	
<b>Regulating ecosystem services</b>					
CO <sub>2</sub> storage and sequestration in forests/Climate Change Mitigation	X	X	X	X	
Natural Hazards (rockfalls, torrent) prevention/mitigation/control		X	X		X
Maintenance of high-quality fresh waters provided by plants and animal species		X	X		
<b>Cultural ecosystem services</b>					
Recreation and tourism		X	X	X	X
Aesthetic value of the forest		X		X	



## 4.2 Biophysical assessment activities: Single Forest ecosystem services assessed in the living labs

After the selection of the forest ecosystem services in each living lab, this set of FES was assessed and mapped based on local/regional conditions. For each FES an indicator for the ecosystem service supply was identified for which existing data could be used.

Data situation in the living labs differed, which required to choose appropriate indicators. Data were used at two levels:

At a multi-territorial level, large scale data were used to capitalise on already existing databases from previous projects and to generate an alpine wide database to show the alpine dimension of these forest ecosystem services.

At local level, small scale data were used to check the accuracy of the large-scale data but also to demonstrate how private forest owners might apply an ecosystem service approach even with easy at hand data.

With these indicators supply of FES were measured and options for maintenance, protection and improvement as well as possible alternatives were considered. For a detailed presentation of the methodology and the results, please refer to D.2.2.1 FOREST ECOSYSTEM SERVICES ASSESSMENT PILOT ACTION REPORT.

*This section will undergo further refinement and integration until the end of the Forest EcoValue project.*

### 4.2.1 Timber wood biomass

The ecosystem service of timber wood biomass has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

The production output of forest is primarily determined by the provision of wood as a raw material. The wood obtained during felling can be categorised as stem wood, energy wood, industrial wood and non- utilisable wood. Sustainable timber production and utilisation ensures that the amount of timber harvested does not exceed the annual growth. This ensures a constant supply of the raw material.

Timberwood biomass provision will be presented for the living labs of Austria, France, Germany, Italy and Slovenia.

### 4.2.2 Firewood biomass

The ecosystem service of firewood biomass has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

Firewood biomass provision will be presented for the living labs of Austria, Germany, Italy and Slovenia.

#### **4.2.4 Provision of Non-Wood Forest Products (NWFP)**

The ecosystem service of Non-Wood Forest Products has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

NWFPs like mushrooms, herbs and chestnuts are deeply tied to both biodiversity and cultural heritage. Ecologically smart management involves regulating harvest intensity, maintaining understory integrity, and ensuring species regeneration. NWFP has been analysed in the Italian Living Lab.

#### **4.2.5 Provision of forest spring water**

The ecosystem service of water provision has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

The ecosystem service of providing drinking water includes the natural filtration and purification of water suitable for human consumption. Forests, along with wetlands and aquifers, play a crucial role in maintaining water quality. Water provision has been analysed in the French Living Lab.

#### **4.2.6 Provision of habitats for wild plants and animals**

The forest ecosystem service is described by the proportion of old trees based on the forest management data of the forest owners and an habitat quality index based on the “Species and Habitats” protected asset map by the Bavarian State Office for the Environment (LfU 2025).

#### **4.2.7 CO<sub>2</sub> storage and sequestration in forests**

The ecosystem service of CO<sub>2</sub> storage and sequestration has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

The ecosystem service describes the ability of forests to absorb carbon dioxide (CO<sub>2</sub>) from the atmosphere and bind it in the long term. This happens through the process of photosynthesis, in which trees absorb CO<sub>2</sub> and store it in the form of carbon in wood, leaves and roots. The indicator best suited to describe the ecosystem service is ton of carbon per hectare (tC/ha) and describes the amount of carbon (C) that is stored or sequestered per hectare (ha).

#### **4.2.8 Natural hazard prevention, mitigation and control**

The ecosystem service of natural hazard prevention, mitigation and control has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

A large number of natural hazards can pose a risk to human health and infrastructure. Forest ecosystems can mitigate the effects and ensure that rockfalls are intercepted and the triggering of avalanches is prevented. In addition, tree roots ensure greater stability of the terrain, which can prevent slope failures. Forests slow down and protect against shallow landslides and avalanches and can absorb rockfalls.

#### **4.2.9 Maintenance of high-quality fresh waters**

The ecosystem service of high-quality fresh waters has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

#### **4.2.10 Recreation**

The ecosystem service recreation has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

The forest ecosystem service recreation refers to the intangible benefits that people derive for their well-being and health from spending time in forest ecosystems. This cultural service includes opportunities for stress reduction, mental and physical regeneration as well as active and passive leisure activities in a natural environment.

#### **4.2.11 Aesthetic value**

The ecosystem service aesthetic value has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

### 4.3. Economic assessment activities: Single FES assessed in the living labs

In each LL a subset of FES was assessed and mapped based on local/regional conditions. FES were measured and options for maintenance, protection and improvement as well as possible alternatives were considered. For a detailed presentation of the methodology and the results, please refer to D.2.3.1.

#### 4.3.1 Timber wood biomass

##### Austria

##### Indicators and data used for the assessment:

- Logging potential in solid cubic meter, before losses due to processing, estimated based on the actual logging data reported for the Weiz District in solid cubic meter, before losses due to processing (Efm in German) and yearly increment reported solid cubic meters without bark (Vfm in German)
- Total forest area in ha
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjusted unit value (AUV) in €/ha/yr (in 2023)
- Total economic values derived using DMV and AUV valuation methods

##### Main results:

##### Status of forest ecosystem service:

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Logging potential	10,368	solid cubic meter, before losses due to processing
	Total forest area	2,127	ha
	Direct market value (DMV)	314.61	€/ha/yr
	Total economic value, DMV	669,069.76	€/yr
	Adjusted unit value (AUV)	173.74	€/ha/yr
	Total economic value, AUV	369,480.34	€/yr

##### Conclusions for the Living Lab

- High relevance within FES portfolio: Timber wood provision ranks among the top five most valuable FES in Thannhausen, contributing about 30% of the total economic value (TEV) of the forest ecosystem.
- Relative importance: Although timber provision has significant social and economic importance, it remains less valuable than key regulating services (e.g., natural hazard mitigation, habitat provision, and carbon sequestration when using recommended carbon price estimates).
- Monetary valuation sensitivity: The method used strongly affects the valuation outcome. The market price (MP) approach suggests that average Alpine value (i.e., adjusted unit value) underestimates the social value of timber provision, though its relative importance remains moderate compared to regulating services. At the same time, adjusted unit values of other FES could also be underestimated, which necessitates great caution in comparative analysis.
- Overlap with other ecosystem services: The forest areas producing timber also provide carbon sequestration and other regulating and cultural services, meaning that intensified timber extraction

could lead to trade-offs and potentially reduce overall social value. Balanced, multifunctional management is therefore essential.

## France

### Indicators and data used for the assessment:

- Total forest area in ha
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic value in €/yr (2023)

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Total forest area	26,208.82	ha
	Adjusted unit value	174.46	€/ha/yr
	Total economic value	4,572,509.75	€/yr
Thonon	Total forest area	9,696.21	ha
	Adjusted unit value	174.46	€/ha/yr
	Total economic value	1,691,645.43	€/yr

### Conclusions for Annecy Living Lab:

- Moderate but secondary contributor to forest total economic value (TEV): Timber wood provision constitutes a modest share of the forest's TEV in Grand Annecy. While economically relevant, its contribution is clearly lower than that of regulating and cultural services such as recreation, rockfall protection, and carbon sequestration. This suggests less reliance on timber production and greater societal emphasis on non-provisioning services.
- Overlap with other ecosystem services: The forest areas producing timber fully overlaps with the area providing carbon sequestration, almost fully overlaps with areas valued for recreation, and partially overlaps with other regulating services, meaning that intensified timber extraction could lead to trade-offs and potentially reduce overall social value. Balanced, multifunctional management is therefore essential.

### Conclusions for Thonon Living Lab:

- Moderate but secondary contributor to forest total economic value (TEV): Timber wood biomass provision represents a relatively small share of the TEV of forests in Thonon. While it maintains an economic role as a provisioning service, its relative importance is clearly secondary to the high-value regulating and cultural services documented in the area.
- Position within the overall FES portfolio: Timber wood provision has a lower relative unit value than major regulating services, particularly natural hazard mitigation and habitat provision. It is also outperformed by carbon sequestration when the latter is valued using upper-bound carbon pricing, indicating that broader societal priorities place more emphasis on regulating services than on timber biomass production.
- Overlap with other ecosystem services: The forest area producing timber fully overlaps with the area providing carbon sequestration and partially overlaps with other services such as habitat provision and recreation. This means that a strong focus on timber production could create trade-offs, potentially reducing the overall multifunctional value of forests in Thonon. The results point to the need for balanced, multifunctional forest management, as a mono-functional focus could reduce total forest

social value.

## Germany

### Indicators and data used for the assessment:

- Logging potential in solid cubic meter, before losses due to processing, estimated based on the actual logging data reported for Bavaria in solid cubic meter, before losses due to processing (Efm in German) and yearly increment reported solid cubic meters without bark (Vfm in German)
- Total forest area in ha
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjusted unit value (AUV) in €/ha/yr (in 2023)
- Total economic values derived using DMV and AUV valuation methods

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Logging potential	46,767	solid cubic meter, before losses due to processing
	Total forest area	9,599	ha
	Direct market value (DMV)	461.92	€/ha/yr
	Total economic value, DMV	4,434,100.80	€/yr
	Adjusted unit value (AUV)	168.69	€/ha/yr
	Total economic value, AUV	1,619,281.76	€/yr

### Conclusions for the Living Lab:

- Moderate contribution to forest TEV: Timber biomass provision accounts for just under 30% of the TEV, making it the largest single contributor among the included FES under conservative estimates. This outcome is driven primarily by the substantial forest area allocated to timber production rather than by high per-unit value.
- High sensitivity to valuation method: Its unit value increases almost threefold when local market prices are applied, revealing that the Alpine average (i.e., adjusted unit value) substantially underestimates its social and economic value in Bad Tölz. However, relative to upper-bound values of other FES, its relative contribution to TEV stays under 30%. At the same time, adjusted unit values of other FES could also be underestimated, which necessitates great caution in comparative analysis.
- Overlap with other FES creates trade-offs: The forest area supplying timber also fully overlaps with carbon sequestration and partially with other FES, implying that management focused primarily on timber could diminish overall social value by undermining higher-valued regulating and cultural services.

## Italy

### Indicators and data used for the assessment:

- Logging potential in m<sup>3</sup>, estimated from the territorial forest plan
- Total forest area
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjusted unit value (AUV) in €/ha/yr (in 2023)
- Total economic values derived using DMV and AUV valuation methods

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Logging potential	381,461	m <sup>3</sup>
	Total forest area	43,356	ha
	Direct market value (DMV)	175.45	€/ha/yr
	Total economic value, DMV	7,606,789.15	€/yr
	Adjusted unit value (AUV)	152.06	€/ha/yr
	Total economic value, AUV	6,592,582.16	€/yr

### Conclusions for the Living Lab:

- Moderate relevance within FES portfolio: Timber wood provision ranks among the top five most valuable FES, contributing however around 20% of the total economic value (TEV) of the forest ecosystem, reflecting the broader social importance of forest beyond timber production.
- Low monetary valuation sensitivity: Both market price valuation and value transfer generate similar unit value per ha, only slightly overestimated by value transfer. This suggests that adjusted unit value transfer method provides an estimate aligned with local context.
- Overlap with other ecosystem services: The forest areas producing timber also fully overlaps with the carbon sequestration and habitat provision forest areas, as well as other regulating and cultural services, meaning that intensified timber extraction could lead to trade-offs and potentially dramatically reduce overall social value. Balanced, multifunctional management is therefore essential.



## Slovenia

### Indicators and data used for the assessment:

- Logging potential in m<sup>3</sup>, estimated based on the average annual logging rate in the LL (5 m<sup>3</sup>/ha) and the total forest area
- Concerned area in ha and % of total forested area
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjusted unit value (AUV) in €/ha/yr (in 2023)
- Total economic values derived using DMV and AUV valuation methods

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Logging potential	55,006	m <sup>3</sup>
	Total forest area	11,829	ha
		100	% of total forested area
	Direct market value (DMV)	393.72	€/ha/yr
	Total economic value, DMV	4,657,380.81	€/yr
	Adjusted unit value (AUV)	139.19	€/ha/yr
	Total economic value, AUV	1,646,488.12	€/yr

### Conclusions for the Living Lab

- Moderate relevance within FES portfolio: Timber wood provision ranks among the top five most valuable FES, however, contributing between 15 and 23% of the total economic value (TEV) of the forest ecosystem, depending on the valuation method used.
- Relative importance: Although timber provision has significant social and economic importance, it remains less valuable than key regulating services (e.g., natural hazard mitigation, torrent control, habitat provision, and carbon sequestration when using recommended carbon price estimates) and recreation.
- Monetary valuation sensitivity: The method used strongly affects the valuation outcome. The market price (MP) approach raises the social relevance of this FES above cultural services, suggesting that average Alpine value (i.e., adjusted unit value) significantly underestimates the social value of timber provision. At the same time, adjusted unit values of other FES could also be underestimated, which necessitates great caution in comparative analysis.
- Overlap with other ecosystem services: The forest areas producing timber also provide carbon sequestration and other regulating and cultural services, meaning that intensified timber extraction could lead to trade-offs and potentially reduce overall social value. Balanced, multifunctional management is therefore essential.

### 4.3.2 Firewood biomass

#### Austria

##### Indicators and data used for the assessment:

- Logging potential in solid cubic meter, before losses due to processing, estimated based on the actual logging data reported for the Weiz District in solid cubic meter, before losses due to processing (Efm in German) and yearly increment reported solid cubic meters without bark (Vfm in German)
- Direct market value in €/ha/yr (in 2023)
- Adjusted unit value in €/ha/yr (in 2023)

##### Main results:

##### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Logging potential	3,012	solid cubic meter, before losses due to processing
	Total forest area	2,127	ha
	Direct market value	145.59	€/ha/yr
	Adjusted unit value	17.47	€/ha/yr

##### Conclusions for the Living Lab:

- High sensitivity to valuation method: Market price valuation yields a substantially higher per-hectare estimate for firewood than the adjusted unit value transfer, indicates that Alpine average values (i.e., adjusted unit value) considerably underrepresent the local economic relevance of firewood. At the same time, it suggests that social value of other FES provided by value transfer could also be underestimated.
- Implications for relative social importance: Although the market price valuation increases the estimated contribution of firewood, its relative position within the broader FES spectrum remains below that of the dominant regulating services. The service gains in absolute value but does not shift the overall hierarchy of FES importance.
- No total economic value (TEV) analysis: Forest area providing this FES fully overlaps with timber wood biomass provision (i.e., total forest area). Meanwhile, only a small subset of non-provisioning FES could be valued in TEV terms, and even those estimates are likely underestimated due to indicator limitations and data scarcity. To avoid double counting and an inflated valuation of provisioning services, this FES was excluded from the TEV analysis.

#### Germany

##### Indicators and data used for the assessment:

- Logging potential in solid cubic meter, before losses due to processing, estimated based on the actual logging data reported for Bavaria in solid cubic meter, before losses due to processing (Efm in German) and yearly increment reported solid cubic meters without bark (Vfm in German)
- Total forest area in ha
- Direct market value in €/ha/yr (in 2023)

- Adjusted unit value in €/ha/yr (in 2023)

#### Main results:

##### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Logging potential	21,980	solid cubic meter, before losses due to processing
	Total forest area	9,599	ha
	Direct market value	62.97	€/ha/yr
	Adjusted unit value	16.96	€/ha/yr

#### Conclusions for the Living Lab:

- High sensitivity to valuation method: Upper-bound unit values incorporate direct market pricing for firewood biomass, which raises per-hectare estimates relative to conservative average Alpine values (i.e., adjusted unit transfer). This highlights the influence of valuation methodology on the estimated unit value of firewood.
- Low relative importance: Regardless of valuation method, provision of firewood biomass remains second the last FES in terms of social value per ha, revealing its rather low relative importance in the area.
- No total economic value (TEV) analysis: Forest area providing this FES fully overlaps with timber wood biomass provision (i.e., total forest area). Meanwhile, only a small subset of non-provisioning FES could be valued in TEV terms, and even those estimates are likely underestimated due to indicator limitations and data scarcity. To avoid double counting and an inflated valuation of provisioning services, this FES was excluded from the TEV analysis.

## Italy

#### Indicators and data used for the assessment:

- Logging potential in m<sup>3</sup>, estimated from the territorial forest plan
- Total forest area in ha
- Direct market value in €/ha/yr (in 2023)
- Adjusted unit value in €/ha/yr (in 2023)

#### Main results:

##### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Logging potential	1,004,201	m <sup>3</sup>
	Total forest area	43,356	ha
	Direct market value	64.84	€/ha/yr
	Adjusted unit value	15.29	€/ha/yr

Conclusions for the Living Lab:

- High sensitivity to valuation method: Market price valuation yields a substantially lower per-hectare estimate for firewood than the adjusted unit value transfer, indicates that Alpine average values (i.e., adjusted unit value) considerably overestimate relevance of firewood to the local economy.
- Implications for relative social importance: Regardless of valuation method, relative position of the firewood provision FES remains among the lowest compared to other FES.
- No total economic value (TEV) analysis: Forest area providing this FES fully overlaps with timber wood biomass provision (i.e., total forest area). Meanwhile, only a small subset of non-provisioning FES could be valued in TEV terms, and even those estimates are likely underestimated due to indicator limitations and data scarcity. To avoid double counting and an inflated valuation of provisioning services, this FES was excluded from the TEV analysis.

**Slovenia**Indicators and data used for the assessment:

- Logging potential in m<sup>3</sup>, estimated based on the average annual logging rate in the LL (5 m<sup>3</sup>/ha) and the total forest area
- Total forest area
- Direct market value in €/ha/yr (in 2023)
- Adjusted unit value in €/ha/yr (in 2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Logging potential	4,140	m <sup>3</sup>
	Total forest area	11,829	ha
	Direct market value	23.1	€/ha/yr
	Adjusted unit value	13.99	€/ha/yr

Conclusions for the Living Lab:

- High sensitivity to valuation method: Market price valuation yields twice as high per-hectare estimate for firewood than the adjusted unit value transfer, indicates that Alpine average values (i.e., adjusted unit value) considerably underrepresent the local economic relevance of firewood. At the same time, it suggests that social value of other FES provided by value transfer could also be underestimated.
- Implications for relative social importance: Although the market price valuation increases the estimated contribution of firewood, its relative position within the broader FES spectrum remains among the lowest in the FES portfolio.
- No total economic value (TEV) analysis: Forest area providing this FES fully overlaps with timber wood biomass provision (i.e., total forest area). Meanwhile, only a small subset of non-provisioning FES could be valued in TEV terms, and even those estimates are likely underestimated due to indicator limitations and data scarcity. To avoid double counting and an inflated valuation of provisioning services, this FES was excluded from the TEV analysis.

### 4.3.3 Fuel wood biomass

#### Austria

##### Indicators and data used for the assessment:

- Logging potential in solid cubic meter, before losses due to processing, estimated based on the actual logging data reported for the Weiz District in solid cubic meter, before losses due to processing (Efm in German) and yearly increment reported solid cubic meters without bark (Vfm in German)
- Total forest area
- Direct market value in €/ha/yr (in 2023)
- Adjusted unit value in €/ha/yr (in 2023)

##### Main results:

##### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Logging potential	4,772	solid cubic meter, before losses due to processing
	Total forest area	2,127	ha
	Direct market value	85.40	€/ha/yr
	Adjusted unit value	93.64	€/ha/yr

##### Conclusions for the Living Lab:

- Low sensitivity to valuation method: Market price valuation and adjusted unit value transfer produce almost identical unit values for fuelwood (slightly lower than adjusted unit value). This suggests that the Alpine average estimates capture local conditions with relatively little distortion for this specific provisioning service.
- Low relative social importance: This FES is valued well below other regulating, cultural and timber provisioning services.
- No total economic value (TEV) analysis: Forest area providing this FES fully overlaps with timber wood biomass provision (i.e., total forest area). Meanwhile, only a small subset of non-provisioning FES could be valued in TEV terms, and even those estimates are likely underestimated due to indicator limitations and data scarcity. To avoid double counting and an inflated valuation of provisioning services, this FES was excluded from the TEV analysis.

#### Italy

##### Indicators and data used for the assessment:

- Logging potential in m<sup>3</sup>, estimated from the territorial forest plan
- Total forest area
- Direct market value in €/ha/yr (in 2023)
- Adjusted unit value in €/ha/yr (in 2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Logging potential	1,618,929	m <sup>3</sup>
	Total forest area	43,356	ha
	Direct market value	45.87	€/ha/yr
	Adjusted unit value	81.95	€/ha/yr

Conclusions for the Living Lab:

- High sensitivity to valuation method: Market price valuation underestimated local value for fuelwood by almost half compared to the adjusted unit value transfer, indicates that Alpine average values (i.e., adjusted unit value) considerably overestimate relevance of fuelwood to the local economy.
- Low relative social importance: Even with the overestimation of the adjusted unit value transfer, the relative position of fuelwood within the broader FES spectrum remains below that of the dominant regulating services, as well as timber provision and recreation. The service gains in absolute value but does not shift the overall hierarchy of FES importance.
- No total economic value (TEV) analysis: Forest area providing this FES fully overlaps with timber wood biomass provision (i.e., total forest area). Meanwhile, only a small subset of non-provisioning FES could be valued in TEV terms, and even those estimates are likely underestimated due to indicator limitations and data scarcity. To avoid double counting and an inflated valuation of provisioning services, this FES was excluded from the TEV analysis.

**4.3.4 Provision of Non-Wood Forest Products (NWFP)****Italy**Indicators and data used for the assessment:

- Adjusted unit value in €/ha/yr (in 2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Adjusted unit value	8.43	€/ha/yr

Conclusions for the Living Lab:

- Relatively low social importance: This FES is ranked lowest within the portfolio of FES valuated for this LL.

### 4.3.5 Provision of forest spring water

#### France

##### Indicators and data used for the assessment:

- Volume of water captured in forest springs in m<sup>3</sup>
- Total forest area in ha
- Direct market value in €/ha/yr (in 2023), estimated by deducting the costs of capturing water from a forest spring from the average costs for capturing water from other sources

##### Main results:

##### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Water captured in forest springs	1,934,046.41	m <sup>3</sup>
	Total forest area	26,208.82	ha
	Direct market value	15.68	€/ha/yr

##### Conclusions for the Annecy Living Lab:

- Relatively low social importance: Provision of forest spring water is among the least valued FES. However, it must be noted that direct market valuation based on the real market prices for water capturing could be a significant underestimation of the overall social value of this FES, as it does not account for other non-marketable benefits received from water captured in forest springs (i.e., cheap does not mean less valuable).

### 4.3.6 Provision of habitats for wild plants and animals

#### Austria

##### Indicators and data used for the assessment:

- Concerned area (area of Natura 2000 habitats and riparian forest area) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic value in €/yr (2023)

##### Main results:

##### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Concerned area	204.97	ha
		9.6	% of total forested area
	Adjusted unit value	407.73	€/ha/yr
	Total economic value	83,571.48	€/yr

Conclusions for the Living Lab:

- High per-hectare valuation with low overall contribution: Provision of habitats ranks among the highest per-hectare values in the area; however, the spatial extent of forests supplying this service is limited. As a result, the service plays a minor role in the total economic value despite its high unit value. However, it must be noted that only areas with high habitat value were included (i.e., Natura 2000 habitats and riparian forests), while in principle all forest provides habitat of varying quality. Other indicators of biodiversity could help draw a fuller picture.
- Potential for increasing TEV through spatial expansion: Expanding the area capable of providing habitat functions would proportionally increase its contribution to overall economic value. The current marginal share reflects area constraints rather than low societal importance.

**Germany**Indicators and data used for the assessment:

- Concerned area (area of Natura 2000 habitats and riparian forest area) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023), the Alpine area average (AUV<sub>1</sub>)
- Adjusted unit value in €/ha/yr (in 2023), from the primary valuation study conducted in Germany on the national scale (AUV<sub>2</sub>)
- Total economic values in €/yr (2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Concerned area	3026.43	ha
		31.5	% of total forested area
	AUV <sub>1</sub>	395.88	€/ha/yr
	Total economic value (AUV <sub>1</sub> )	1,198,111.44	€/yr
	AUV <sub>2</sub>	1168.76	€/ha/yr
	Total economic value (AUV <sub>2</sub> )	3,537,155.59	€/yr

Conclusions for the Living Lab:

- High local relevance: Habitat provision ranks among the highest valued services on a per-hectare basis under both conservative and upper-bound assumptions. The upper-bound estimate derived from a national primary study doubles the FES value, suggesting that FES are generally underestimated when valued using adjusted Alpine average.
- Adjusted unit value vs. TEV discrepancy: Despite its high unit value, habitat provision contributes a smaller share to the TEV because the forest area dedicated to habitat functions is comparatively limited. This creates a divergence between relative and absolute importance. However, it must be noted that only areas with high habitat value were included (i.e., Natura 2000 habitats and riparian forests), while in principle all forest provides habitat of varying quality. Other indicators of biodiversity could help draw a fuller picture.
- Potential for TEV increase: An expansion of habitat-providing forest area would significantly raise the total



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value of this service. Increasing spatial provision is therefore directly associated with higher aggregate economic value.

## France

### Indicators and data used for the assessment:

- Concerned area (area of Natura 2000 habitats and riparian forest area) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic value in €/yr (2023)

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Concerned area	1,299.60	ha
		5%	% of total forested area
	Adjusted unit value	409.44	€/ha/yr
	Total economic value	532,109.04	€/yr
Thonon	Concerned area	1,333.36	ha
		13.8%	% of total forested area
	Adjusted unit value	409.44	€/ha/yr
	Total economic value	545,930.49	€/yr

### Conclusions for the French Living Labs:

- High unit value with limited contribution to TEV: Habitat provision receives a high per-hectare valuation, reflecting strong societal importance; however, its contribution to total economic value is comparatively minor. This is primarily due to the relatively small spatial extent of forest areas supplying this service. However, it must be noted that only areas with high habitat value were included (i.e., Natura 2000 habitats and riparian forests), while in principle all forest provides habitat of varying quality. Other indicators of biodiversity could help draw a fuller picture.
- Potential for TEV increase: Expanding habitat-relevant forest areas would proportionally increase its economic significance. Current patterns suggest that the low total contribution arises from limited area rather than limited societal valuation.

## Italy

### Indicators and data used for the assessment:

- Concerned area (area of Natura 2000 habitats and riparian forest area) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic value in €/yr (2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Concerned area	43,355.88	ha
		100%	% of total forested area
	Adjusted unit value	356.85	€/ha/yr
	Total economic value	15,471,732.06	€/yr

Conclusions for the Living Lab:

- High local relevance: Habitat provision is among the most valued services on a per-hectare basis, rounding up three most socially valuable regulating FES.
- Biggest contributor to TEV: As the entire area of the LL is a designated Natura 2000 habitat, high social relevance per ha is consistently reflected in the contribution of the FES to the total economic value of the forest area.
- Overlap with other services: Habitat provision forest area has a 100% overlap with timber provision and carbon sequestration, indicating potential conflicts and suggesting the importance of a multifunctional approach in forest management.

### 4.3.7 CO<sub>2</sub> storage and sequestration in forests

#### Indicators and data used for the economic assessment:

- Total forest area in ha
- Mean sequestered carbon in tCO<sub>2</sub>/ha
- Average price on Italian carbon voluntary market in €/tCO<sub>2</sub> and in €/ha, adjusted to inflation, using consumer price index (VCMP)
- Upper-bound price in €/tCO<sub>2</sub> and in €/ha of the price range recommended by the High-Level commission on Carbon Prices to limit temperature rise to well below 2°C adjusted to the economic conditions in Italy, using PPP conversion factor (RCP, upper-bound)
- Total economic values in €/yr (2023)

## Austria

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Total forest area	2126.66	ha
	Mean sequestered carbon	5.49	tCO <sub>2</sub> /ha
	VCMP	18.88	€/tCO <sub>2</sub>
		103.67	€/ha
	Total economic value (VCMP)	220,481.01	€/yr
	RCP, upper-bound	97.60	tCO <sub>2</sub> /ha
		535.88	€/tCO <sub>2</sub>
	Total economic value (RCP, upper-bound)	1,139,645.43	€/yr

### Conclusions for the Living Lab:

- High valuation sensitivity to carbon pricing assumptions: Valuation outcomes differ substantially depending on whether voluntary carbon market pricing or recommended carbon pricing is applied. Using recommended prices increases the unit value from the lower range (below timber values) to the third highest valued FES among all regulating services.
- Strong influence on TEV composition: Under voluntary pricing, CO<sub>2</sub> sequestration contributes 18% to total economic value; under recommended pricing, it rises to 46%, however, does not significantly increase the total economic value of the LL forests.
- Spatial overlap with timber and habitat provision: The same forest area supplies both CO<sub>2</sub> sequestration, habitat provisioning and timber provisioning services. Management strategies oriented strongly toward timber extraction therefore carry implications for carbon-related social value, particularly under the higher recommended carbon price scenario. At the same time, strategies aimed at capturing the value of carbon sequestration should not conflict with biodiversity and reduce value of habitats.

## France

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Total forest area	26208.82	ha
	Mean sequestered carbon	3.10	tCO <sub>2</sub> /ha
	VCMP	18.96	€/tCO <sub>2</sub>
		58.83	€/ha
	Total economic value (VCMP)	1,541,961.754	€/yr
	RCP, upper-bound	98.01	tCO <sub>2</sub> /ha
		304.11	€/tCO <sub>2</sub>
	Total economic value (RCP, upper-bound)	7,970,254.08	€/yr
Thonon	Total forest area	9696.21	ha
	Mean sequestered carbon	2.26	tCO <sub>2</sub> /ha
	VCMP	18.96	€/tCO <sub>2</sub>
		42.90	€/ha
	Total economic value (VCMP)	415,939.15	€/yr
	RCP, upper-bound	98.01	tCO <sub>2</sub> /ha
		221.73	€/tCO <sub>2</sub>
	Total economic value (RCP, upper-bound)	2,149,950.00	€/yr

Conclusions for the French Living Lab:

- High valuation sensitivity to carbon pricing assumptions: Conservative valuation based on voluntary carbon market pricing places CO<sub>2</sub> sequestration among the lower-valued services per hectare. When upper-bound recommended carbon pricing is applied, its per-hectare value rises significantly, positioning it among the three and five most valuable regulating services in Annecy and Thonon Living Labs respectively.
- Influence on total economic value: CO<sub>2</sub> sequestration contributes substantially to total economic value under upper-bound pricing scenarios, reflecting its high societal importance when climate mitigation considerations are accounted for.
- Overlap with provisioning areas: The forest area providing carbon sequestration fully coincides with zones supplying timber and partially overlaps with other FES. Management strategies oriented primarily toward timber or other provisioning services may therefore affect the overall social value of carbon storage.

**Germany**Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Total forest area	9599.28	ha
	Mean sequestered carbon	8.06	tCO <sub>2</sub> /ha
	VCMP	18.33	€/tCO <sub>2</sub>
		147.73	€/ha
	Total economic value (VCMP)	1,418,107.26	€/yr
	RCP, upper-bound	94.76	tCO <sub>2</sub> /ha
		763.61	€/tCO <sub>2</sub>

D.2.3.2: Transnational Collaboration Report on Ecological / Economic Valuation of Forest Ecosystem Services

	Total economic value (RCP, upper-bound)	7,330,061.93	€/yr
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Conclusions for the Living Lab:

- Sensitivity to pricing assumptions: The valuation of CO<sub>2</sub> sequestration varies substantially depending on the pricing method. Recommended carbon pricing yields a per-hectare value approximately five times higher than voluntary carbon market pricing, while voluntary carbon market values this FES in the same price range as provision of timber wood biomass (using Alpine average estimates)
- Significant TEV contribution: Using pricing compliant with Paris Agreement climate change mitigation targets, CO<sub>2</sub> sequestration accounts for around 44% of TEV, making the principal contributors to total forest value.
- Spatial overlap with timber: The forest area that sequesters carbon fully overlaps with the area used for timber production. Forest management decisions targeting timber extraction therefore directly influence the social value from carbon sequestration.

**Italy**Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Total forest area	43,355.88	ha
	Mean sequestered carbon	3.45	tCO <sub>2</sub> /ha
	VCMP	29.72	€/tCO <sub>2</sub>
		102.63	€/ha
	Total economic value (VCMP)	4,449,597.06	€/yr
	RCP, upper-bound	85.42	tCO <sub>2</sub> /ha
		294.96	€/tCO <sub>2</sub>
	Total economic value (RCP, upper-bound)	12,788,421.37	€/yr

Conclusions for the Living Lab:

- Sensitivity to pricing assumptions: The valuation of CO<sub>2</sub> sequestration varies substantially depending on the pricing method. Recommended carbon pricing yields a per-hectare value almost three times higher than pricing on the Italian voluntary carbon market. Local market values carbon sequestration significantly lower than timber, while pricing compliant with Paris Agreement climate change mitigation targets makes this FES top fourth most socially relevant in the FES portfolio.
- Significant TEV contribution: Using pricing compliant with Paris Agreement climate change mitigation targets, CO<sub>2</sub> sequestration accounts for around 36 % of TEV, making the principal contributors to total forest value.
- Spatial overlap with timber: The forest area that sequesters carbon fully overlaps with the area used for timber production. Forest management decisions targeting timber extraction therefore directly influence the social value from carbon sequestration.

### 4.3.8 Natural hazard prevention, mitigation and control

#### France

Indicators and data used for the assessment of the protection against rockfall:

- Concerned area (protective forest) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023), the Alpine area average (AUV<sub>1</sub>)
- Adjusted unit value in €/ha/yr (in 2023), based on the estimates provided by the 2011 Interreg France–Switzerland Protective Forest (AUV<sub>2</sub>)
- Total economic values in €/yr (2023)

Main results:

Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Concerned area	8688.42	ha
		35.2%	% of total forested area
	AUV <sub>1</sub>	1258.92	€/ha/yr
	Total economic value (AUV <sub>1</sub> )	10,938,027.24	€/yr
	AUV <sub>2</sub>	427.85	€/ha/yr
	Total economic value (AUV <sub>2</sub> )	3,717,357.12	€/yr
	AUV <sub>1</sub>	1258.92	€/ha/yr
	AUV <sub>2</sub>	427.85	€/ha/yr

Conclusions for the French Living Labs:

- High social relevance and sensitivity to valuation method: Data used for adjusted unit value transfer has a big influence on the valuation result, as the more local estimates provide a value more than twice lower than Alpine average. Nevertheless, regardless of the data used, this ecosystem service is among the most socially relevant (per ha) in the LL areas.
- Significant contribution to total economic value in different value scenarios: When upper-bound estimates are used, protection against rockfalls becomes one of the largest contributors to total economic value. This FES valued with the lower local estimates nevertheless is among top three comparable contributors to the conservative TEV.
- No data for concerned forest area was provided for the Thonon Living Lab

#### Germany

Indicators and data used for the assessment of the protection against rockfall:

- Concerned area (protective forest) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic values in €/yr (2023)



Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Concerned area	55.20	ha
		0.58%	% of total forested area
	Adjusted unit value	1,217.24	€/ha/yr
	Total economic value	67,193.83	€/yr

Conclusions for the Living Lab:

- Highest social relevance: Protection against rockfalls exhibits the highest per-hectare value among the assessed services. This reflects the high societal importance attributed to natural hazard mitigation.
- Adjusted unit-value vs. TEV discrepancy: The area supplying this service is very small (55 ha), resulting in a total annual value of approximately 67 thousand euros. Despite the high unit value, the limited spatial extent leads to a minimal contribution to overall TEV.

**Slovenia**Indicators and data used for the assessment of the torrent control:

- Concerned area (40m buffer area around torrents) in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023) of flood control<sup>1</sup>
- Total economic values in €/yr (2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Concerned area	2,806.81	ha
		23.7%	% of total forested area
	Adjusted unit value	839.05	€/ha/yr
	Total economic value	2,355,048.22	€/yr

Conclusions for the Living Lab:

- High social relevance: Torrent control, or flood control, FES is estimated to be the second most relevant (per ha) FES in the area, however, its overall contribution to the total economic value remains moderate, which is rather a reflection of the forest area used for analysis, not the social value of the service. Increasing the size of the buffer area around torrents dedicated to the provision of this service could substantially increase the total economic value of the forests in the area.

<sup>1</sup> As there are no valuation studies looking specifically into torrent control, it was decided to take existing values for the broader FES of flood control.

### 4.3.9 Maintenance of high-quality fresh waters

#### France

Indicators and data used for the assessment:

- Adjusted unit value in €/ha/yr (in 2023), the Alpine area average (AUV<sub>1</sub>)
- Adjusted unit value in €/ha/yr (in 2023), based on the locally used values (AUV<sub>2</sub>) Main

results:

Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy and Thonon	AUV <sub>1</sub>	82.94	€/ha/yr
	AUV <sub>2</sub>	26.72	€/ha/yr

Conclusions for the French Living Labs:

- Sensitivity to valuation method: Unit value and its relative importance in the set of FES is dependent on data choice, as data used locally in the Living Lab areas is more than three times lower than Alpine average value.
- Relatively low social importance: Regardless of the method used, FES is among the least valued ones, losing to most regulating and timber provisioning services.
- Spatial interplay with water provision: Areas offering water filtration often coincide with zones of water provision. This reinforces the importance of considering multiple hydrological services jointly when evaluating management options.

### 4.3.10 Recreation

#### France

Indicators and data used for the assessment:

- Concerned area in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic values in €/yr (2023)

Main results:

Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Concerned area	22,945.33	ha
		87.6%	% of total forested area
	Adjusted unit value	271.22	€/ha/yr
	Total economic value	6,223,320.59	€/yr
Thonon	Concerned area	9409.60	ha
		97%	% of total forested area
	Adjusted unit value	271.22	€/ha/yr
	Total economic value	2,552,107.79	€/yr

Conclusions for Annecy Living Lab:

- Largest contributor to conservative TEV: Recreation contributes the most to the conservative total economic value, reflecting both its relatively high unit value and the substantial forest area that provides this service within Grand Annecy.
- Spatial concentration around key landscape features: Forest areas with higher recreational value per hectare cluster around Annecy Lake and in southern and eastern zones of the region. These patterns highlight the link between recreational demand and specific landscape characteristics.
- Spatial overall with timber: majority of forests with recreational value overlap with productive forest, indicating potential trade-offs and sensitivity of this FES to forest management strategies focusing on timber extraction.

Conclusions for Thonon Living Lab:

- Largest contributor to TEV: Recreation contributes the most to the total economic value in both scenarios (conservative and upper-bound), reflecting both its relatively high unit value and the substantial forest area that provides this service within Thonon.
- Spatial concentration around key landscape features: Forest areas with higher recreational value per hectare cluster around Ripaille Forest (Forêt de Ripaille), in the southern tip of Agglomeration where residents and visitors can access Thonon Forest, and in a few residential areas. These patterns highlight the link between recreational demand and specific landscape characteristics.
- Spatial overall with timber: majority of forests with recreational value overlap with productive forest, indicating potential trade-offs and sensitivity of this FES to forest management strategies focusing on timber extraction.

**Germany**Indicators and data used for the assessment:

- Concerned area in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic values in €/yr (2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Concerned area	4,822.08	ha
		50.2%	% of total forested area
	Adjusted unit value	262.24	€/ha/yr
	Total economic value	1,264,558.04	€/yr

Conclusions for the Living Lab:

- Substantial share of TEV: Recreation represents 23% of TEV under conservative assumptions, reflecting the extensive area of forest accessible for recreational use. The magnitude of this contribution is driven by spatial availability rather than high per-hectare values.
- Spatial heterogeneity: Per-hectare recreational value is unevenly distributed, with only a few areas approaching the expected average. Most forest areas fall below this benchmark, indicating significant



- Spatial overlap with timber: 50% of forests with recreational value overlap with productive forest, indicating potential trade-offs and sensitivity of this FES to forest management strategies focusing on timber extraction.

## Italy

### Indicators and data used for the assessment:

- Concerned area in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic values in €/yr (2023)

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Concerned area	19,879.04	ha
		45.9%	% of total forested area
	Adjusted unit value	236.39	€/ha/yr
	Total economic value	4,699,196.08	€/yr

### Conclusions for the Living Lab:

- Moderate social relevance in the overall portfolio of FES: Although the unit value is relatively high, as this FES consistently remains within top four most highly valued services, the total contribution to TEV is relatively small. This is regardless of the fact that almost half of the total forest area provides this FES, which is a reflection of both comparatively moderate per unit value (compare to the value per ha of protection against rockfall, which is 1098 €/ha) and relatively moderate size of forest valuable for recreation, while three (out of five) other FES with similar per unit value occupy total forest area.
- Spatial overlap: 46% overlap with timber provision, carbon sequestration and habitat provision could cause significant conflicts in forest management, as focus on one of these FES could cause trade-offs in their provision and trigger a dramatic loss in the total economic value of the forest.

## Slovenia

### Indicators and data used for the assessment:

- Concerned area in ha and % of total forested area
- Adjusted unit value in €/ha/yr (in 2023)
- Total economic values in €/yr (2023)

### Main results:

#### Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Concerned area	4,414.47	ha

		37.3%	% of total forested area
	Adjusted unit value	216.38	€/ha/yr
	Total economic value	955,220.45	€/yr

Conclusions for the Living Lab:

- Moderate social relevance in the overall portfolio of FES: Depending on the valuation scenario, the social value per ha ranges between top fourth and sixth FES in the portfolio, losing to carbon sequestration and timber provision in upper-bound scenario.
- Marginal contribution to total economic value: Irrespective of valuation scenario, this FES remains a consistently marginal contributor to TEV, ranging between 5 and 9%.

**4.3.11 Aesthetic value****France**Indicators and data used for the assessment:

- Adjusted unit value in €/ha/yr (in 2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Annecy and Thonon	Adjusted unit value	94.42	€/ha/yr

Conclusions for the French Living Lab:

- Relatively low social relevance: The value of this FES is at the upper range of the least valued FES in both areas. However, this FES is highly dependent on the local context and estimation provided by adjusted value transfer might be a serious underestimation.

**Italy**Indicators and data used for the assessment:

- Adjusted unit value in €/ha/yr (in 2023)

Main results:

## Status of forest ecosystem service

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Adjusted unit value	82.29	€/ha/yr

Conclusions for the Living Lab:

- Relatively low social relevance: The value of this FES is at the upper range of the least valued FES. However, this FES is highly dependent on the local context and estimation provided by adjusted value transfer might be a serious underestimation.

## 4.4 Transnational conclusions for the Alpine area

In this chapter conclusions from a transnational perspective are drawn on the living lab insights. There may be similarities but also differences between the different areas. As a matter of course, such a transnational perspective has to consider different ecological and social conditions in the living labs. Therefore the conclusions are based mainly on values which are calculated on a comparable basis, such as per hectare, per year.

As the living lab areas are of very different size, values for total areas are not very significant, as they depend mainly on the forest area which was assessed.

However, some main observations are possible and could offer other Alpine areas some insights which ecosystem services are of particular importance and would be easier to increase or implement their maintenance.

### Timber wood biomass

#### Biophysical assessment

The production output of the forest is primarily determined by the provision of wood as a raw material. The wood obtained during felling can be categorised as stem wood, energy wood, industrial wood and non-utilisable wood. Sustainable timber production and utilisation ensures that the amount of timber harvested does not exceed the annual growth. This ensures a constant supply of the raw material.

*A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.*

#### Economic assessment

Timber wood provision of the different forest types is generally one of the most valuable FES in all pilot areas. However, often timber provision has a moderate contribution only to the total economic value for society. It is less valuable than regulating services (such as natural hazard mitigation, carbon sequestration). This becomes evident when sensitivity is particularly high, and market prices exceed Alpine average values, such as in Austria, Germany and Slovenia.

The table below (Table 2) gives an overview of main similarities and differences of the social value of timber provision in the five different living lab areas.

Table 2 Comparison of timber provision

Living Lab country	Direct market value (€/ha/yr)	Adjusted unit value (€/ha/yr)	Contribution to forest total economic value (TEV)	Sensitivity to valuation method
<b>Austria</b>	314.61	173.74	High contribution to TEV: timber is estimate about 30% of TEV.	High: market prices exceed average Alpine values
<b>France</b>	?	174.46	Moderate contribution to TEV: regulating services are clearly more valuable	<i>No market prices available</i>
<b>Germany</b>	461.92	168.69	Moderate contribution to TEV : timber is largest single contributor, contributing with less than 30%.	High: value increases three-fold when local market prices are applied
<b>Italy</b>	175.45	152.06	Moderate contribution to TEV, contributing with about 20 % to TEV.	Low: values from transfer method meet the local price level

<b>Slovenia</b>	393.72	139.19	Moderate contribution to TEV, contributing with 15–23 % to TEV.	High: value transfer requires great caution as cultural
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Certainly commercial timber production provide always some regulating services as well but a well- balanced forest management is key for avoiding negative trade-offs. In the past forest management has been the origin for the concept of sustainable development, meaning at least, that timber extraction may not exceed natural increment.

### **Firewood biomass**

#### *Biophysical assessment*

*A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.*

#### *Economic assessment*

The provision of firewood represents within the other FES only a rather minor relevance in terms of social values, even if the economic relevance may appear high, as market values for firewood are generally significantly higher than the adjusted unit values.

Table 3 Comparison of firewood provision

LivingLab country	Direct market value (€/ha/yr)	Adjusted unit value (€/ha/yr)	Contribution to forest total economic value (TEV)	Sensitivity to valuation method
<b>Austria</b>	145.59	17.47	Low contribution to TEV	High: market prices are substantially higher than adjusted unit values.
<b>Germany</b>	62.97	16.96	Low contribution to TEV	High: market prices are about four-times higher than adjusted unit values.
<b>Italy</b>	64.84	15.29	Low contribution to TEV	High: market prices are about four-times higher than adjusted unit values.
<b>Slovenia</b>	23.1	13.99	Low contribution to TEV	High: market prices are about twice than adjusted unit values.

As the social value of firewood is underestimated in all living lab areas, a conclusion across all living labs that also social values of other FES may be underestimated by value transfer.

### **Provision of Non-Wood forest products (NWFP)**

This ecosystem service was analysed in the Italian living lab only, so no comparative analysis can be drawn. Results are presented in chapter 4.3.4.



### Provision of forest spring water

This ecosystem service was analysed in the French living lab only, so no comparative analysis can be drawn. Results are presented in chapter 4.3.5.

### Provision of habitats for wild plants and animals

#### Biophysical assessment

*A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.*

#### Economic assessment

The provision of habitats for wild plants and animals is one of the ecosystem services with the highest per-hectare value. The total value of an area however depends on the surface area and, as near-nature forests with high habitat provision are diminished in favour of commercially used forests, the total values are rather low. An exemption is the Italian living lab with 100% of forests with habitat provision (cf.

Table 4).

From an economic point of view, the increase of near-nature forests in size would increase the total value of forest offering this ecosystem service.

Table 4 Comparison of habitat provision for wild plants and animals

Living Lab country	Adjusted unit value (€/ha/yr)	% of total forested area	FES forest area, hectares	FES economic value for the area €/yr
<b>Austria</b>	407.73	9.6%	204.97	83,571.48
<b>France</b>				
Annecy	409.44	5.0 %	1,299.60	532,109.04
Thonon	409.44	13.8%	1,333.36	545,930.49
<b>Germany</b>				
Waakirchen	395.88 1.168.76	31.5 %	3026.43	1,198,111.44 3,537,155.59
<b>Italy</b>	356.85	100%	43,355.88	15,471,732.06

Explanation of two German values needed.

### CO<sub>2</sub> storage and sequestration in forests

#### Biophysical assessment

The ecosystem service describes the ability of forests to absorb carbon dioxide (CO<sub>2</sub>) from the atmosphere and bind it in the long term. This happens through the process of photosynthesis, in which trees absorb CO<sub>2</sub> and store it in the form of carbon in wood, leaves and roots. The indicator best suited to describe the ecosystem service is ton of carbon per hectare (tC/ha) and describes the amount of carbon (C) that is stored or sequestered per hectare (ha).

*A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.*

### Economic assessment

The valuation of the ecosystem service CO<sub>2</sub> storage and sequestration is very sensitive to the pricing model which is used. The upper-bound prices recommended by the High-Level commission on carbon prices (RCP) are about 10-40 times higher than prices on the voluntary market (VCMP) (cf. Table 5). The first ones are following the objective to limit climate change caused temperature rise below 2°C. Accordingly economic values for this ecosystem service differ significantly and can be the major part of the total economic value (between 36–44%), if RCP prices are applied.

Table 5 Comparison of CO<sub>2</sub> storage and sequestration

Living Lab country	VCMP €/ha	Total economic value (VCMP) €/yr	VCMP €/tCO <sub>2</sub>	RCP, upper-bound €/tCO <sub>2</sub>	Total economic value (RCP, upper-bound) €/yr
<b>Austria</b>	103.67	220,481.01	18.88	535.88	1,139,645.43
<b>France</b>					
Annecy	58.83	1,541,961.754	18.96	304.11	7,970,254.08
Thonon	42.90	415,939.15	18.96	221.73	2,149,950.00
<b>Germany</b>	147.73	1,418,107.26	18.33	763.61	7,330,061.93
<b>Italy</b>	102.63	4,449,597.06	29.72	294.96	12,788,421.37

The forest area that sequesters carbon fully overlaps with the area used for timber production. Forest management decisions targeting timber extraction therefore directly influence the social value from carbon sequestration.

### Natural hazard prevention, mitigation and control

#### Biophysical assessment

The ecosystem service of natural hazard prevention, mitigation and control has been assessed on local and large-scale level. The results of forest ecosystem services assessment and the potential effects of forest management on ecosystem services supply are presented in D2.2.1 Forest Ecosystem services assessment pilot action report and are summarized here.

*A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.*

### Economic assessment

The economic relevance was assessed using Adjusted Unit Values (AUV), the one based on the Alpine average (AUV 1), in case of the French living lab area a second one based on estimations by the 2011 Interreg project France-Switzerland (AUV 2).

Table 6 Comparison of natural hazard prevention, mitigation and control

Living Lab country	AUV1 in €/ha/yr	AUV2 in €/ha/yr
<b>France</b>	1,258.92	427.85
<b>Germany</b>	1,217.24	-
<b>Slovenia</b>	839.05	-

In general, protection against natural hazards exhibits to the highest (FR, DE) or second highest (SI) per- hectare values among the assessed ecosystem services. This reflects the high societal importance attributed to natural hazard mitigation.

### **Maintenance of high-quality fresh waters**

This ecosystem service was analysed in the French living lab only, so no comparative analysis can be drawn. Results are presented in chapter 4.3.9.

### **Recreation**

#### *Biophysical assessment*

The forest ecosystem service recreation refers to the intangible benefits that people derive for their well- being and health from spending time in forest ecosystems. This cultural service includes opportunities for stress reduction, mental and physical regeneration as well as active and passive leisure activities in a natural environment.

*A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.*

#### *Economic assessment*

Recreation as a cultural ecosystem services becomes relevant in forest areas with special landscape amenities such as lakes, rivers, viewpoints, etc. In these cases recreation can contribute significantly to social values. Adjusted Unit Values (AUV) for recreation show the highest values in France (being close to Lake Annecy and agglomeration) and lowest values in Slovenia, maybe because the Tržic area is not so close to the next agglomeration.

Table 7 Comparison of recreation

Living Lab country	AUV in €/ha/yr
<b>France</b>	271.22
<b>Germany</b>	262.24
<b>Italy</b>	236.39
<b>Slovenia</b>	216.38

Generally, in all areas recreation takes place in forests which are also used for timber production or which may be relevant for other ecosystem services. In many cases there could be synergies such as forests offering habitat services may be attractive for regeneration or aesthetic values. If there is a near- nature forest management in place also timber provision and recreation can be in place if there is no direct overlap with forest measures.

### **Aesthetic value**

#### *Biophysical assessment*

A comparative analysis will be part of further refinement and integration until the end of the Forest EcoValue project.

### *Economic assessment*

The aesthetic value of forests, as a cultural service is shows a relatively low social relevance compared to other forest ecosystem services. This is somehow surprising as it is to some extent a cultural service which is condition for recreation which is higher social relevance.

*Table 8 Comparison of aesthetic value*

Living Lab country	AUV in €/ha/yr
<b>France</b>	94.42
<b>Italy</b>	82.29

## 5. Value chain development in the Living labs

### 5.1 Overview of assessed business models

The following table gives an overview of the five living labs and their assessed business models.

Table 9: Overview of assessed business models of the Living Labs.

Living Lab	Business models
Germany - Tegernsee Valley, Upper Bavaria	<p><u>Burial Forest in Buchberg:</u> spiritual and cultural services will be supported through forest cemeteries with biodegradable urns</p> <p><u>Green Initiative in Waakirchen:</u> collaborative public-private partnerships will foster habitat and biodiversity conservation</p>
Austria - Province of Styria	<p><u>Reverse Auction as an Enabling Mechanism:</u> Reverse auctions serve as innovative financing mechanisms that promote biodiversity and habitat provision, as well as carbon sequestration and storage</p>
France - Haute-Savoie	<p><u>Tourism tax:</u> Securing dedicated funding from the Grand Annecy/Thonon tourism tax to co-finance recreational ecosystem services, water regulation services, and mitigate tourism impacts on local forests.</p>
Italy - Valle Tanaro, Piedmont	<p><u>Multifunctional Forest Economy for the Tanaro Valley:</u> Innovative strategies for diversified forest resource valorization, focusing on chestnut groves, non-timber products, carbon/biodiversity credits, and forest/rural heritage experiences.</p>
Slovenia - Karavanke Mountains, municipality Tržič	<p><u>Provision of wood biomass:</u> Sourcing and supplying low-quality wood from Tržič's underutilized forests to establish a local energy market and incentivize active forest management.</p> <p><u>Protection against torrents:</u> Delivering specialized, proactive forest management and monitoring services in upstream forested areas to prevent torrential floods, addressing the critical gap in coordinated preventive measures.</p> <p><u>Recreation and tourism:</u> Developing and managing diverse forest-based recreational and tourism experiences, integrating local products and addressing landowner compensation for public access.</p>

## 5.2 Main outcomes of the assessment in the living labs

### 5.2.1 Reverse auction (Austria)

Reverse auctions are a form of organizing a payment for ecosystem services scheme (PES), where landowners bid the price for providing ecosystem services or implementing sustainable management measures aimed at FES provision. Such a model, which application in environmental management has been growing in the past decades (Kindu et al., 2022), promises higher cost-efficiency, as landowners are invited to state their opportunity costs in the competitive context, i.e., they are motivated not to overestimate their costs. There are many reverse auction types, and discriminatory price auction is considered to be the most fitting one to the context of forests in the Alpine area, due to their high heterogeneity that influences opportunity costs. In such an auction, each bidder that falls within the budget threshold will be paid the price that they asked for. This way it is also possible to include other ecological and social criteria to evaluate the effectiveness of the bid. Our approach also allowed to reward forest owners who already have experience with biodiversity and carbon stability measures, as they are nudged towards thinking about their real opportunity costs, not profit generation, while those who had no prior experience were encouraged to look at their forests differently – through the lens of most biodiverse rich trees and possibilities to implement continuous cover forestry.

In the Austrian Living Lab, we invited all private forest owners of the state of Styria to make their bids for two forest management measures – deadwood/biotope trees and transformation of secondary spruce monocultures into a continuous cover forestry. The first measure was targeting provision of habitats for wild plants and animals; the second measure was targeting CO<sub>2</sub> storage and sequestration through stabilizing the forest ecosystem (i.e., increasing ecosystem resilience, reducing the risk of bark beetle attacks, planting species fitting to new climate, etc.). The criteria used in the evaluation of the applications are provided below for each measure (s. Table 10).

Table 10 Criteria for evaluation of the reverse auction applications.

Measure	Criteria type	Criteria	Rational
Deadwood and biotope trees	Economic	Requested funding	Cost-efficiency
	Ecologic	Duration of tree preservation, min 20 years	Leaving deadwood in forests below 20 years has low ecologic value, while longer commitment to keeping the tree in the forest creates habitat for more plants and animals
		Diameter	Thicker trees create more habitat for plants and animals
		Height	Higher trees create more habitat for plants and animals
		Health status (living and healthy – living and sick – recently dead – rotten)	While sick trees provide more habitat for plants and animals, rotten trees will not stay long in the forest, therefore, provide less ecological value
		Tree species quality	Species that are less common in Styrian forests are encouraged
		Microhabitat abundance	Presence of branches, tree wounds, tree hollows, etc. provides more habitat for plants and animals
	Social	Total size of forest property(ies)	While everyone can participate, forest owners who have higher opportunity costs with less resources to apply for governmental subsidies and other forms of support are prioritized (Engel et al., 2008; Namirembe et al., 2014; Pagiola et al., 2008; Wegner, 2016)

Measure	Criteria type	Criteria	Rational
Transformation of secondary spruce monocultures into a continuous cover forestry	Economic	Requested funding per ha of transformation plot	Cost-efficiency
		Harvesting maturity	Forest plots mature or nearly mature for harvesting are discouraged as the potential possibility of harvest (i.e., clear-cut) in the nearest future undermines the effect of the measure (i.e., transition for clear-cut to continuous cover forestry)
		Slope	Forest plots with steeper slopes might require more management costs in continuous cover forestry regime and are more prone to clear-cutting
	Ecologic	Size of transformation plot	Changing management practice in the bigger area will lead to a bigger impact on carbon stability and resilience in the forest property in question as well as neighbouring properties (i.e., spillover effect)
		Planned diversity, minimum three new tree species	Introduction or natural regeneration of less than three new species will have a negligible effect on carbon stability and management practices
		Diversity concentration (planned diversity/size of transformation plot)	Number of new species introduced should be proportionate to the size of transformation plot to have a meaningful ecological effect
		Tree species quality and fitness to climate change	Species that are less common in Styrian forests are encouraged, while they must be suitable for the plot according to the Dynamic Forest typification of Styria (i.e., future climate change).
		Forest plot instability (height/diameter)	Focusing on forest plots with least stability and resilience to weather events will have larger ecologic impact and ensure stability of the carbon cycle in the changing climate
		Spruce must be unnatural	Focusing on forest plots where spruce is unnatural or will become unnatural due to the climate change will have larger ecologic impact and ensure stability of the carbon cycle in the changing climate
	Social	Total size of forest property(ies)	While everyone can participate, forest owners who have higher opportunity costs with less resources to apply for governmental subsidies and other forms of support are prioritized (Engel et al., 2008; Namirembe et al., 2014; Pagiola et al., 2008; Wegner, 2016)

Forest owners could apply for reverse auction from November 2024 until July 2025. An online application form was distributed online and via information events in cooperation with the Styrian Forest owners' association. Interested forest owners were consulted in phone conversations and via e-mail. Overall, 103 applications were received (71 for deadwood/biotope tree and 32 for transforming a forest plot to continuous cover forestry, with 40 and 6 accepted to evaluation, respectively).

Reversing the auctioning procedure also allows for engagement of unlimited funding sources, from crowdfunding to public money and business donations. In our case, Raiffeisen Landesbank Steiermark donated a sum of money sufficient to successfully fund 15 deadwood/biotope tree projects and one spruce-to-continuous-cover transformation plot. Styrian Forest owners' association stepped in as an

intermediary between the donor and a winning forest owner. The contracting conditions for each measure is presented in Table 11.

Table 11 Conditions for winners of the reverse auction.

Deadwood and biotope trees	Transformation of secondary spruce monocultures into a continuous cover forestry
The applications must be completed by the forest owners themselves, no third parties may be involved and the content of the application may not be passed on to other forest owners or third parties	
Before the ranking is determined, each winning site will be checked to confirm the validity of the information provided in the application; in the event of misinformation, the applicant will be excluded from the current competition and the next best application will take its place	
The successful forest owner must sign a contract with the Styrian Forest owners' association in which the duration of the implementation and the control and monitoring measures are specified	
The one-off payment is transferred via the Styrian Forest owners' association after the contract is signed	
The winner forest owner must allow access for Styrian Forest owners' association to the forest area where a measure(s) is(are) implemented at any time for controlling, after they receive the payment	
Applicants have the option of withdrawing from the contract at any time, on condition that they repay the full amount, except in cases of force majeure	
Duration of the contract is prescribed by the duration stated in the application, however, shall be no shorter than 20 years	A forest owner applies with a specific forest plot within his forest property and declares his willingness to convert it into a mixed forest with continuous management
Images of the trees can be used by the donors in reporting if the forest owner gives their consent	The forest parcel in question must be a secondary spruce monoculture that is less than 60 years old
	Contract duration is 5 years meaning that the transformation must start within this time
	A deadline for the start of the changeover is specified in the contract; if this is not met, the forest owner must give notice and either return the money or set a new date

### 5.2.2 Tourism Tax (France)

#### Business model:

The integrated business model developed for the Grand Annecy Living Lab is the result of a participatory and iterative design process, combining local stakeholder input with technical and economic projection.

Its purpose is to maintain and enhance forest ecosystem services while creating diversified income streams that sustain the forest owner economy and preserve the tourist recreational service. It aims to allocate a share of the tourism tax that has been in place since 2017 to fund actions that support foresters and forests in coping with the impacts of tourism and outdoor activities in the region. It is also a new way of investing in the forest in the context of climate change.

Two possible solutions have been proposed:

- either by increasing the tax by 2 or 3 cents per tourist overnight stay
- or by allocating a percentage of the current tax between 1% and 2% The

model is built on two complementary pillars:

1. **Active land stewardship and climate-smart forest management:** targeted interventions designed to promote a sustainable forest management in order to adapt the forest to climate change



2. **Development of services: deliver measurable impacts on recreational and landscaping features,** biodiversity issues, and other ecosystem services, potentially monetised through the reallocation of tourist tax and reinvestment mechanisms for landscape maintenance.

### **Forest Ecosystem Services**

The Living Lab concentrates on several ecosystem services:

- Leisure and eco-tourism in the forest,
- Production and supply for the forestry and timber industry,
- Preservation of Alpine biodiversity and related species,
- Protection against natural hazards (avalanches, landslides),
- Protection and preservation of water quality,
- Carbon sequestration and reduction of air pollution.

### **Options for the development of value chains and the local implementation of business models:**

The Grand Annecy Living Lab is implementing an integrated business model for Forest Ecosystem Services (FES) through a phased approach, focused on demonstrating early results and scalable impact. Key strategies involve: prioritizing FES and leveraging innovative monitoring; strengthening stakeholder cooperation and governance; integrating FES into sustainable forest management; utilizing tourism tax for funding; ensuring adaptable, long-term planning for climate change; and transparently communicating outcomes.

Implementation proceeds in three stages: **Short-term (1-2 years):** Establishes foundations, pilots initiatives, and secures initial funding (e.g., tourism tax discussions) through dedicated working groups.

**Medium-term (3-6 years):** Scales operations by formalizing governance, launching pilot interventions, and refining technical guidelines, primarily funded by the tourism tax.

**Long-term (7-15 years):** Consolidates actions across forests, diversifies FES markets (e.g., biodiversity), augments funds, and replicates the model regionally, supported by stable tourism tax and robust long-term governance.

### 5.2.3 Burial forests in Living Lab Endlhausen (Germany)

#### Business model

The selected business model in the Living Lab Endlhausen is the establishment and operation of a **burial forest** ("**Kirchlicher Bestattungswald**") at the Buchberg location, operated by the Archdiocese of Munich and Freising ("Erzdiözese München und Freising").

The core service is offering the right to have one's ashes interred in a biodegradable urn at the base of a designated tree within a living forest ecosystem. This model directly addresses the growing societal demand for nature-based, low-maintenance, and spiritually meaningful burial alternatives.

As the operator, the Archdiocese brings a unique value proposition: it combines professional forest stewardship with pastoral care and a mission of preserving creation ("Bewahrung der Schöpfung"). This differentiates it from purely commercial or municipal providers and creates a high level of trust.

#### Forest ecosystem services

The business model mainly focuses on the Aesthetic / spiritual value of nature and is expressed by the FES "Recreation and tourism". The business model makes use of provisioning services (e.g. provision of old trees as burial trees) and conserves other FES, for example maintaining of soil functions and habitats for biodiversity through a reduced and natural forest management.

#### Options for the development of value chains and the local implementation of business models:

During the participation process, several areas of business of interest were identified. After various bilateral consultations, the decision was made in favour of the burial forest. During the decision making process three location alternatives were discussed: The forest at Buchberg and two locations near Sauerlach. The Buchberg area was chosen because it offers the most suitable conditions for establishing a burial forest. The site is characterised by medium-aged to mature mixed forests consisting of spruce, beech, pine, larch, and other species between 101 and 120 years old. The forest also benefits from well-developed infrastructure, including an extensive road network and close proximity to the city of Geretsried. Another topic of debate was whether the forest areas should be leased to a burial forest company or whether the archdiocese should operate the burial forest itself. This point is currently still being discussed internally.

#### Business model archetype

- Service provider model offering a unique solution with elements of "direct sales" and "customer-funded", because the customer finances the service
- Given the operator, it also has strong characteristics of a "mission-driven/social enterprise", where primary goal is fulfilling social/spiritual mission while being sustainable

#### Good practice examples for business models

- **FriedWald® and RuheForst®:** These are the market-leading commercial providers in Germany. They have strong brand recognition, professional marketing, and standardized processes. They serve as the primary benchmark for pricing and service offerings.
- **Bayerische Staatsforsten (BaySF):** As the state-owned forest enterprise, BaySF is also a significant provider of burial forests in Bavaria, leveraging its extensive forest holdings, established forest management expertise, and regional presence.

### 5.2.4 Green Initiative in the Living Lab Waakirchen (Germany)

#### Business model:

The selected business model in the German Living Lab “Waakirchen” is the **"Grüne Initiative" (Green Initiative)**, founded by forest owner L.B.. It is conceived as a mission-driven, community-based organization (potentially a registered association - "eingetragener Verein") in cooperation with local clubs and the municipality.

The initiative is built on two core pillars:

1. **Nature Education:** Offering professional, curriculum-aligned nature-pedagogical tours and workshops in the forest. Target groups include schools, kindergartens, families, and tourists. The focus is on creating a tangible connection to the forest ecosystem and promoting understanding of sustainable forest management.
2. **Public Relations & Advocacy ("Lobbying for the Forest"):** Acting as a voice for the forest and its owners. This pillar aims to raise awareness among the public and local policymakers about the forest's multifunctionality and its ecosystem services (carbon sink, water reservoir, biodiversity hotspot, place of recreation) and the challenges forest owners face (climate change, economic pressure).

The unique value proposition lies in the authenticity of the "forest owner's perspective" and the strong local network.

#### Forest ecosystem services

The "Grüne Initiative" explicitly addresses a comprehensive range of Forest Ecosystem Services (FES) across all categories:

- **Cultural FES:** Directly provided through the Nature Education pillar, offering aesthetic appreciation, spiritual values, recreational opportunities, and a strong educational component. Participants gain a deeper understanding and personal connection to the forest.
- **Regulating FES:** The Public Relations & Advocacy pillar explicitly highlights the forest's role as a "carbon sink," "water reservoir," and its contribution to air purification. By raising awareness and advocating for sustainable forest management, the initiative indirectly supports the long-term provision of these vital services.
- **Supporting FES:** The focus on "provision of habitats for wild animals and plants" directly underscores the importance of biodiversity and the underlying ecological processes that sustain the forest ecosystem. Education about these processes enhances public appreciation.
- **Provisioning FES:** While not directly selling timber or non-wood products, the advocacy for "multifunctionality" includes sustainable resource use.

#### Options for the development of value chains and the local implementation of business models:

The Green Initiative model fits primarily into the following archetypes:

- **Mission-Driven / Social Enterprise:** The primary goal is not profit maximization but achieving social and environmental impact (education, awareness, FES protection)

- Service Provider: The Nature Education pillar operates as a service provider, offering tailored educational tours and workshops.
- Community Platform / Network Orchestrator: Through its cooperation with local clubs and the municipality, and by fostering dialogue between forest owners, the public, and policymakers, the initiative acts as a hub, connecting various stakeholders around a shared interest in the forest.
- Advocacy / Lobbying Organization: The second pillar is explicitly dedicated to advocating for the forest and its owners, influencing public opinion and policy decisions.

#### **Good practice examples for business models**

- Forest experience centers like Walderlebniszentrum Grünwald near Munich
- Environmental education centers like Umweltstation Würzburg
- Nature parks and biosphere reserves
- Adventure farms and farm pedagogy initiatives
- Local chapter of environmental NGOs with specific projects

#### **5.2.5 Multifunctional Forest Economy for the Tanaro Valley (Italy)**

##### **Business model:**

The business model developed for the Valle Tanaro Living Lab is based on the integration of sustainable forest management, value chain diversification and ecosystem service monetisation. Designed through a participatory process, it combines ecological restoration with local economic development, aiming to make climate- and biodiversity-smart forestry financially viable. The model is structured around **two complementary pillars**:

- **Land stewardship and ecosystem service valorisation**, where targeted forest interventions generate measurable environmental outcomes (carbon sequestration, biodiversity enhancement, landscape quality) certified and monetised through voluntary markets or sponsorships;
- **Development of value-added forest-based products and services**, including timber, non-wood forest products (mushrooms, honey, chestnuts) and experiential tourism, whose revenues directly support forest management activities.

The model functions as a circular system where part of the profits from product sales and tourism experiences is reinvested into restoration, certification and monitoring. It promotes cooperation among municipalities, *Associazioni Fondiarie* (ASFOs), forest consortia, community cooperatives and private companies, creating a territorial alliance for forest stewardship.

##### **Forest ecosystem services:**

The main targeted forest ecosystem services are carbon storage and sequestration, provision of biodiversity, recreation and the provision of Non-Wood Forest Products (NWFPs).

##### **Options for the development of value chains and the local implementation of business models:**

There are a lot of good practices and opportunities in the area which support the establishment of the



- Local networks (Chestnut orchard networks, forest landowner associations and consortia, green community)
- Energy and green chemistry sector (District heating in Ormea, Tannins value chains)
- Experiences in carbon markets and biodiversity (Small pilots financing bank foundations)
- Slow tourism and non-wooden products (Presence of parks and natura 2000 habitats, valorization of mushrooms and chestnuts)
- Social innovation and inclusion (Community cooperative and *NuoveRadici* project)

The implementation of the business model is structured in three phases, with the progressive alignment of skills, stakeholders and resources. The initial focus will be on demonstrating concrete results, in order to build trust and attract investments.

- **Phase 1: Foundation and testing (year 1-2)**  
Initial agreements, pilot testing, branding, certification and launch
- **Phase 2 – Scaling and market penetration (year 3-6)**  
Increase of managed surface, product/services development and market activation
- **Phase 3 – Consolidation and innovation (year 7-15)**  
Stabilization of the model, long term agreements, innovation

### 5.2.6 Provision of Wood Biomass (Slovenia)

#### Business model

BDHS are becoming increasingly common due to the use of renewable and local energy sources—primarily wood biomass—and related incentives. In the Municipality of Tržič, no large-scale municipal BDHS currently exist, although the municipality has extensive forest cover, favourable settlement patterns, and a suitable ownership structure for such systems. Strategic municipal documents, including the Local Energy Concept, already reference renewable energy sources and BDHS. Decisions regarding BDHS implementation are typically gradual and based on municipal strategies related to energy self-sufficiency and the green transition. The establishment of a BDHS would create a new market for lower-quality wood in the municipality, offering potential additional income for forest owners, farmers managing overgrown areas, and companies involved in biomass production and supply. Biomass procurement can be organized either by the municipality or by specialized companies. Agreements with forest owners usually take the form of one- or multi-year contracts, defining prices based on quantity and quality, with possible adjustments for inflation. Greater flexibility from the buyer—allowing smaller delivery volumes or flexible delivery schedules—can attract a wider range of forest owners. Beyond economic benefits (additional income for owners and companies, lower heating costs), BDHS systems increase local energy self-sufficiency, reduce carbon footprints, and promote a circular economy.

#### Forest ecosystem service:

The main targeted FES is the provision of Wood Biomass.

#### Options for the development of value chains and the local implementation of business models:

The Tržič Living Lab pursued a comprehensive, phased approach to develop local wood biomass value

D.2.3.2: Transnational Collaboration Report on Ecological / Economic Valuation of Forest Ecosystem Services chains and implement a biomass district heating system (BDHS).

It began by **comprehensively analyzing** municipal biomass potential (using SFS data, WISDOM model, and ownership structures) and demand (municipal plans, local businesses). This was complemented by a thorough review of national legislation (incentives for renewables) and **best practices** from other municipalities regarding BDHS financing, management, and biomass supply chains.

Crucially, the process involved **engaging key local stakeholders**: continuous cooperation with the Municipality supported its Local Energy Concept, and a survey assessed large forest owners' high willingness to supply low-quality wood if a local purchasing system was organized. Interviews with local biomass companies further informed market dynamics.

Awareness-raising activities (local newspaper articles) and a **multi-stakeholder workshop** (including SFS, municipal representatives, forest owners, energy agencies, and best-practice examples) fostered networking, generated ideas, and built consensus for BDHS development.

Future implementation focuses on presenting results regionally, integrating the SFS into energy policies for detailed biomass potential, promoting active and regular forest management among owners, and ensuring continued local cooperation to establish and expand the BDHS long-term. This systematic approach aims to transition from potential to realized BDHS operation, leveraging a well-researched supply chain and strong local buy-in.

### 5.2.7 Protection against torrents (Slovenia)

#### Business Model:

Our business model is not typical; it is more of a payment scheme. Payment schemes linked to FES provide financial incentives to forest owners and managers to deliver not only timber but also other essential FES. These benefits are achieved through forest protection measures, silvicultural practices, restoration activities, watercourse bank stabilization measures, and higher standards of sustainable forest management, which indirectly increase forest resilience. In the context of managing torrential areas, the state and local communities contribute to public benefits—primarily enhancing the safety of people and their property from the harmful effects of torrential floods—by supporting comprehensive management of these areas. Torrent management encompasses several components, including establishing a monitoring system and service that connects key stakeholders, implementing stabilization and restoration measures, promoting resilient and vital forests within torrential areas, and conducting specific interventions for slope and bank stabilization.

#### Forest ecosystem service:

The main targeted FES is the protection against torrents.

#### Options for the development of value chains and the local implementation of business models:

The Tržič Living Lab developed a systematic approach for the **hazard protection FES** through enhanced torrent management, emphasizing collaborative value chain development and local implementation.

#### Value Chain Development:

- **Knowledge Base & Standardization:** The process commenced with a comprehensive review of legislation and best practices, complemented by specialized employee training (Austrian model). This expertise



D.2.3.2: Transnational Collaboration Report on Ecological / Economic Valuation of Forest Ecosystem Services  
was leveraged to co-create a tailored torrent inventory and monitoring

methodology for Slovenian headwater areas, including field forms and a QField application for standardized data collection and assessment of forest conditions around torrents.

- **Economic Justification:** Preliminary assessments estimated SFS personnel and cost requirements, alongside an analysis comparing flood/erosion damages with preventive forest management costs, underscoring the economic importance of proactive measures.
- **Multi-Stakeholder Collaboration:** The value chain involved extensive cooperation among SFS, research institutions, state forests, private companies, and ministries, ensuring an integrated and informed approach to torrent management.

#### Local Implementation:

- **Pilot Application:** The developed methodology was rigorously tested and applied in the Municipality of Tržič, with close involvement of local SFS foresters, to identify critical torrents and propose specific forest management and infrastructure interventions.
- **Awareness & Buy-in:** Public and professional awareness-raising activities (articles, workshops, conferences, educational videos) were crucial for fostering local understanding and support for the initiative.
- **Future Systematization:** Long-term implementation focuses on formalizing the torrent inventory system, integrating management guidelines into SFS planning, securing stable financing for preventive measures, updating relevant legislation, and promoting interdisciplinary training and cooperation to embed proactive torrent management permanently into regional practice.

### **5.2.8 Recreation and tourism (Slovenia)**

#### **Business model:**

The Municipality of Tržič offers exceptional opportunities for recreation and tourism, providing potential income for the local community and its residents. Multiple business models for recreation are possible. The first is in the form of payment schemes designed to incentivize forest owners to improve conditions for recreational use within their forests. Other business models can generate additional income for landowners, such as through parking fees, sales of local products, and related services. Indirect benefits are also possible: appropriate measures reduce conflicts and enable regular forest management by owners.

#### **Forest ecosystem service:**

The main targeted FES is recreation.

#### **Options for the development of value chains and the local implementation of business models:**

The Tržič Living Lab developed value chains for sustainable forest recreation by analyzing visitor behavior and engaging stakeholders. A comprehensive visitor survey (415 responses) provided crucial data on recreational patterns and attitudes.

Value Chain Development Options: The project identified opportunities to develop new services such as structured visitor access (parking, public transport solutions) and proposes controls for mountain forest areas. It also aims to create incentives for forest owners to adapt management for recreation and empower

local residents to generate income from tourism. Technical guidelines are being prepared to professionalize recreational use.

Local Implementation: This involved extensive stakeholder workshops (SFS, forest owners, municipality, tourism) to collaboratively identify challenges and propose solutions. Close cooperation with the Municipality of Tržič facilitated data collection, communication, and event organization. Public and professional awareness campaigns (media, educational videos) built support. Future activities include presenting these models, formalizing visitor access solutions with the municipality, and continuing collaboration with local communities to ensure long-term, adaptive management of recreational FES.

## 5.3 Conclusions for the Alpine area

### Opportunities

#### *Fostering and encouragement of forest ecosystem services*

In the previous chapters the value chain development in the five living lab areas has been presented. The exchange with stakeholder about new value chains in the living labs revealed different opportunities how individually tailored, site-specific business models can be developed which support the maintenance of forest ecosystem services (cf. Table 12).

Table 12 Coverage of forest ecosystem services by proposed business models

Main forest ecosystem services	Timber biomass provision	Firewood biomass	Natural hazard prevention	Carbon sequestration	Biodiversity & habitat provision	Water regulation	Recreation	Aesthetic & spiritual services
Business model								
Reverse Auction (AT)				x	x			
Tourism Tax (FR)	x		x	x	x	x	x	
Burial Forest (DE)					x		x	x
Green Initiative (DE)				x	x		x	x
Multifunctional Forest Economy (IT)				x			x	
Provision of wood biomass (SI)	x	x						
Protection against torrents (SI)			x					
Recreation & tourism (SI)							x	

The table shows that each business model can cover at least one, often multiple ecosystem services. This means, that each business model can contribute to an increase of social value of the forests according to the values presented in chapter 4.4. These interlinkages can be enriched in future by adding good practice examples and offer opportunities for forest owners, what they might do with their forests.

#### *Identification and development of business models*

There is a much broader portfolio of business options available for forest owners as timber production. A diversification of the “product portfolio” of forest owners may offer economic stability and resilience. The opportunity is to widen the perspective and develop a broader business portfolio. This could be also an option of sharing portfolio components within owner associations. Such as different owners in a geographic neighbourhood offer different business components and share revenues.

If read from the ecosystem service columns, the Table 12 would also allow to look for suitable business models, which can foster specific forest ecosystem services.

#### *Stakeholder involvement and governance development*

The participative approach in the living labs certainly offers closer contact to stakeholder and decision maker for a longer time period. It offers the side effect that interaction between different, and sometimes unknown, stakeholder new decision processes and governance styles are developed.

#### **Challenges**

Certainly the business model approaches and development processes include also challenges, which are briefly listed below.

#### *Knowledge, ecosystem service data and assessment*

The framework for developing business models based on forest ecosystem services require certain knowledge, the access to appropriate forest data and the capability to perform an assessment. This may be a challenge, if people are completely new to this field. A starting point can be the guideline, which was developed in course of this project, the support of forest experts.

#### *Climate change effects*

Forests in the Alpine area will undergo severe changes of their environmental conditions due to climate change, and by this they are affected by related challenges. Again here, the “inactivity option” may be the most vulnerable and risky one.

#### *Business model selection and development*

The selection of an appropriate, site-specific and successful business model and its development contain the general enterprise's risk. However, the business diversification may also be an opportunity at the same time.

#### *Investments in the participation process*

The process to develop new business ideas and involving relevant stakeholder is consuming time and energy, which may challenge those being the entrepreneurs in this field.

## 6. Conclusion for transnational collaboration with institutions

In this chapter we draw some conclusions how the approach and the results of the ForestEcoValue project might support the collaboration and the objectives of selected transnational institutions in the Alpine area.

We have selected institutions which could support also a transnational collaboration supporting the maintenance of mountain forests and sustainable value chains for them. In the subchapters we will address selected main objectives of the institution, potential support of the ForestEcoValue approach and some indications for opportunities of the institution's objectives.

The institutions addressed are:

- Alpine Convention Working Group Mountain Forest and Agriculture
- Alpine Convention Alpine Climate Board
- Alpine Convention Alpine Biodiversity Board
- EUSALP AG 6 Resources
- EUSALP AG 7 Green infrastructure
- EUSALP AG 8 Risk Governance

The conclusions for transnational collaboration are presently going to be suggested to the respective bodies of the Alpine Convention and EUSALP before being published. Therefore the chapters 6.1 and 6.2 will be not presented in version 1 but will be part of the final version.