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Alpine Space

Forest EcoValue

TRANSNATIONAL COLLABORATION REPORT ON ECOLOGICAL / ECONOMIC VALUATIONOFFORESTECOSYSTEM SERVICES

D.2.3.2

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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 – Regiona lfinancial 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 – Zavodza Gozdove Slovenije [ZGS]
PP6. Institute for Environmental Planning and Spatial Development GmbH & Co. KG – Institut für Umweltplanungund Raumentwicklung GmbH&Co.KG [ifuplan]
PP7. Lombardy Green Chemistry Association – Cluster Lombardo della Chimica Verde [LGCA]
PP8. University of Graz, Institute of Environmental Systems Sciences [UNIGRAZ]
PP9. Regional Centre for Forest Property Auvergne-Rhône-Alpes – Centre Régional de la Propriété Forestiére [CNPF]
PP10. The French National Forest Office – Office National des Forêts [ONF]
PP11. Hozcluster Steiermark – Woodcluster Styria [HCS]

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Glossary

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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 exchangebetweenprojectpartners on theirexperiences in the livinglabswillbe 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_2 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 schemesfor FESarewidelydiscussedbutrarelysuccessfullyapplied.

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.

TheprojectfocusesonasubsetofFESfromthefollowingcategories:

- **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_2 absorption) concretely working on carbon and biodiversity credits, natural risk management through protective forests, and innovativeenvironmentalfinanceinstrumentssuch as greenbonds and reverseauctions.
- **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 andrepresentingdiverse ecologicaland socio-economiccontexts:

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

biodiversity credits, and fosteringexperientialactivities 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 regulationservices throughapublic-privatepartnership.
- **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 sustainabletourismandrecreationaluse offorests.
- **Austria – Province of Styria:** The Styrian LL concentrates on biodiversity and habitat provision and carbonsequestration andstoragethroughinnovative financingmechanisms 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 conservationthroughcollaborative public–private partnerships.

Accordingly, the projectis aimingto:

- MapandanalysetheAlpine SpaceforestsdeliverycapacityofFES;
- Identify and estimate the economic potential, define business models and FES market frameworks;
- Test the models/toolsdeveloped by the consortiumin pilot LLs involvinglocalplayers;
- Compareresults at transnationallevel, identifyingobstacles andfacilitatingfactors;
- 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 marketsandvaluechainswhilesafeguardingtheprovisionofecosystemservicesintheAlpineSpace.

Projectduration: 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 alpineareas 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 actingas animportant CO_2 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_2 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^2 in the northern French Pre-Alps. Centred on Lake Annecy (27 km^2), 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 annualprecipitation of1,600–1,650mm.

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 ownershipalmostevenlysplitbetweenpublic and communal forestsmanagedby the National Forestry Office (ONF; 42 %) and private forests supported by the National Centre for Forest Ownership (CNPF; 58 %).KeyforestedmassifsincludeSemnoz–ValLaudon, Tournette–Veyrier,andParmelan–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. Deciduousforestsrepresentapproximately65–70%offorestcover,conifers25–30%.Standsaretypically

mixed-aged and two-layered, with natural forests comprising 70–80 % of the area. Average growing stock reaches 300–350 m^3/ha, with an annual increment of 6–7 m^3/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 MunichandFreising,andaprivateforestowner.

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. Elevationsvarysignificantly, fromsites alongthe Tanaroriverbedtopeaks reaching550 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 Maragueis. 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 ml of regional cycling tracks, with a growing agrotourism sector. A unique educational asset is the Forestry School of Ormea, the only Italian publichighschoolofferingprofessionalapprenticeships 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 averagepropertysizeof0.5 ha,complementedbystate(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^3/ha, with an annual increment of 7.87 m^3/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

Thischaptergivesanoverviewoftheforestecosystemserviceswhichhavebeenassessedin theLiving Labs from abiophysical andeconomic perspective. Thechapterpresentsafter anoverview firstthe differentforest ecosystemservices, thenthebusinessmodels andfinally drawssomeconclusionsfroma transnational perspective.

4.1 Overview assessed Forest Ecosystem Services

Thetablebelowprovidesashortoverviewof theforestecosystemservices whichhavebeenselected according tothe localconditions and wereassessedinall livinglabs. Theecosystemservicesaregrouped according to the international classification system in provisioning, regulating and cultural services. In totaleleven, six provisioning, threeregulatingandtwo culturalecosystemservices havebeenassessed.

Table1: Presentation of ashortoverview ofForestEcosystem Servicesinthe Living Labs.

Forest Ecosystem Service	AUSTRIA	FRANCE	GERMANY	ITALY	SLOVENIA
Provisioning ecosystem services					
Provisionoftimberwoodbiomass	X	X	X	X	X
Provisionoffirewoodbiomass	X	X	X	X	X
Provisionoffuelwoodbiomass				X	
ProvisionofNon-WoodForest Products (NWFP)				X	
Provisionof forestspringwater		X			
Provisionofhabitatsforwildplants and animals	X	X	X	X	
Regulating ecosystem services					
CO_2 storage and sequestration in forests/ClimateChangeMitigation	X	X	X	X	
NaturalHazards(rockfalls,torrent) prevention/mitigation/control		X	X		X
Maintenanceofhigh-qualityfresh waters provided by plants and animal species		X	X		
Cultural ecosystem services					
Recreationandtourism		X	X	X	X
Aestheticvalueoftheforest		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.

Thissectionwillundergofurtherrefinementandintegrationuntiltheendoftheforest EcoValueproject.

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.

Theproductionoutputofforestisprimarilydetermined bytheprovisionofwood as arawmaterial. The wood obtainedduringfellingcan be categorised as stemwood,energywood, industrialwoodandnon- utilisable wood. Sustainable timberproductionand utilisationensures thatthe amountoftimber harvesteddoesnotexceed the annualgrowth. Thisensuresaconstantsupplyof the rawmaterial.

Timberwoodbiomassprovisionwillbe presentedforthe livinglabs ofAustria,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.

Firewoodbiomassprovisionwillbe presentedforthe livinglabs ofAustria,Germany,Italyand 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 ensuringspeciesregeneration.NWFPhasbeenanalysedin theItalianLivingLab.

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.

Theecosystemservice of providingdrinkingwaterincludes the naturalfiltration andpurification of water suitable for human consumption. Forests, alongwith wetlands and aquifers, playacrucialrole in maintaining waterquality. Waterprovisionhasbeenanalysed in the French Living Lab.

4.2.6 Provision of habitats for wild plants and animals

Theforestecosystemserviceis describedby the proportionofoldtreesbasedonthe forestmanagement dataof the forestowners andanhabitatqualityindexbasedonthe “Species and Habitats”protected assetmapbythe BavarianState OfficefortheEnvironment(LfU2025).

4.2.7 CO_2 storage and sequestration in forests

The ecosystem service of CO_2 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.

Theecosystemservicedescribes theabilityofforeststoabsorbcarbondioxide (CO_2)fromthe atmosphere and bind it in the longterm. Thishappensthrough the process of photosynthesis, in which treesabsorb $CO_2$and storeitin theformofcarbon inwood, leavesandroots. Theindicatorbestsuitedto describetheecosystem serviceistonofcabonperhetarce(tC/ha)anddescribestheamountofcarbon
(C) thatisstoredorsequestered perhectare(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.

Alargenumberofnaturalhazards canposearisk tohumanhealthandinfrastructure.Forestecosystems can mitigate the effects and ensurethatrockfallsareinterceptedand the triggeringof avalanches is prevented. In addition, treerootsensuregreaterstabilityof the terrain, whichcanpreventslopefailures. Forestsslowdownand protectagainstshallowlandslides andavalanches andcanabsorb 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.

Theforestecosystemservicerecreationrefers to the intangiblebenefitsthatpeoplederive fortheirwell- being and health from spendingtime in forestecosystems. Thisculturalserviceincludes opportunities forstress reduction,mentalandphysicalregenerationaswellasactiveandpassiveleisureactivitiesina 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. Fora detailed presentation of the methodology and the results, please refer to D.2.3.1.

4.3.1 Timber wood biomass

Austria

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinsolidcubicmeter, beforelossesdue toprocessing,estimatedbasedonthe actualloggingdatareported for the Weiz District in solidcubicmeter, beforelosses due to processing (EfminGerman)andyearlyincrementreportedsolidcubicmeterswithoutbark(Vfm in German)
- Totalforestareain ha
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjustedunitvalue(AUV)in€/ha/yr(in2023)
- TotaleconomicvaluesderivedusingDMVandAUVvaluationmethods

Mainresults:

Statusofforestecosystemservice:

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Loggingpotential	10,368	solid cubicmeter, before lossesdue to processing
	Totalforestarea	2,127	ha
	Directmarketvalue(DMV)	314.61	€/ha/yr
	Totaleconomicvalue, DMV	669,069.76	€/yr
	Adjustedunitvalue(AUV)	173.74	€/ha/yr
	Totaleconomicvalue, AUV	369,480.34	€/yr

Conclusions for the Living Lab

- Highrelevance within FESportfolio: Timberwoodprovisionranksamongthe topfive mostvaluable FESin Thannhausen,contributingabout30%ofthetotaleconomicvalue(TEV) ofthe forest ecosystem.
- Relativeimportance:Although timberprovisionhassignificantsocialandeconomicimportance,it remainslessvaluablethankeyregulatingservices(e.g., naturalhazardmitigation,habitatprovision, and carbonsequestration whenusingrecommended carbonpriceestimates).
- Monetaryvaluationsensitivity:Themethodusedstronglyaffectsthevaluationoutcome. Themarket price (MP) approachsuggeststhataverage Alpinevalue(i.e., adjustedunitvalue) underestimatesthe socialvalue oftimberprovision, thoughitsrelativeimportanceremainsmoderate comparedto regulatingservices.At thesametime, adjustedunitvalues of otherFEScouldalsobe underestimated, which necessitates great caution in comparative analysis.
- Overlapwithotherecosystemservices: Theforestareasproducingtimberalsoprovidecarbon sequestrationandotherregulatingand cultural services, meaningthatintensifiedtimber extraction

couldleadtotrade-offsandpotentiallyreduceoverallsocialvalue.Balanced,multifunctional management is therefore essential.

France

Indicatorsanddatausedfor theassessment:

- Totalforestareain ha
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluein€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Totalforestarea	26,208.82	ha
	Adjustedunitvalue	174.46	€/ha/yr
	Totaleconomicvalue	4,572,509.75	€/yr
Thonon	Totalforestarea	9,696.21	ha
	Adjustedunitvalue	174.46	€/ha/yr
	Totaleconomicvalue	1,691,645.43	€/yr

Conclusions forAnnecyLivingLab:

- Moderatebutsecondarycontributor to foresttotaleconomicvalue(TEV): Timberwoodprovision constitutesamodestshareof theforest's TEV in GrandAnnecy. Whileeconomicallyrelevant, its contributionisclearlylowerthanthatofregulatingandculturalservicessuchasrecreation,rockfall protection,andcarbonsequestration.Thissuggestslessrelianceontimberproductionandgreater societal emphasis on non-provisioning services.
- Overlapwithotherecosystemservices: Theforestareasproducingtimberfullyoverlapswiththearea providingcarbon sequestration, almostfullyoverlapswith areasvaluedforrecreation, andpartially overlapswithotherregulatingservices,meaningthatintensified timberextractioncouldleadto trade-offsandpotentiallyreduceoverallsocialvalue.Balanced,multifunctional managementis therefore essential.

Conclusionsfor ThononLivingLab:

- Moderatebutsecondarycontributor to foresttotaleconomicvalue(TEV): Timberwoodbiomass provisionrepresentsarelativelysmallshareof the TEVof forests in Thonon. Whileit maintainsan economicrole as aprovisioningservice, its relative importance is clearlysecondary to thehigh-value regulatingand cultural services documented inthe area.
- Positionwithintheoverall FESportfolio: Timberwoodprovisionhasalowerrelativeunitvaluethan major regulating services, particularlynatural hazard mitigationand habitatprovision. It is also outperformed by carbonsequestrationwhenthelatter is valuedusingupper-boundcarbonpricing, indicatingthat broadersocietalprioritiesplacemoreemphasisonregulatingservicesthanontimber biomass production.
- Overlapwithotherecosystemservices: Theforestareaproducingtimberfullyoverlapswiththearea providingcarbon sequestrationand partially overlapswithother servicessuch as habitatprovision and recreation. Thismeansthatastrongfocus on timberproductioncould createtrade-offs, potentially reducingtheoverall multifunctionalvalueofforestsinThonon. Theresultspointtothe needfor balanced, multifunctionalforest management, as amono-functional focuscould reduce total forest

social value.

Germany

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinsolidcubicmeter, beforelossesdue toprocessing, estimatedbasedonthe actualloggingdatareportedfor Bavariainsolidcubicmeter,before losses duetoprocessing (Efmin German) andyearlyincrementreportedsolidcubicmeterswithoutbark(VfminGerman)
- Totalforestareain ha
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjustedunitvalue(AUV)in€/ha/yr(in2023)
- TotaleconomicvaluesderivedusingDMVandAUVvaluationmethods

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Loggingpotential	46,767	solidcubicmeter,before losses due toprocessing
	Totalforestarea	9,599	ha
	Directmarketvalue(DMV)	461.92	€/ha/yr
	Totaleconomicvalue, DMV	4,434,100.80	€/yr
	Adjustedunitvalue(AUV)	168.69	€/ha/yr
	Totaleconomicvalue, AUV	1,619,281.76	€/yr

Conclusions for the Living Lab:

- Moderatecontributiontoforest TEV: Timberbiomassprovisionaccountsforjust under30%ofthe TEV, making it thelargest single contributoramongtheincluded FESunderconservativeestimates. This outcomeisdrivenprimarilybythesubstantialforestareaallocatedtotimberproductionrather than by high per-unit value.
- Highsensitivity to valuationmethod: Itsunit valueincreasesalmostthreefoldwhenlocalmarket prices areapplied,revealingthatthe Alpineaverage(i.e., adjustedunitvalue) substantially underestimatesits socialandeconomicvalue inBad Tölz. However, relative to upper-boundvalues of otherFES,itsrelative contributiontoTEVstaysunder30%.Atthesametime,adjustedunitvaluesof other FEScould also be underestimated, whichnecessitatesgreatcaution in comparativeanalysis.
- OverlapwithotherFEScreatestrade-offs:Theforestareasupplyingtimberalsofullyoverlapswith carbonsequestrationandpartiallywithotherFES,implyingthatmanagementfocusedprimarilyon timber coulddiminish overallsocialvaluebyundermining higher-valuedregulatingand cultural services.

Italy

Indicatorsanddatausedfor theassessment:

- Loggingpotential in m^3, estimatedfromtheterritorialforestplan
- Totalforestarea
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjustedunitvalue(AUV)in€/ha/yr(in2023)
- TotaleconomicvaluesderivedusingDMVandAUVvaluationmethods

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Loggingpotential	381,461	m^3
	Totalforestarea	43,356	ha
	Directmarketvalue(DMV)	175.45	€/ha/yr
	Totaleconomicvalue, DMV	7,606,789.15	€/yr
	Adjustedunitvalue(AUV)	152.06	€/ha/yr
	Totaleconomicvalue, AUV	6,592,582.16	€/yr

Conclusions for the Living Lab:

- Moderaterelevancewithin FESportfolio: Timberwoodprovisionranksamongthe top fivemost valuable FES, contributinghoweveraround 20% of thetotaleconomicvalue(TEV) of theforest ecosystem,reflectingthebroadersocialimportanceofforestbeyond timberproduction.
- Low monetaryvaluationsensitivity: Bothmarketpricevaluationandvaluetransfergeneratesimilar unit valueperha,onlyslightlyoverestimated byvalue transfer. Thissuggeststhatadjustedunitvalue transfer method provides an estimate aligned with localcontext.
- Overlapwithotherecosystemservices: Theforestareasproducingtimberalsofullyoverlapswiththe carbonsequestrationandhabitatprovisionforest areas, as well as otherregulatingandcultural services, meaningthatintensifiedtimberextractioncould leadtotrade-offsandpotentially dramaticallyreduce overallsocialvalue.Balanced,multifunctionalmanagementistherefore essential.

Slovenia

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinm³,estimatedbasedontheaverageannualloggingrateintheLL(5m³/ha) and the total forest area
- Concernedareainhaand%oftotalforestedarea
- Direct market value (DMV) in €/ha/yr (in 2023)
- Adjustedunitvalue(AUV)in€/ha/yr(in2023)
- TotaleconomicvaluesderivedusingDMVandAUVvaluationmethods

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Loggingpotential	55,006	m³
	Totalforestarea	11,829	ha
		100	%oftotalforestedarea
	Directmarketvalue(DMV)	393.72	€/ha/yr
	Totaleconomicvalue, DMV	4,657,380.81	€/yr
	Adjustedunitvalue(AUV)	139.19	€/ha/yr
	Totaleconomicvalue, AUV	1,646,488.12	€/yr

Conclusions for the Living Lab

- ModerateralevancewithinFESportfolio: Timberwoodprovisionranks amongthetopfivemost valuableFES,however,contributingbetween15and23%ofthetotaleconomicvalue(TEV)ofthe forest ecosystem, depending onthe valuationmethod used.
- Relativeimportance: Although timber provisionhassignificantsocialandeconomicimportance, it remainslessvaluablethankeyregulatingservices(e.g., naturalhazardmitigation,torrentcontrol, habitatprovision, and carbonsequestrationwhenusingrecommendedcarbonpriceestimates) and recreation.
- Monetaryvaluationsensitivity: Themethodusedstronglyaffectsthevaluationoutcome. Themarket price (MP) approachraisesthesocialrelevanceof this FESaboveculturalservices, suggestingthat average Alpinevalue(i.e., adjustedunitvalue) significantlyunderestimatesthesocialvalue of timber provision. At thesametime, adjustedunitvalues of other FEScouldalso be underestimated, which necessitates great caution incomparative analysis.
- Overlapwithotherecosystemservices: Theforestareasproducingtimberalsoprovidecarbon sequestrationandotherregulatingand cultural services, meaningthatintensifiedtimber extraction couldleadto trade-offsandpotentially reduceoverallsocialvalue.Balanced,multifunctional management is therefore essential.

4.3.2 Firewood biomass

Austria

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinsolidcubicmeter, beforelossesdue toprocessing,estimatedbasedonthe actualloggingdatareported for the Weiz District in solidcubicmeter, beforelosses due to processing (EfminGerman)andyearlyincrementreportedsolidcubicmeterswithoutbark(Vfm in German)
- Directmarketvalue in€/ha/yr(in2023)
- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Loggingpotential	3,012	solid cubicmeter, before lossesdue to processing
	Totalforestarea	2,127	ha
	Directmarketvalue	145.59	€/ha/yr
	Adjustedunitvalue	17.47	€/ha/yr

Conclusions for the Living Lab:

- Highsensitivity to valuationmethod: Marketpricevaluationyields asubstantially higher per-hectare estimateforfirewoodthantheadjustedunitvaluetransfer,indicatesthat Alpineaveragevalues(i.e., adjustedunit value) considerablyunderrepresentthe localeconomicrelevance of firewood. At the same time, it suggeststhatsocialvalue of other FESprovided by valuetransfer couldalsobe underestimated.
- Implications for relative social importance: Althoughthe market price valuationincreases the estimated contributionoffirewood, itsrelativepositionwithinthebroader FESspectrumremains belowthatof the dominantregulatingservices. Theservicegains in absolutevaluebutdoesnotshift the overall hierarchy of FES importance.
- No totaleconomicvalue(TEV) analysis: Forestareaprovidingthis FESfullyoverlapswithtimberwood biomassprovision(i.e.,totalforestarea).Meanwhile,onlyasmallsubsetof non-provisioningFES could be valued in TEVterms, andeventhoseestimatesarelikelyunderestimateddue to indicator limitations and datascarcity. To avoid doublecountingand aninflated valuationof provisioning services, thisFESwas excludedfromthe TEVanalysis.

Germany

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinsolid cubicmeter, beforelossesdue toprocessing, estimatedbasedonthe actualloggingdatareportedfor Bavariainsolidcubicmeter,before losses duetoprocessing (Efmin German)andyearlyincrementreportedsolidcubicmeterswithoutbark(VfminGerman)
- Totalforestareain ha
- Directmarketvalue in€/ha/yr(in2023)

- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Loggingpotential	21,980	solid cubicmeter, before lossesdue to processing
	Totalforestarea	9,599	ha
	Directmarketvalue	62.97	€/ha/yr
	Adjustedunitvalue	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 relativeimportance: Regardless of valuationmethod, provision of firewoodbiomassremains secondthelastFESintermsofsocialvalueperha,revealingitsratherlowrelativeimportanceinthe area.
- No totaleconomicvalue(TEV) analysis: Forestareaprovidingthis FESfullyoverlapswithtimberwood biomassprovision(i.e.,totalforestarea).Meanwhile,onlyasmallsubsetof non-provisioningFES could be valued in TEVterms, andeventhoseestimatesarelikelyunderestimateddue to indicator limitations and datascarcity. To avoid doublecountingand aninflated valuationof provisioning services, thisFESwas excludedfromthe TEVanalysis.

Italy

Indicatorsanddatausedfor theassessment:

- Loggingpotential in m^3, estimatedfromtheterritorialforestplan
- Totalforestareain ha
- Directmarketvalue in€/ha/yr(in2023)
- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Loggingpotential	1,004,201	m^3
	Totalforestarea	43,356	ha
	Directmarketvalue	64.84	€/ha/yr
	Adjustedunitvalue	15.29	€/ha/yr

Conclusions for the Living Lab:

- Highsensitivitytovaluationmethod: Marketpricevaluationyieldsasubstantiallylowerper-hectare estimateforfirewoodthantheadjustedunitvaluetransfer,indicatesthat Alpineaveragevalues(i.e., adjustedunit value) considerablyoverestimate relevance of firewood to thelocaleconomy.
- Implications for relative social importance: Regardless of valuationmethod, relative position of the firewoodprovisionFESremains amongthelowest comparedtootherFES.
- No totaleconomicvalue(TEV) analysis: Forestareaprovidingthis FESfullyoverlapswithtimberwood biomassprovision(i.e.,totalforestarea).Meanwhile,onlyasmallsubsetof non-provisioningFES could be valued in TEVterms, andeventhoseestimatesarelikelyunderestimateddue to indicator limitations and datascarcity. To avoid doublecountingand aninflated valuationof provisioning services, thisFESwas excludedfromthe TEVanalysis.

Slovenia

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinm^3,estimatedbasedontheaverageannualloggingrateintheLL(5m^3/ha) and the total forest area
- Totalforestarea
- Directmarketvalue in€/ha/yr(in2023)
- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Loggingpotential	4,140	m^3
	Totalforestarea	11,829	ha
	Directmarketvalue	23.1	€/ha/yr
	Adjustedunitvalue	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 socialvalue of other FESprovided by valuetransfer couldalso be underestimated.
- Implications for relative social importance: Althoughthe market price valuationincreases the estimatedcontributionoffirewood,itsrelativepositionwithinthebroaderFESspectrumremains among the lowest in the FES portfolio.
- No totaleconomicvalue(TEV) analysis: Forestareaprovidingthis FESfullyoverlapswithtimberwood biomassprovision(i.e.,totalforestarea).Meanwhile,onlyasmallsubsetof non-provisioningFES could be valued in TEVterms, andeventhoseestimatesarelikelyunderestimateddue to indicator limitations and datascarcity. To avoid doublecountingand aninflated valuationof provisioning services, thisFESwas excludedfromthe TEVanalysis.

4.3.3 Fuel wood biomass

Austria

Indicatorsanddatausedfor theassessment:

- Loggingpotentialinsolidcubicmeter, beforelossesdue toprocessing,estimatedbasedonthe actualloggingdatareported for the Weiz District in solidcubicmeter, beforelosses due to processing (EfminGerman)andyearlyincrementreportedsolidcubicmeterswithoutbark(Vfm in German)
- Totalforestarea
- Directmarketvalue in€/ha/yr(in2023)
- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Loggingpotential	4,772	solid cubicmeter, before lossesdue to processing
	Totalforestarea	2,127	ha
	Directmarketvalue	85.40	€/ha/yr
	Adjustedunitvalue	93.64	€/ha/yr

Conclusions for the Living Lab:

- Low sensitivity to valuationmethod: Marketpricevaluationand adjustedunitvaluetransferproduce almostidenticalunitvaluesforfuelwood(slightlylowerthanadjustedunitvalue).Thissuggeststhat the Alpine averageestimates capture localconditionswithrelativelylittle distortionforthis specific provisioningservice.
- Lowrelativesocialimportance: ThisFESisvaluedwellbelowotherregulating,culturalandtimber provisioningservices.
- No totaleconomicvalue(TEV) analysis: Forestareaprovidingthis FESfullyoverlapswithtimberwood biomassprovision(i.e.,totalforestarea).Meanwhile,onlyasmallsubsetof non-provisioningFES could be valued in TEVterms, andeventhoseestimatesarelikelyunderestimateddue to indicator limitations and datascarcity. To avoid doublecountingand aninflated valuationof provisioning services, thisFESwas excludedfromthe TEVanalysis.

Italy

Indicatorsanddatausedfor theassessment:

- Loggingpotential in m^3, estimatedfromtheterritorialforestplan
- Totalforestarea
- Directmarketvalue in€/ha/yr(in2023)
- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Loggingpotential	1,618,929	m^3
	Totalforestarea	43,356	ha
	Directmarketvalue	45.87	€/ha/yr
	Adjustedunitvalue	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) considerablyoverestimate relevance of fuelwood to thelocaleconomy.
- Lowrelative socialimportance: Evenwiththeoverestimationof theadjustedunitvaluetransfer, the relativepositionoffuelwoodwithinthebroader FESspectrumremainsbelowthatofthedominant regulatingservices, as wellas timberprovisionandrecreation.Theservicegains in absolutevaluebut does not shift the overallhierarchy of FESimportance.
- No totaleconomicvalue(TEV) analysis: Forestareaprovidingthis FESfullyoverlapswithtimberwood biomassprovision(i.e.,totalforestarea).Meanwhile,onlyasmallsubsetof non-provisioningFES could be valued in TEVterms, andeventhoseestimatesarelikelyunderestimateddue to indicator limitations and datascarcity. To avoid doublecountingand aninflated valuationof provisioning services, thisFESwas excludedfromthe TEVanalysis.

4.3.4 Provision of Non-Wood Forest Products (NWFP)

Italy

Indicatorsanddatausedfor theassessment:

- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Adjustedunitvalue	8.43	€/ha/yr

Conclusions for the Living Lab:

- Relativelylowsocialimportance: This FES is rankedlowestwithintheportfolio of FESvaluatedfor this LL.

4.3.5 Provision of forest spring water

France

Indicatorsanddatausedfor theassessment:

- Volumeofwatercaptured in forestsprings inm^3
- Totalforestareain ha
- Directmarketvaluein€/ha/yr(in2023),estimatedbydeductingthecostsofcapturingwater from a forestspringfrom the averagecosts for capturingwater from othersources

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Watercaptured inforest springs	1,934,046.41	m^3
	Totalforestarea	26,208.82	ha
	Directmarketvalue	15.68	€/ha/yr

ConclusionsfortheAnnecyLivingLab:

- Relativelylowsocialimportance: Provisionof forestspringwater is amongtheleastvalued FES. However, it must be notedthatdirectmarketvaluationbased on therealmarketpricesfor water capturingcouldbe asignificantunderestimationof theoverallsocialvalueofthisFES, as it doesnot account forothernon-marketablebenefitsreceivedfromwatercapturedinforestsprings (i.e.,cheap does not mean less valuable).

4.3.6 Provision of habitats for wild plants and animals

Austria

Indicatorsanddatausedfor theassessment:

- Concernedarea(areaofNatura2000habitatsandriparianforestarea)inhaand%oftotal forested area
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluein€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Concerned area	204.97	ha
		9.6	%oftotalforestedarea
	Adjustedunitvalue	407.73	€/ha/yr
	Totaleconomicvalue	83,571.48	€/yr

Conclusions for the Living Lab:

- Highper-hectarevaluationwithlowoverallcontribution: Provisionofhabitatsranksamongthe highest per-hectarevaluesinthearea;however,thespatialextentofforestssupplyingthisserviceis limited.As a result,theserviceplaysaminorroleinthetotaleconomicvaluedespiteitshighunit value.However,it mustbenotedthatonlyareaswithhighhabitatvalue wereincluded(i.e.,Natura 2000 habitatsand riparianforests), while in principleallforest provideshabitat of varyingquality. Other indicators of biodiversity could help drawafuller picture.
- PotentialforincreasingTEVthroughspatialexpansion: Expandingtheareacapable of providing habitatfunctions wouldproportionallyincreaseits contribution to overalleconomicvalue. The currentmarginalshareреflects areaconstraintsratherthan lowsocietalimportance.

Germany

Indicatorsanddatausedfor theassessment:

- Concernedarea(areaofNatura2000habitatsandriparianforestarea)inhaand%oftotal forested area
- Adjustedunitvaluein€/ha/yr(in2023),the Alpineareaaverage(AUV_1)
- Adjustedunitvaluein€/ha/yr(in2023),fromtheprimaryvaluationstudyconductedinGermany on the national scale (AUV_2)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Concerned area	3026.43	ha
		31.5	%oftotalforestedarea
	AUV_1	395.88	€/ha/yr
	Totaleconomicvalue(AUV_1)	1,198,111.44	€/yr
	AUV_2	1168.76	€/ha/yr
	Totaleconomicvalue(AUV_2)	3,537,155.59	€/yr

Conclusions for the Living Lab:

- Highlocalrelevance:Habitatprovisionranksamongthehighestvaluedservicesonaper-hectare basis underbothconservativeandupper-boundassumptions. Theupper-boundestimatederived froma nationalprimarystudydoublesthe FESvalue, suggestingthat FESaregenerally underestimated when valuedusingadjustedAlpine average.
- Adjustedunitvaluevs. TEVdiscrepancy:Despiteitshighunitvalue, habitatprovisioncontributesa smallershare to the TEVbecausetheforest areadedicated to habitatfunctions is comparatively limited.Thiscreatesadivergencebetweenrelativeandabsoluteimportance.However,itmustbe noted thatonlyareaswithhighhabitatvaluewereincluded(i.e.,Natura2000 habitatsandriparian forests), whileinprinciple allforestprovideshabitatof varyingquality.Otherindicatorsof biodiversity could help draw a fuller picture.
- Potentialfor TEVincrease: An expansion of habitat-providingforestareawouldsignificantlyraisethe total

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

France

Indicatorsanddatausedfor theassessment:

- Concernedarea(areaofNatura2000habitatsandriparianforestarea)inhaand%oftotal forested area
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluein€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Concerned area	1,299.60	ha
		5%	%oftotalforestedarea
	Adjustedunitvalue	409.44	€/ha/yr
	Totaleconomicvalue	532,109.04	€/yr
Thonon	Concerned area	1,333.36	ha
		13.8%	%oftotalforestedarea
	Adjustedunitvalue	409.44	€/ha/yr
	Totaleconomicvalue	545,930.49	€/yr

Conclusions for the FrenchLivingLabs:

- Highunit value withlimitedcontribution to TEV: Habitat provisionreceivesahighper-hectare valuation, reflectingstrongsocietalimportance;however,itscontributiontototaleconomicvalueis comparatively minor.Thisisprimarilyduetotherelatively smallspatialextentofforest areas supplyingthisservice. However, it must be notedthatonlyareaswithhighhabitatvaluewere included(i.e., Natura2000 habitats andriparianforests), while inprinciple all forestprovideshabitat of varyingquality. Otherindicatorsof biodiversity couldhelpdrawafuller picture.
- Potentialfor TEVincrease: Expandinghabitat-relevantforest areaswouldproportionallyincreaseits economicsignificance. Current patterns suggest that the lowtotalcontributionarisesfromlimited area rather than limited societal valuation.

Italy

Indicatorsanddatausedfor theassessment:

- Concernedarea(areaofNatura2000habitatsandriparianforestarea)inhaand%oftotal forested area
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvalue in€/yr (2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Concerned area	43,355.88	ha
		100%	%oftotalforestedarea
	Adjustedunitvalue	356.85	€/ha/yr
	Totaleconomicvalue	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.
- Overlapwithotherservices: Habitatprovisionforestareahasa100%overlapwithtimberprovision and carbonsequestration, indicatingpotentialconflicts andsuggestingtheimportanceof a multifunctional approach in forest management.

4.3.7 CO_2 storage and sequestration in forests

Indicatorsanddatausedfor theeconomicassessment:

- Totalforestareain ha
- MeansequesteredcarbonintCO_2/ha
- Averageprice onItaliancarbonvoluntarymarketin€/tCO_2 andin€/ha,adjustedtoinflation, using consumer price index (VCMP)
- Upper-boundpricein€/tCO_2 andin€/haofthepricerangerecommendedbytheHigh-Level commissiononCarbon Prices tolimittemperature rise towellbelow2 °Cadjusted to the economicconditions in Italy, using PPP conversion factor(RCP, upper-bound)
- Totaleconomicvaluesin€/yr(2023)

Austria

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Thannhausen	Totalforestarea	2126.66	ha
	Mean sequestered carbon	5.49	tCO2/ha
	VCMP	18.88	€/tCO_2
		103.67	€/ha
	Totaleconomicvalue(VCMP)	220,481.01	€/yr
	RCP, upper-bound	97.60	tCO2/ha
		535.88	€/tCO_2
	Totaleconomicvalue(RCP, upper-bound)	1,139,645.43	€/yr

Conclusions for the Living Lab:

- High valuationsensitivitytocarbonpricingassumptions: Valuationoutcomesdiffersubstantially dependingonwhethervoluntarycarbonmarketpricingorrecommendedcarbonpricingisapplied. Using recommendedpricesincreasestheunitvaluefromthelowerrange(belowtimbervalues) to the third highest valued FESamongallregulatingservices.
- StronginfluenceonTEVcomposition:Undervoluntarypricing, CO_2sequestrationcontributes18%to total economicvalue; underrecommendedpricing,it rises to 46%, however, doesnotsignificantly increase the total economic value of the LL forests.
- Spatialoverlapwithtimberandhabitatprovision: Thesameforestareasuppliesboth CO_2 sequestration, habitatprovisioningand timber provisioningservices. Managementstrategiesoriented stronglytoward timberextractionthereforecarryimplicationsforcarbon-relatedsocialvalue, particularlyunderthe higherrecommendedcarbonprice scenario. At thesametime, strategiesaimed at capturingthevalue of carbonsequestrationshouldnotconflictwithbiodiversityandreduce value ofhabitats.

France

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Totalforestarea	26208.82	ha
	Mean sequestered carbon	3.10	tCO2/ha
	VCMP	18.96	€/tCO_2
		58.83	€/ha
	Totaleconomicvalue(VCMP)	1,541,961.754	€/yr
	RCP, upper-bound	98.01	tCO2/ha
		304.11	€/tCO_2
	Totaleconomicvalue(RCP, upper-bound)	7,970,254.08	€/yr
Thonon	Totalforestarea	9696.21	ha
	Mean sequestered carbon	2.26	tCO2/ha
	VCMP	18.96	€/tCO_2
		42.90	€/ha
	Totaleconomicvalue(VCMP)	415,939.15	€/yr
	RCP, upper-bound	98.01	tCO2/ha
		221.73	€/tCO_2
	Totaleconomicvalue(RCP, upper-bound)	2,149,950.00	€/yr

Conclusions for the FrenchLivingLab:

- High valuationsensitivity to carbonpricingassumptions: Conservative valuationbased on voluntary carbonmarketpricingplaces CO_2sequestrationamongthelower-valuedservicesperhectare.When upper-boundrecommended carbon pricing is applied, its per-hectare value rises significantly, positioning it amongthethreeandfivemost valuableregulatingservices in Annecyand Thonon Living Labs respecitvely.
- Influence on totaleconomicvalue: CO_2sequestration contributes substantially to totaleconomic value underupper-boundpricingscenarios,reflectingitshighsocietalimportancewhenclimate mitigation considerations are accounted for.
- Overlapwithprovisioningareas: Theforestareaprovidingcarbonsequestrationfullycoincideswith zones supplyingtimber andpartiallyoverlaps withother FES. Managementstrategies oriented primarily towardtimberorotherprovisioningservicesmaythereforeaffecttheoverallsocialvalueof carbon storage.

Germany

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Totalforestarea	9599.28	ha
	Mean sequestered carbon	8.06	tCO2/ha
	VCMP	18.33	€/tCO_2
		147.73	€/ha
	Totaleconomicvalue(VCMP)	1,418,107.26	€/yr
	RCP, upper-bound	94.76	tCO2/ha
		763.61	€/tCO_2
	Totaleconomicvalue(RCP, upper-bound)	7,330,061.93	€/yr

Conclusions for the Living Lab:

- Sensitivity to pricingassumptions: Thevaluation of CO_2sequestrationvariessubstantiallydepending on thepricingmethod. Recommended carbonpricingyields aper-hectare value approximatelyfive times higherthanvoluntarycarbonmarketpricing, whilevoluntarycarbonmarketvaluesthisFESin thesame pricerange as provisionof timberwoodbiomass(using Alpineaverageestimates)
- Significant TEV contribution: Using pricing compliant with Paris Agreement climate change mitigation targets, CO_2 sequestration accounts for around 44% of TEV, making the principal contributors to total forest value.
- Spatialoverlapwithtimber:Theforestareathatsequesterscarbonfullyoverlapswiththeareaused for timberproduction.Forestmanagementdecisionstargetingtimberextractionthereforedirectly influence the social value from carbon sequestration.

Italy

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Totalforestarea	43,355.88	ha
	Mean sequestered carbon	3.45	tCO2/ha
	VCMP	29.72	€/tCO_2
		102.63	€/ha
	Totaleconomicvalue(VCMP)	4,449,597.06	€/yr
	RCP, upper-bound	85.42	tCO2/ha
		294.96	€/tCO_2
	Totaleconomicvalue(RCP, upper-bound)	12,788,421.37	€/yr

Conclusions for the Living Lab:

- Sensitivity to pricingassumptions: Thevaluation of CO_2sequestrationvariessubstantiallydepending on thepricingmethod. Recommendedcarbonpricingyields aper-hectare value almostthreetimes higher thanpricing on the Italianvoluntarycarbonmarket. Localmarketvalues carbonsequestration significantly lowerthantimber,whilepricingcompliantwithParisAgreement climate change mitigationtargets makesthisFEStopfourthmostsocially relevantintheFESportfolio.
- Significant TEV contribution: Using pricing compliant with Paris Agreement climate change mitigation targets, CO_2 sequestration accounts for around 36 % of TEV, making the principal contributors to total forest value.
- Spatialoverlapwithtimber:Theforestareathatsequesterscarbonfullyoverlapswiththeareaused for timberproduction.Forestmanagementdecisionstargetingtimberextractionthereforedirectly influence the social value from carbon sequestration.

4.3.8 Natural hazard prevention, mitigation and control

France

Indicatorsanddatausedfor theassessmentoftheprotectionagainstrockfall:

- Concernedarea(protectiveforest) in ha and% of totalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023),the Alpineareaaverage(AUV_1)
- Adjustedunitvalue in€/ha/yr(in2023), basedonthe estimatesprovidedbythe2011 Interreg France–Switzerland Protective Forest(AUV_2)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Concerned area	8688.42	ha
		35.2%	%oftotalforestedarea
	AUV_1	1258.92	€/ha/yr
	Totaleconomicvalue(AUV_1)	10,938,027.24	€/yr
	AUV_2	427.85	€/ha/yr
	Totaleconomicvalue(AUV_2)	3,717,357.12	€/yr
	AUV_1	1258.92	€/ha/yr
	AUV_2	427.85	€/ha/yr

Conclusions for the FrenchLivingLabs:

- Highsocialrelevanceandsensitivity to valuationmethod: Dataused for adjustedunitvaluetransfer hasa biginfluenceonthe valuationresult,asthemore localestimatesprovide avaluemorethan twicelower thanAlpineaverage.Nevertheless,regardlessofthedataused,thisecosystemserviceis amongthemost sociallyrelevant(per ha)intheLL 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.
- NodataforconcernedforestareawasprovidedfortheThonon LivingLab

Germany

Indicatorsanddatausedfor theassessmentoftheprotectionagainstrockfall:

- Concernedarea(protectiveforest) in ha and% of totalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Concerned area	55.20	ha
		0.58%	%oftotalforestedarea
	Adjustedunitvalue	1,217.24	€/ha/yr
	Totaleconomicvalue	67,193.83	€/yr

Conclusions for the Living Lab:

- Highestsocialrelevance: Protectionagainstrockfallsexhibitsthehighestper-hectarevalueamong the assessed services. Thisreflectsthehighsocietalimportanceattributed to naturalhazard mitigation.
- Adjustedunit-valuevs.TEVdiscrepancy:Theareasupplyingthisserviceisverysmall(55ha),resulting in a totalannualvalue of approximately 67 thousandeuros. Despitethehighunit value, thelimited spatial extent leads toa minimal contribution to overall TEV.

Slovenia

Indicatorsanddatausedfor theassessmentofthetorrentcontrol:

- Concernedarea(40mbufferareaaroundtorrents) inhaand% of totalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023) offloodcontrol[1]
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tržic	Concerned area	2,806.81	ha
		23.7%	%oftotalforestedarea
	Adjustedunitvalue	839.05	€/ha/yr
	Totaleconomicvalue	2,355,048.22	€/yr

Conclusions for the Living Lab:

- Highsocialrelevance: Torrent control, or floodcontrol,FES is estimated to be the secondmost relevant (perha) FES in thearea, however, itsoverallcontribution to thetotaleconomic value remainsmoderate, which isratherareflection ofthe forestareausedforanalysis, notthesocialvalue oftheservice.Increasing thesizeofthebufferareaaroundtorrentsdedicatedtotheprovisionofthis service could substantially increasethetotaleconomicvalueoftheforestsinthearea.

[1] Astherearenovaluationstudies lookingspecificallyintotorrentcontrol, itwas decidedto takeexistingvaluesfor the broader FES of flood control.

4.3.9 Maintenance of high-quality fresh waters

France

Indicators anddatausedfor theassessment:

- Adjustedunitvaluein€/ha/yr(in2023),the Alpineareaaverage(AUV_1)
- Adjustedunitvaluein€/ha/yr(in2023),basedonthe locallyusedvalues(AUV_2) Main

results:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
AnnecyandThonon	AUV_1	82.94	€/ha/yr
	AUV_2	26.72	€/ha/yr

ConclusionsfortheFrenchLivingLabs:

- Sensitivityto valuationmethod: Unitvalueanditsrelativeimportancein thesetofFES isdependent on datachoice, as datausedlocally in the Living Labareasis morethanthreetimeslowerthan Alpine average value.
- Relativelylowsocialimportance: Regardlessofthe methodused,FESisamongtheleastvalued ones, losing to most regulating and timber provisioning services.
- Spatialinterplaywithwaterprovision: Areas offeringwaterfiltrationoften coincide with zonesof water provision.Thisreinforcestheimportanceofconsideringmultiplehydrologicalservicesjointly when evaluating management options.

4.3.10 Recreation

France

Indicatorsanddatausedfor theassessment:

- Concernedareainhaand%oftotalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Annecy	Concerned area	22,945.33	ha
		87.6%	%oftotalforestedarea
	Adjustedunitvalue	271.22	€/ha/yr
	Totaleconomicvalue	6,223,320.59	€/yr
Thonon	Concerned area	9409.60	ha
		97%	%oftotalforestedarea
	Adjustedunitvalue	271.22	€/ha/yr
	Totaleconomicvalue	2,552,107.79	€/yr

Conclusions forAnnecyLivingLab:

- Largestcontributorto conservative TEV: Recreationcontributesthemost to theconservativetotal economicvalue,reflectingbothitsrelativelyhighunitvalue andthe substantialforestareathat 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 highlightthe linkbetweenrecreationaldemandandspecificlandscapecharacteristics.
- 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.

Conclusionsfor ThononLivingLab:

- Largestcontributor to TEV: Recreationcontributesthemost to thetotaleconomicvalue in both scenarios(conservativeandupper-bound),reflectingbothitsrelativelyhighunitvalueandthe substantialforest areathat providesthis service within Thonon.
- Spatialconcentrationaroundkeylandscapefeatures: Forestareaswithhigherrecreationalvalueper hectareclusteraroundRipailleForest(ForêtdeRipaille),inthesoutherntipofAgglomerationwhere residentsandvisitorscanaccess Thonon Forest, and ina few residentialareas. Thesepatterns highlight the linkbetweenrecreationaldemandandspecificlandscape 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

Indicatorsanddatausedfor theassessment:

- Concernedareainhaand%oftotalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Waakirchen	Concerned area	4,822.08	ha
		50.2%	%oftotalforestedarea
	Adjustedunitvalue	262.24	€/ha/yr
	Totaleconomicvalue	1,264,558.04	€/yr

Conclusions for the Living Lab:

- Substantialshare of TEV: Recreationrepresents 23% of TEVunderconservativeassumptions, reflectingtheextensiveareaof forestaccessibleforrecreationaluse. Themagnitudeof this contributionisdrivenbyspatialavailability ratherthanhigh per-hectarevalues.
- Spatialheterogeneity: Per-hectarerecreationalvalue is unevenlydistributed, withonlya few areas approachingtheexpectedaverage. Mostforestareasfallbelowthisbenchmark, indicatingsignificant

spatial variation in recreational benefits.

- Spatialoverlapwithtimber: 50% of forestswithrecreationalvalueoverlapwithproductiveforest, indicatingpotentialtrade-offsandsensitivity of thisFES to forestmanagementstrategiesfocusingon timberextraction.

Italy

Indicatorsanddatausedfor theassessment:

- Concernedareainhaand%oftotalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Concerned area	19,879.04	ha
		45.9%	%oftotalforestedarea
	Adjustedunitvalue	236.39	€/ha/yr
	Totaleconomicvalue	4,699,196.08	€/yr

Conclusions for the Living Lab:

- ModeratesocialrelevanceintheoverallportfolioofFES:Althoughtheunitvalueisrelativelyhigh,as this FESconsistentlyremainswithintopfour mosthighlyvaluedservices,thetotalcontributionto TEV is relativelysmall. This is regardless ofthefact thatalmosthalfof thetotalforestareaisprovides this FES, which is areflection of bothcomparativelymoderateperunit value(compare to the value per ha of protectionagainstrockfall, which is1098 €/ha) andrelativelymoderatesize of forest valuablefor recreation, whilethree(out of five) other FESwithsimilarperunit valueoccupytotal forestarea.
- Spatialoverlap: 46% overlapwithtimberprovision, carbonsequestrationandhabitat provisioncould causesignificantconflictsinforestmanagement,asfocusononeoftheseFEScouldcausetrade-offs in their provision andtrigger adramatic lossinthetotaleconomic valueoftheforest.

Slovenia

Indicatorsanddatausedfor theassessment:

- Concernedareainhaand%oftotalforestedarea
- Adjustedunitvaluein€/ha/yr(in2023)
- Totaleconomicvaluesin€/yr(2023)

Mainresults:

Statusofforestecosystemservice

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

		37.3%	%oftotalforestedarea
	Adjustedunitvalue	216.38	€/ha/yr
	Totaleconomicvalue	955,220.45	€/yr

Conclusions for the Living Lab:

- Moderatesocialrelevance in theoverallportfolio of FES: Dependingon thevaluationscenario, the social valueperharangesbetweentopfourthandsixthFESin theportfolio, losingto carbon sequestration and timber provision in upper-bound scenario.
- Marginalcontribution to totaleconomicvalue: Irrespective of valuationscenario, this FESremains a consistentlymarginalcontributor to TEV, rangingbetween 5 and 9%.

4.3.11 Aesthetic value

France

Indicatorsanddatausedfor theassessment:

- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
AnnecyandThonon	Adjustedunitvalue	94.42	€/ha/yr

Conclusions for the FrenchLivingLab:

- 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 valuetransfermightbe aseriousunderestimation.

Italy

Indicatorsanddatausedfor theassessment:

- Adjustedunitvaluein€/ha/yr(in2023)

Mainresults:

Statusofforestecosystemservice

Living Lab	Indicator	Value (in 2023)	Unit
Tanaro	Adjustedunitvalue	82.29	€/ha/yr

Conclusions for the Living Lab:

- Relativelylowsocialrelevance:Thevalue of thisFESisat theupperrangeoftheleast valuedFES. However, this FES is highlydependent on the localcontextandestimationprovided by adjustedvalue transfer might be a serious underestimation.

4.4 Transnational conclusions for the Alpine area

Inthis chapterconclusionsfromatransnationalperspective aredrawnon the livinglabinsights. There maybe similaritiesbutalsodifferencesbetweenthedifferentareas. As amatterofcourse, sucha transnational perspectivehas toconsiderdifferentecologicalandsocialconditions inthe livinglabs. Therefore the conclusionsarebasedmainlyonvalues whicharecalculatedonacomparable basis, such as per hectare, per year.

Asthelivinglabareasareofverydifferentsize,valuesfortotalareasarenotverysignificant,asthey depend mainlyonthe forestareawhichwas assessed.

However,somemainobservationsarepossibleandcouldofferother Alpineareassomeinsightswhich ecosystemservicesare of particularimportanceand would be easier to increase or implementtheir maintenance.

Timberwood biomass

Biophysical assessment

Theproductionoutputoftheforestisprimarilydeterminedbytheprovisionofwoodasarawmaterial. The woodobtainedduringfellingcanbecategorisedasstemwood,energywood,industrialwoodand non-utilisablewood. Sustainabletimberproductionand utilisationensuresthat the amount of timber harvesteddoesnotexceedthe annualgrowth. Thisensuresaconstantsupply of the rawmaterial.

Acomparativeanalysiswill be partof furtherrefinementandintegrationuntilthe end of the Forest EcoValue project.

Economic assessment

Timberwoodprovisionof the differentforesttypes is generallyone of the mostvaluable FES inall pilot areas. However, oftentimberprovisionhasamoderatecontributiononly to the totaleconomicvaluefor society. It is lessvaluablethanregulatingservices(such as naturalhazardmitigation, carbon sequestration). Thisbecomes evidentwhensensitivity is particularly high, andmarket pricesexceed Alpineaveragevalues, such as inAustria, Germanyand Slovenia.

Thetablebelow(Table2)givesanoverviewofmainsimilaritiesanddifferences of the socialvalueof timber provision in the five different living labareas.

Table 2 Comparison of timber provision

LivingLab country	Directmarket value (€/ha/yr)	Adjusted unitvalue (€/ha/yr)	Contributiontoforesttotal economic value (TEV)	Sensitivitytovaluationmethod
Austria	314.61	173.74	HighcontributiontoTEV: timberisestimateabout30% ofTEV.	High: marketpricesexceed average Alpine values
France	?	174.46	*Moderate contribution to TEV:regulatingservicesare clearly more valuable*	*No marketpricesavailable*
Germany	461.92	168.69	Moderate contribution to TEV :timberislargestsingle contributer, contributing withlessthan 30%.	High: valueincreasesthree-fold when local market prices are applied
Italy	175.45	152.06	Moderate contribution to TEV,contributingwithabout 20 % to TEV.	Low: valuesfromtransfer methodmeetthelocalprice level

Slovenia	393.72	139.19	Moderate contribution to TEV, contributingwith15–23 % to TEV.	High: valuetransferrequires great caution as cultural

Certainlycommercialtimber productionprovide alwayssome regulatingservices as wellbutawell- balanced forestmanagement is keyforavoidingnegativetrade-offs. In thepastforestmanagementhas been the originfor the concept of sustainabledevelopment, meaning at least, thattimberextractionmay not exceed natural increment.

Firewood biomass

Biophysical assessment

Acomparativeanalysiswill be partoffurtherrefinementandintegrationuntilthe end of the Forest EcoValue project.

Economic assessment

Theprovisionoffirewoodrepresents within the other FESonlyaratherminorrelevance interms ofsocial values, eveniftheeconomicrelevancemayappear high, asmarketvaluesforfirewoodare generally significantly higher than the adjusted unit values.

Table 3 Comparison of firewood provision

LivingLab country	Directmarket value (€/ha/yr)	Adjusted unitvalue (€/ha/yr)	Contributiontoforesttotal economic value (TEV)	Sensitivitytovaluationmethod
Austria	145.59	17.47	Low contribution to TEV	High: market prices are substantiallyhigherthan adjustedunitvalues.
Germany	62.97	16.96	Low contribution to TEV	High : market prices are about four-timeshigherthanadjusted unitvalues.
Italy	64.84	15.29	Low contribution to TEV	High: marketpricesareabout four-timeshigherthanadjusted unit values.
Slovenia	23.1	13.99	Low contribution to TEV	High: marketpricesareabout twicethanadjustedunitvalues.

Asthesocialvalueoffirewoodisunderestimatedinalllivinglabareas,aconclusionacrossalllivinglabs that also socialvalues of other FES may be underestimated by valuetransfer.

Provision of Non-Wood forest products (NWFP)

Thisecosystemservicewasanalysedin the Italianlivinglabonly, so nocomparative analysiscanbe drawn. Results are presentedinchapter 4.3.4.

Provision of forest spring water

Thisecosystemservicewasanalysedinthe Frenchlivinglabonly, so nocomparative analysiscanbe drawn. Results are presentedinchapter 4.3.5.

Provision of habitats forwild plants and animals

Biophysical assessment

Acomparativeanalysiswill be partoffurtherrefinementandintegrationuntilthe end of the Forest EcoValue project.

Economic assessment

Theprovisionof habitats for wildplants and animals is one of the ecosystemserviceswith the highest per-hectarevalue.Thetotalvalueofanareahoweverdependsonthesurfaceareaand,asnear-nature forestswith highhabitatprovisionarediminished infavour of commerciallyusedforests, the totalvalues areratherlow.An exemptionis theItalianlivinglabwith100% offorsests withhabitatprovision(cf. Table 4).

Froman economicpointofview,the increaseofnear-natureforestsinsizewouldincrease the total value offorestofferingthisecosystem service.

Table 4 Comparison of habitat provision for wild plants and animals

Living Lab country	Adjustedunit value(€/ha/yr)	% of total forestedarea	FES forest area, hectares	FESeconomicvalue forthearea€/yr
Austria	407.73	9.6%	204.97	83,571.48
France				
Annecy	409.44	5.0 %	1,299,60	532,109.04
Thonon	409.44	13.8%	1,333.36	545,930.49
Germany				
Waakirchen	395.88 1.168.76	31.5 %	3026.43	1,198,111.44 3,537,155.59
Italy	356.85	100%	43,355,88	15,471,732.06

ExplanationoftwoGermanvaluesneeded.

CO_2 storage and sequestration in forests

Biophysical assessment

Theecosystemservicedescribes theabilityofforeststoabsorbcarbondioxide (CO_2)fromthe atmosphere and bind it in the longterm. Thishappensthrough the process of photosynthesis, in which treesabsorb $CO_2$and storeitin theformofcarbon inwood, leavesandroots. Theindicatorbestsuitedto describetheecosystem serviceistonofcabonperhetarce(tC/ha)anddescribestheamountofcarbon (C) thatisstoredorsequestered perhectare(ha).

Acomparativeanalysiswill be partoffurtherrefinementandintegrationuntilthe end of the Forest EcoValue project.

Economic assessment

Thevaluationofthe ecosystemserviceCO2storageand sequestrationis verysensitive to the pricing model whichisused.Theupper-boundpricesrecommendedbytheHigh-Levelcommissiononcarbon prices(RCP) areabout10-40timeshigherthanpricesonthevoluntarymarket(VCMP)(cf.Table5).The firstonesare followingthe objective to limitclimatechange caused temperature risebelow 2°C. Accordinglyeconomic valuesforthisecosystemservicediffersignificantlyandcanbethemajorpartof thetotaleconomicvalue (between36–44%),ifRCPpricesareapplied.

Table 5 Comparison of CO2 storage and sequestration

Living Lab country	VCMP €/ha	Totaleconomic value (VCMP) €/yr	VCMP €/tCO_2	RCP, upper-bound €/tCO_2	Total economic value (RCP, upper-bound)€/yr
Austria	103.67	220,481.01	18.88	535.88	1,139,645.43
France					
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
Germany	147.73	1,418,107.26	18.33	763.61	7,330,061.93
Italy	102.63	4,449,597.06	29.72	294.96	12,788,421.37

Theforestareathatsequesterscarbonfullyoverlapswiththe areausedfortimber production. Forest managementdecisionstargetingtimberextractiontherefore directlyinfluencethe socialvaluefrom 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.

Acomparativeanalysiswill be partoffurtherrefinementandintegrationuntilthe end of the Forest EcoValue project.

Economic assessment

Theeconomicrelevancewasassessedusing Adjusted Unit Values(AUV), the onebasedon the Alpine average(AUV 1),incaseofthe Frenchlivinglabareaasecondonebasedonestimationsbythe2011 Interregproject France-Switerland(AUV2).

Table 6 Comparison of natural hazard prevention, mitigation and control

Living Lab country	AUV 1 in€/ha/yr	AUV 2 in€/ha/yr
France	1,258.92	427.85
Germany	1,217.24	-
Slovenia	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 Tržica reais not so close to the next agglomeration.

Table 7 Comparison of recreation

Living Lab country	AUV in €/ha/yr
France	271.22
Germany	262.24
Italy	236.39
Slovenia	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
France	94.42
Italy	82.29

5. Value chain development in the Living labs

5.1 Overview of assessed business models

Thefollowingtablegivesanoverviewofthefivelivinglabsandtheirassessedbusinessmodels.

Table9:Overview ofassessed businessmodelsof theLivingLabs.

Living Lab	Business models
Germany - Tegernsee Valley, Upper Bavaria	BurialForestin Buchberg: spiritualandculturalserviceswill besupportedthroughforest cemeteries with biodegradable urns GreenInitiativeinWaakirchen: collaborativepublic–privatepartnershipswillfosterhabitatand biodiversity conservation
Austria- Provinceof Styria	ReverseAuctionasanEnablingMechanism: Reverseauctionsserveasinnovativefinancing mechanismsthat promote biodiversity and habitat provision, as well as carbon sequestration and storage
France - Haute-Savoie	Tourismtax: Securingdedicatedfundingfromthe Grand Annecy/Thonontourism taxto co-finance recreational ecosystem services, waterregulation services, and mitigate tourism impacts on local forests.
Italy - Valle Tanaro, Piedmont	Multifunctional Forest Economy forthe Tanaro Valley: Innovative strategiesfordiversifiedforestresourcevalorization, focusing on chestnut groves, non-timber products, carbon/biodiversity credits, and forest/rural heritage experiences.
Slovenia - Karavanke Mountains, municipality Tržič	Provisionofwoodbiomass: Sourcingandsupplyinglow-qualitywoodfromTržič'sunderutilized forests to establish a local energy marketand incentivize active forest management. Protectionagainsttorrents: Delivering specialized, proactive forestmanagementand monitoring services in upstream forested areas to prevent torrential floods, addressing the critical gap in coordinated preventive measures. Recreationandtourism: Developingandmanagingdiverseforest-basedrecreationaland tourism experiences, integrating local productsandaddressing landowner compensation for public access.

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_2 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 providedbelow for eachmeasure(s. Table 10).

Table 10 Criteria for evaluation of the reverse auction applications.

Measure	Criteria type	Criteria	Rational
Deadwoodand biotopetrees	Economic	Requestedfunding	Cost-efficiency
	Ecologic	Durationoftreepreservation, min 20 years	Leavingdeadwoodinforestsbelow20years has low ecologic value, while longer commitment to keepingthetree in theforest createshabitatformoreplantsandanimals
		Diameter	Thickertreescreatemorehabitatforplants andanimals
		Height	Highertreescreatemorehabitatforplants andanimals
		Healthstatus(livingand healthy –livingandsick– recently dead – rotten)	While sick trees provide more habitat for plants andanimals,rottentreeswillnotstay long in the forest, therefore, provide less ecological value
		Tree species quality	Speciesthatarelesscommon in Styrian forestsareencouraged
		Microhabitatabundance	Presenceofbranches,treewounds,tree hollows,etc.providesmorehabitatforplants and animals
	Social	Totalsizeofforest property(ies)	Whileeveryonecanparticipate,forestowners who have higher opportunity costs with less resources to applyforgovernmentalsubsidies 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
Transformationof secondaryspruce monoculturesintoa continuouscover forestry	Economic	Requestedfundingperha of transformation plot	Cost-efficiency
		Harvesting maturity	Forest plots mature or nearly mature for harvestingarediscouraged asthe potential possibility of harvest (i.e., clear-cut) in the nearest futureunderminestheeffectof the measure (i.e., transition for clear-cut to continuous cover forestry)
		Slope	Forestplotswithsteeperslopesmightrequire moremanagement costs incontinuouscover forestryregimeandaremoreproneto clear-cutting
	Ecologic	Size of transformationplot	Changingmanagementpractice inthebigger area will lead to a bigger impact on carbon stability and resilience in the forest property inquestionaswellasneighbouringproperties (i.e., spillover effect)
		Planneddiversity,minimum three new tree species	Introduction or naturalregeneration of less than threenewspecieswillhaveanegligible effecton carbonstabilityandmanagement practices
		Diversity concentration (planneddiversity/sizeof transformationplot)	Number of newspeciesintroduced should be proportionatetothesizeoftransformation plot to havea meaningfulecologicaleffect
		Treespeciesquality and fitnesstoclimatechange	Species that are less common in Styrian forests are encouraged, while they must be suitablefor theplotaccordingtotheDynamic Forest typification of Styria (i.e., future climatechange).
		Forestplotinstability (height/diameter)	Focusing on forest plots with least stability and resilience to weather events will have larger ecologicimpactandensurestabilityof thecarboncycle in thechangingclimate
		Sprucemustbe unnatural	Focusing on forest plots where spruce is unnaturalorwillbecomeunnaturalduetothe climate change will have larger ecologic impact and ensure stability of the carbon cycle in thechangingclimate
	Social	Totalsizeofforest property(ies)	Whileeveryonecanparticipate,forestowners who have higher opportunity costs with less resources to applyforgovernmentalsubsidies and other forms of support are prioritized (Engeletal., 2008;Namirembeetal.,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 continuouscoverforestry, with 40 and 6 accepted toevaluation, 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 reverseauction.

<table>
<tr><th>Deadwood and biotope trees</th><th>Transformation of secondary spruce monocultures into a continuous cover forestry</th></tr>
<tr><td colspan="2">Theapplicationsmustbe completed by theforestownersthemselves, no thirdpartiesmay be involved andthecontentof the applicationmaynotbepassedontootherforestownersorthird parties</td></tr>
<tr><td colspan="2">Beforetherankingisdetermined, eachwinningsitewillbecheckedtoconfirmthevalidityofthe informationprovidedinthe application; inthe eventofmisinformation, theapplicantwillbeexcludedfromthecurrentcompetitionand thenextbest application will take itsplace</td></tr>
<tr><td colspan="2">Thesuccessfulforestownermustsignacontractwiththe Styrian Forestowners' association in whichtheduration of the implementationand the controland monitoring measuresare specified</td></tr>
<tr><td colspan="2">Theone-offpayment istransferred viathe Styrian Forestowners' associationafterthecontract is signed</td></tr>
<tr><td colspan="2">Thewinnerforestownermustallowaccessfor Styrian Forestowners' association to theforestareawhereameasure(s) is(are) implementedatany timeforcontrolling, aftertheyreceivethepayment</td></tr>
<tr><td colspan="2">Applicantshavetheoption of withdrawingfromthecontract at anytime, on conditionthat theyrepaythefullamount, except incasesofforcemajeure</td></tr>
<tr><td>Duration of thecontractisprescribed by thedurationstated in theapplication, however, shall be noshorter than 20years</td><td>Aforestownerappliesw ithaspecificforestplotwithinhis forestpropertyanddeclareshiswillingnesstoconvertitinto a mixed forest with continuous management</td></tr>
<tr><td>Imagesofthetreescanbeused bythedonorsinreportingif theforestownergivestheirconsent</td><td>Theforestparcel in questionmust be asecondaryspruce monoculturethatisless than 60 yearsold</td></tr>
<tr><td rowspan="2"></td><td>Contractduration is5 yearsmeaningthatthetransformation muststartwithinthistime</td></tr>
<tr><td>Adeadlineforthestartofthechangeover isspecified in the contract; if thisisnotmet, theforestownermustgivenotice andeitherreturnthemoneyorsetanewdate</td></tr>
</table>

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 iterativedesignprocess, combininglocalstakeholderinputwithtechnicalandeconomicprojection.

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 ofinvesting inthe forestinthe context ofclimate change.

Twopossiblesolutionshavebeenproposed:

- eitherbyincreasingthetaxby2or3centspertouristovernightstay
- 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 touristtaxand reinvestment mechanismsfor landscape maintenance.

Forest Ecosystem Services

TheLivingLabconcentrates onseveralecosystemservices:

- Leisureandeco-tourismintheforest,
- Production and supply forthe forestryandtimberindustry,
- Preservation of Alpinebiodiversity and relatedspecies,
- Protectionagainstnaturalhazards(avalanches, landslides),
- Protectionandpreservation of waterquality,
- Carbonsequestrationandreductionof airpollution.

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 communicatingoutcomes.

Implementation proceeds in three stages: **Short-term (1-2 years):** Establishes foundations, pilots initiatives, andsecures initialfunding(e.g., tourismtaxdiscussions)throughdedicatedworkinggroups.

Medium-term (3-6 years): Scales operations by formalizing governance, launching pilot interventions, and refiningtechnicalguidelines, primarily fundedbythe tourismtax.

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 ("ErzdiözeseMünchenundFreising").

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 itfrompurelycommercialormunicipalproviders andcreates ahighleveloftrust.

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 throughareducedandnaturalforestmanagement.

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 "costumer-funded", because the customer finances theservice
- Given the operator, it halso has strong characteristics of a "mission-driven/social enterprise", where primary goalis fulfillingsocial/spiritualmissionwhile beingsustainable

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 primarybenchmark for pricing andservice offerings.
- **Bayerische Staatsforsten (BaySF):** As the state-owned forest enterprise, BaySF is also a significant provider of burial forests in Bavaria, leveragingits extensive forestholdings, established forest managementexpertise, and regionalpresence.

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.

Theinitiativeis builtontwo corepillars:

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 gainadeeperunderstandingand personalconnectionto 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 forestecosystem. Educationaboutthese processes enhancespublicappreciation.
- 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 Initiativemodelfitsprimarlyintothe followingarchetypes:

- Mission-Driven / Social Enterprise: The primary goal is not profit maximization but achieving social and environmentalimpact(education,awareness, FESprotection)

- 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 initiativeacts as ahub, connectingvariousstakeholdersaroundasharedinterest 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

- Forestexperiencecenterslike WalderlebniszentrumGrünwaldnearMunich
- Environmental education centers like Umweltstation Würzburg
- Natureparksandbiosphererereserves
- Adventurefarmsandfarmpedagogyinitiatives
- Localchapterof environmentalNGOswithspecificprojects

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 complementarypillars**:

- **Land stewardship and ecosystem service valorisation**, where targeted forest interventions generate measurable environmental outcomes (carbon sequestration, biodiversity enhancement, landscape quality) certified and monetised throughvoluntary 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, creatingaterritorialalliance forforest stewardship.

Forest ecosystem services:

The main targeted forest ecosystem services are carbon storage and sequestration, provision of biodiversity, recreationand the provisionof 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

business model:

- Local networks (Chestnutorchard networks, forest landowner associations and consortia, green community
- Energyandgreenchemistrysector(Districtheatingin Ormea, Tanninsvaluechains)
- Experiences in carbonmarkets and biodiversity(Smallpilosfinancingbankfoundations)
- Slowtourismandnon-woodenproducts(Presenceofparksandnatura2000habitats,valorization of mushrooms and chestnuts)
- Socialinnovationandinclusion(Communitycooperativeand*NuoveRadiciproject)*

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)**
  Initialagreements, pilottesting, branging, certificationandlaunch
- **Phase 2 – Scaling and market penetration (year 3–6)**
  Increase of managedsurface, product/services development andmarketactivation
- **Fase 3 – Consolidation and innovation (year 7–15)**
  Stabilization of the model, longtermagreements, 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, andpromote acirculareconomy.

Forest ecosystem service:

Themaintargeted FESistheprovisionofWoodBiomass.

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

chains andimplementabiomass district heatingsystem(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, andbiomass supplychains.

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, generatedideas, and builtconsensus 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 torrentential areas, and conducting specific interventions for slope and bank stabilization.

Forest ecosystem service:

Themaintargeted FESisthe protectionagainsttorrents.

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,emphasizingcollaborative valuechaindevelopmentandlocalimplementation.

ValueChainDevelopment:

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

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 collaborationwith 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 forestecosystemservices (cf. Table 12).

Table 12Coverage of forest ecosystem servicesby 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
MultifunctionalForest Economy(IT)				x			x	
Provision of woodbiomass (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 ecosystemservices. 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 offeropportunities for forestowners, whattheymight do withtheirforests.

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 geographicneighbourhoodofferdifferentbusinesscomponentsandsharerevenues.

If read from the ecosystem service columns, the Table 12 would also allow to look for suitable business models,whichcanfosterspecific forestecosystemservices.

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, stakeholdernewdecisionprocesses and governance stylesaredeveloped.

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 incourseofthis project, thesupportof forestexperts.

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, whichmaychallengethosebeing 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 supportthecollaborationandtheobjectivesofselected transnationalinstitutionsintheAlpinearea.

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.

Theinstitutionsaddressedare:

- Alpine ConventionWorkingGroupMountainForestandAgriculture
- Alpine Convention Alpine Climate Board
- Alpine Convention Alpine Biodiversity Board
- EUSALP AG 6 Resources
- EUSALP AG 7 Green infrastructure
- EUSALPAG8RiskGovernance

Theconclusions for transnationalcollaborationare presentlygoing to be suggested to the respective bodies oftheAlpineConventionandEUSALPbeforebeingpublished.Thereforethechapters6.1and6.2 will benot presented in version1 but willbe part ofthe finalversion.