

Interreg



Co-funded by
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Alpine Space

Forest EcoValue

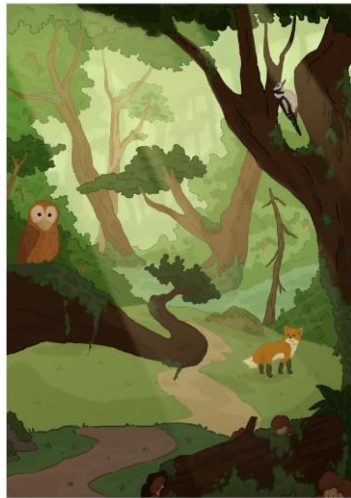
Forest Ecosystem Services Assessement

26/03/2026 – FINAL CONFERENCE

F.Berger, B.Desbuquois & M. Momber INRAE



FES “bio” assessment: a practical framework



Methodology based on Large-Scale Data (LSD)

Why?

- Data sourced from multiple channels

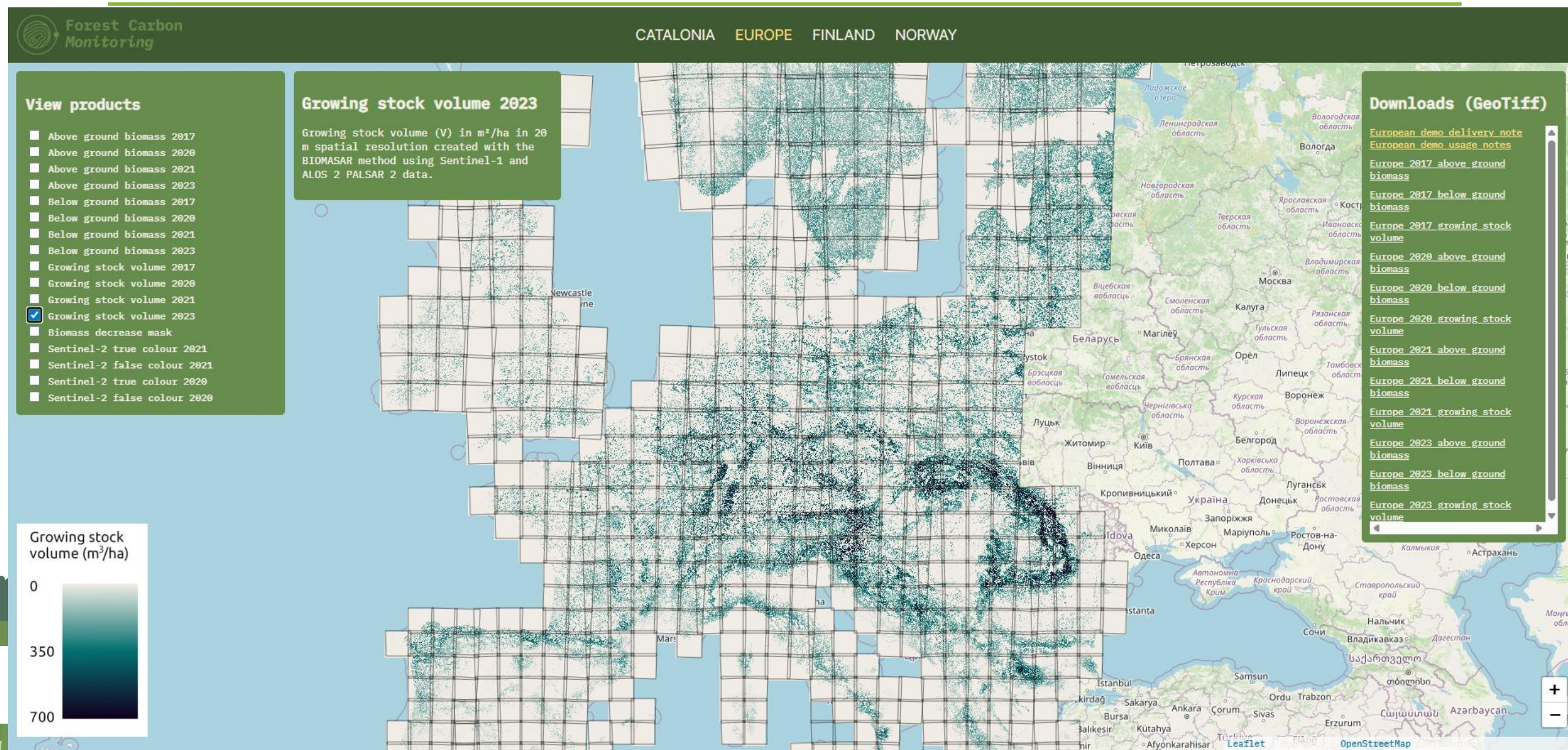


PROGRAMME OF THE
EUROPEAN UNION



- **Harmonized data enabling easy comparison of study sites and their SEF portfolios**
- **European dimension supporting SEF recognition initiatives in EU and regional policies** (see: *Support for a European Mountain Pact*)
- **Aligned with strategic policy decision-making:** long-term perspective, big-picture vision, key priorities, mediation, budget programming – addressing the system as a whole.

Large-Scale Data Examples (1)



Large-Scale Data Examples (2)

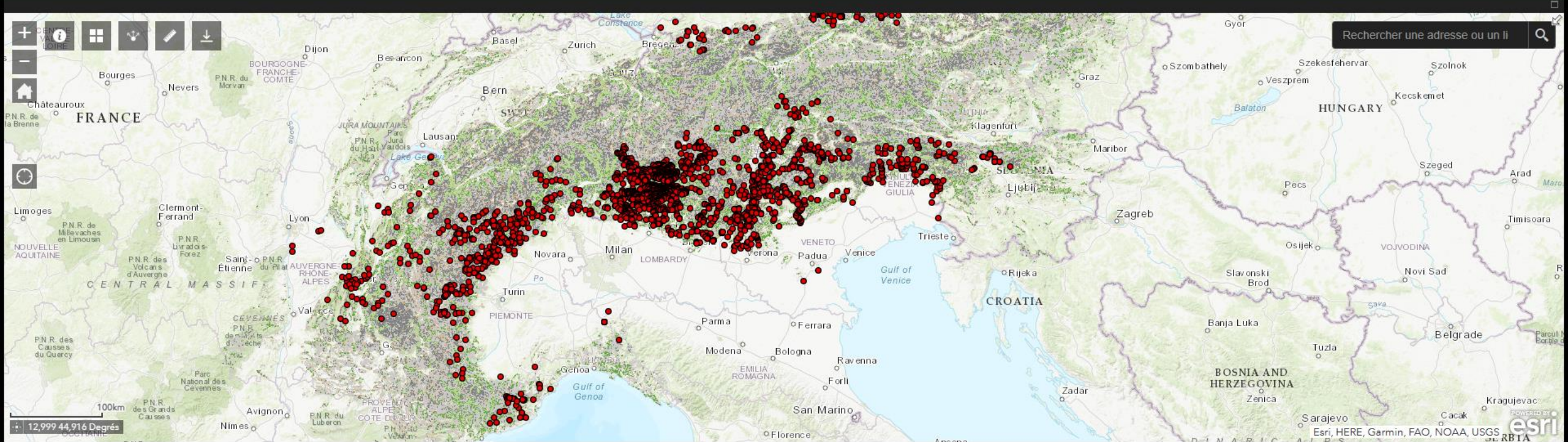


Large-Scale Data Examples (3)



Rockfall database in Alpine Space: past events, rockfall areas & rockfall protection forest

Interreg Alpine Space project "ROCKtheALPS"



About the ROCKtheALPS

The overall objective of the project ROCKtheALPS is to reinforce and strengthen the implementation of rockfall risk prevention policy and mitigation strategy support in line with a sustainable forest management approach. For achieving that objective, the first harmonized rockfall natural risk and protection forest mapping for the entire Alpine Space will be provided. More information about the project: <http://www.alpine-space.eu/projects/rockthealps/en/home>

In order to improve and further develop harmonized rockfall models, there is a need for international cooperation in building up international past events database. If you are interested please contact us: leadpartner - frederic.berger@irstea.fr

- Map layers
- Couches**
- Past rockfall deposits
 - Past rockfall event (release area)
 - Rockfall protection forest
 - Rockfall release area
 - Rockfall propagation area

Last update: 25.11.2019

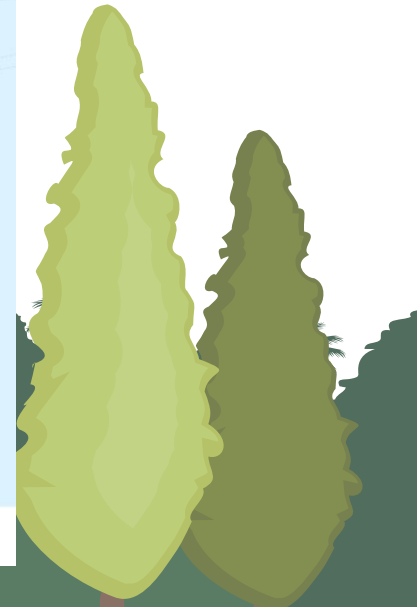
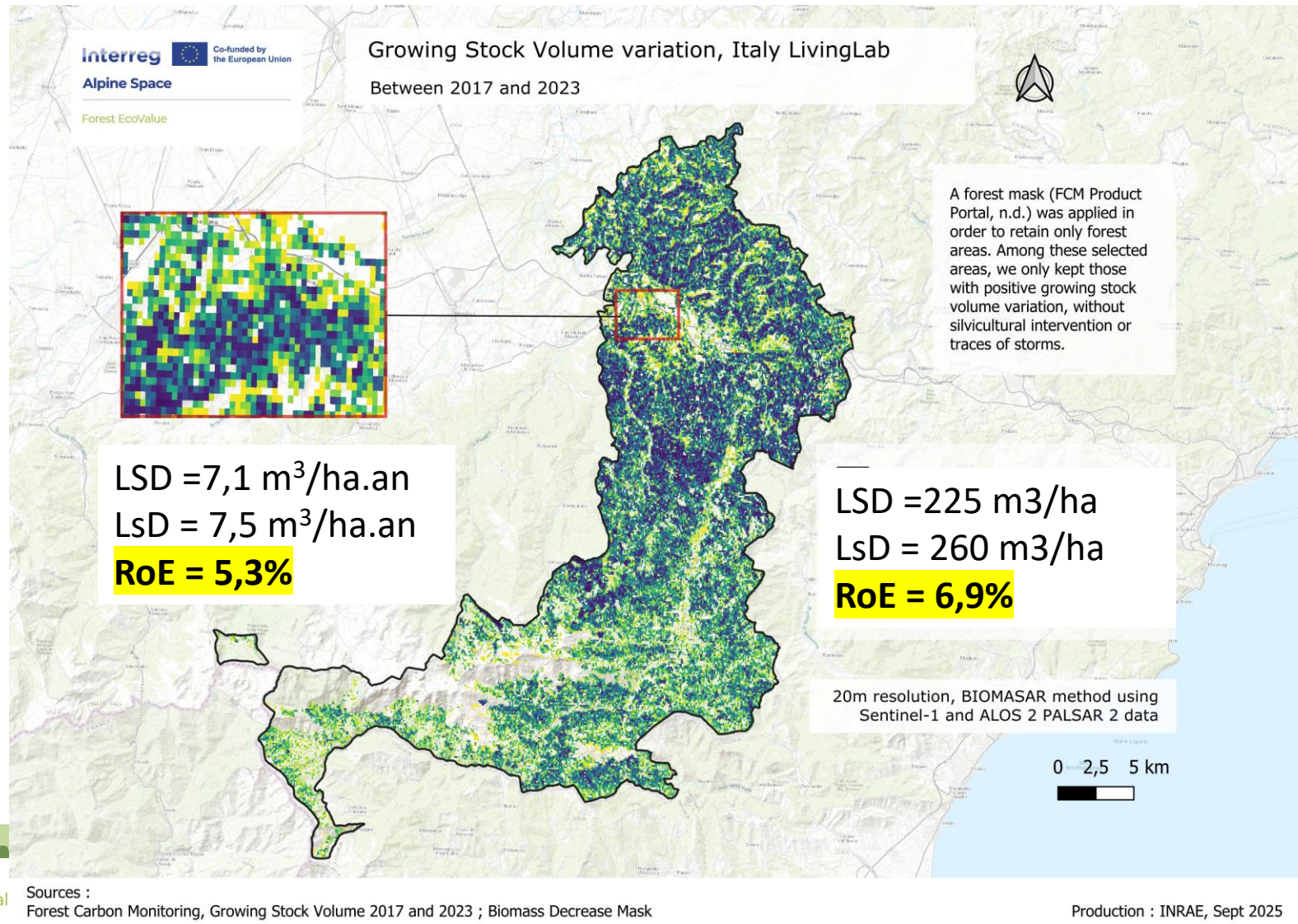
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ROCK the ALPS

Relevance of these Large-Scale Data?



Relevance of these Large-Scale Data?







Methodology based also on Local-scale Data (LsD)

Why?

- Not all stakeholders are **GIS savvy**
- Question of **resolution and accuracy** of the available data
- Some **scale-sensitive** indicators
- Easy to use for **rapid in-situ assessment**

Selected set of criteria and indicators (example related to accessibility)

IMPACT OF ACCESSIBILITY ON FOREST BIODIVERSITY Key Metrics for Assessment

Criterion	Calculation Method	Thresholds & Impact Level	Ecological Impact	References
 Linear Density of Infrastructure	Density = $\frac{\text{km Roads + Tracks + Trails}}{\text{km}^2 \text{ Forest Area}}$ [km/km ²]	<ul style="list-style-type: none"> $K < 0.5$ Low 0.5 - 1.5 Moderate 1.5 - 3.0 High > 3.0 Very High 	Fragmentation ↑ Edge Effects ↑ Disturbance ↑	Forman & Alexander, 1998 Trombulak & Frissell, 2000
 Weighted Density by Access Type	Weighted Density = $\frac{\sum (\text{km} \times \text{Coefficient})}{\text{km}^2}$ - Road = 1.0 ↓ Track = 0.6 ↓ Trail = 0.2	<ul style="list-style-type: none"> $K < 0.4$ Low 0.4 - 1.0 Moderate 1.0 - 2.0 High > 2.0 Very High 	Disturbance Intensity by Type	Gurrubxaga et al., 2019 Forman, 2003
 % Forest Area <100 m from Access	% Area within 100 m buffer Total Forest Area IZ	<ul style="list-style-type: none"> $< 20\%$ Low 20 - 40% Moderate 40 - 60% High $> 60\%$ Very High 	Exposure to Disturbance	Benitez-López et al., 2010 Forman, 2003
 Core Forest Area (<500 m from Access)	Average Size of Forest Patches > 500 m from Infrastructure [ha]	<ul style="list-style-type: none"> < 500 ha Very High 100 - 500 ha High 25 - 100 ha Low < 25 ha Very Low 	Habitat Resilience Biodiversity ↑ Connectivity ↑	Lindennayer & Fischer, 2006 Benhamou & Riote-Lambert, 2012

Impact Level: ■ Low ■ Moderate ■ High ■ Very High

Forest Recreation & Tourism Evaluation Criteria

Assessing Accessibility and Attractiveness of Forest Areas

Trail & Access Density



⊙ Km of Trails / km²

- ✗ < 0.5 Low Service
- ⚠ 0.5 - 2.0 Moderate
- ✓ > 2.0 High Service

Weighted Trail Accessibility



- ✗ < 0.4 Low
- ⚠ 0.4 - 1.0
- ✓ > 1.0 High

x1. Paved Roads
x0.8 Forest Tracks
x0.5 Hiking Trails

Slope & Terrain Suitability



- ✓ 0 - 10% Easy
- ⚠ 10 - 25% Moderate
- ✗ $> 25\%$ Difficult

Distance to Hotspots



- ✓ < 500 m Very Accessible
- ⚠ 500 m - 1 km Accessible
- ⚠ 1 - 3 km Moderate
- ✗ > 3 km Difficult

 Balancing Access, Safety & Visitor Satisfaction 

Forest Production Assessment Criteria

Forest Road Density



- ✓ High > 2.0 km/km²
- ⚠ Moderate 0.5 - 2.0 km/km²
- ✗ Low < 0.5 km/km²

Weighted Accessibility



- ✓ High 1.0 - 2.0
- ⚠ Moderate 0.4 - 1.0
- ✗ Low < 0.4

Slope



- ✓ Easy 0 - 15%
- ⚠ Moderate 15 - 30%
- ✗ Difficult $> 30\%$

Skidding Distance



- ✓ Short < 50 m
- ⚠ Moderate 50 - 100 m
- ✗ Long > 100 m

Yarding Distance



- ✓ Easy < 500 m
- ⚠ Moderate 500 m - 1 km
- ✗ Difficult > 1 km

Results : Operationalizing with Simple, User-Friendly Evaluation Tools

Forest Water Services

Assessing Water Regulation & Quality

Forest Structure

Forest Cover

✗ ≤ 30%
✓ 30 < ≤ 70%

Percentage of Broadleaves Species

✗ < 20% 20 < ≤ 40%
✓ 20 < ≤ 40%

Age Structure

✗ 20 years < >50 years
✓ 80 years <

Forest Accessibility

Forest Road/Path Condition

✗ **Poor**: Heavily damaged surface, deep ruts, heavily compacted or eroded soil, ineffective
 ✗ **Moderate**: Partially damaged surface, light ruts, moderate compaction, drainage sometimes impaired

Soil

Compaction

✓ **Low**
 ✓ **Low**: 2% Partially compacted soil, sog

Slope

Low: 0 < ≤ 8 degrees Medium: 8 < ≤ 20
 ✓ Low: 0 < ≤ 8 degrees ✓ High: 20 degrees <

Main Hydrological Elements present in the plot

River with banks forested

✗ Riparian width < 10m
 ✓ Riparian width 10 ≤ < 30m
 ✓ Torrent/width 30 m ≤

Torrent/stream with banks forested

✗ Riparian width < 10m
 ✓ Riparian width 10 ≤ < 30m
 ✓ Ravine/Gully
 ✗ None ✓ Present

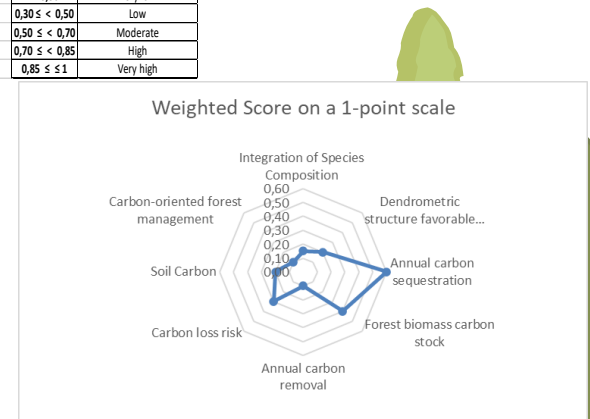
✗ Unfavorable / ! Moderate / ✓ Favorable

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Forest Ecosystem Service Assessment – Carbon storage and sequestration				
Criterion	Indicator	Score	Weight	Weighted score
Integration of Species Composition	Functional Classification of Tree Species	3	0,05	0,15
Dendrometric structure favorable to carbon storage	A forest stand structure characterized by dendrometric parameters that maximizes carbon storage and sequestration in both living biomass and soil	3	0,05	0,15
	Diameter distribution	1	0,05	0,05
Annual carbon sequestration	The amount of carbon dioxide (CO ₂) removed from the atmosphere and stored in a forest ecosystem over a one-year period.	3	0,20	0,60
Forest biomass carbon stock	Aboveground forest biomass carbon stock	1	0,15	0,15
	Belowground (root) forest biomass carbon stock	2	0,10	0,20
	Deadwood (standing and lying) carbon stock	1	0,05	0,05
Annual carbon removal	The amount of carbon removed or transferred out of a forest ecosystem each year due to human activities that extract biomass or wood from the forest stock.	1	0,10	0,10
Carbon loss risk	Stored carbon in a forest ecosystem released back into the atmosphere due to natural disturbances or environmental changes.	3	0,10	0,30
Soil Carbon	The carbon stored in the soil of a forest ecosystem, including both the organic layer (litter, humus) and the mineral topsoil, excluding the carbon contained in forest root biomass.	2	0,10	0,20
Carbon-oriented forest management	Forest management approach that prioritizes the maintenance, enhancement, and long-term storage of carbon in forest ecosystem	2	0,05	0,10
Total weighted score (on a 1-point scale)				0,68

	Indicative value	Total score	Carbon Service Level
Annual carbon sequestration [tC·ha ⁻¹ ·yr ⁻¹]	0,86	< 0,30	Very low
Forest total carbon (trees, dead wood, soil) [tC·ha ⁻¹]	206,27	0,30 ≤ < 0,50	Low
		0,50 ≤ < 0,70	Moderate
		0,70 ≤ < 0,85	High
		0,85 ≤ ≤ 1	Very high

Criterion	Weighted Score on a 1-point scale
Integration of Species Composition	0,15
Dendrometric structure favorable to carbon storage	0,20
Annual carbon sequestration	0,60
Forest biomass carbon stock	0,40
Annual carbon removal	0,10
Carbon loss risk	0,30
Soil Carbon	0,20
Carbon-oriented forest management	0,10
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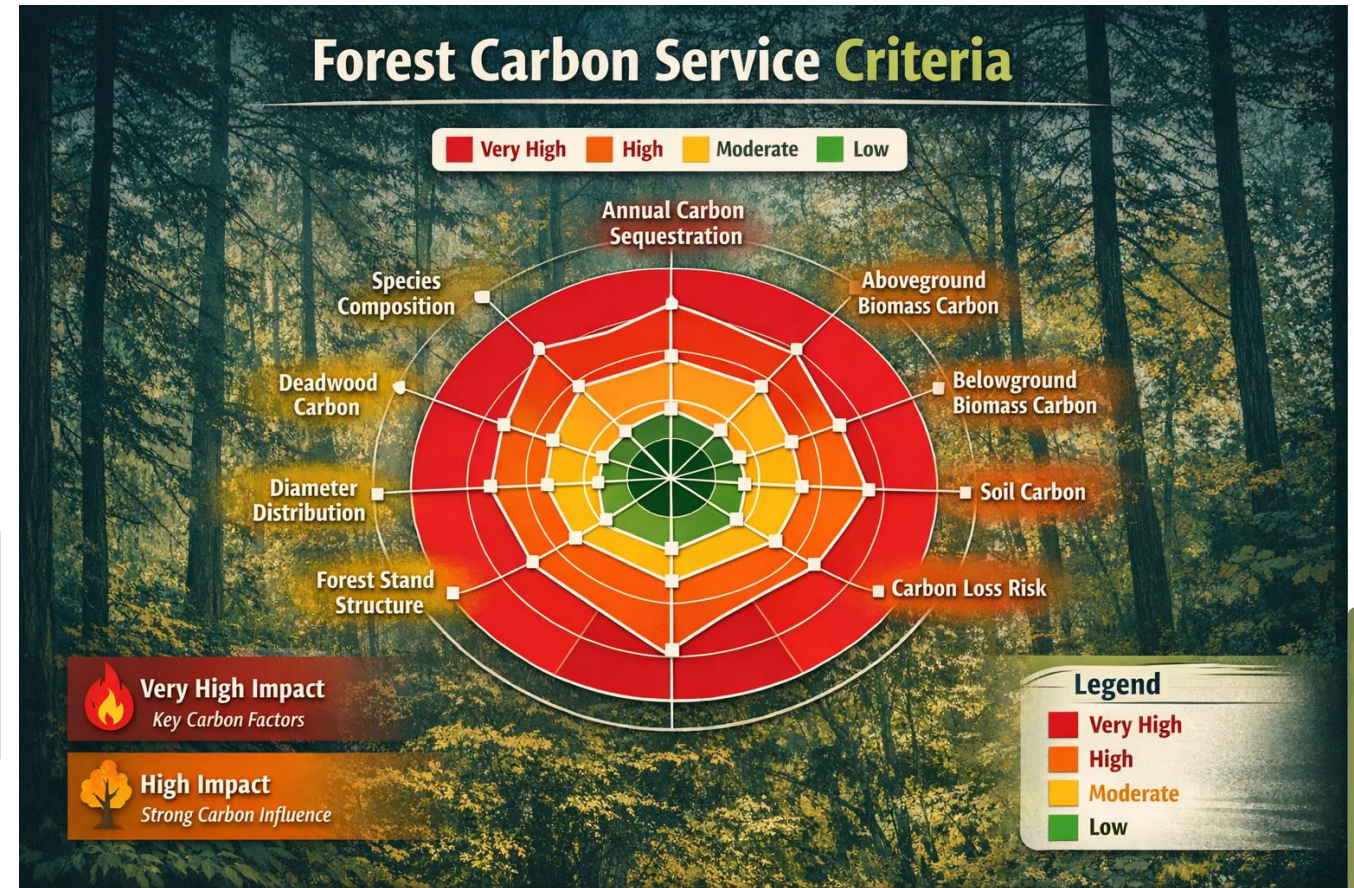
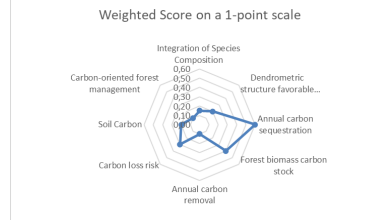
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Forest biomass carbon stock	Aboveground forest biomass carbon stock	3	0,15	0,45
	Belowground (root) forest biomass carbon stock	2	0,10	0,20
Annual carbon removal	Deadwood (standing and lying) carbon stock	1	0,05	0,05
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0,30 ≤ < 0,50	0,30 ≤ < 0,50	Low
0,50 ≤ < 0,70	0,50 ≤ < 0,70	Moderate
0,70 ≤ < 0,85	0,70 ≤ < 0,85	High
0,85 ≤ ± 1	0,85 ≤ ± 1	Very high

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FEV Insights(1)

- **High-Res Large-Scale Data (LSD)**
 - Finer spatial & temporal resolution → HI-RES
 - Now compatible with operational & tactical scales (short/medium term, strategy, planning, forestry)
 - LiDAR & satellite data rapidly expanding across countries
 - Advances: tech, modeling, open source!
 - Limits: not all SEFs covered
 - Public access: visitor counts
 - Water resources: measured catchments, forest share
 - Limitations: Not all stakeholders are GIS-savvy

FEV Insights(2)

- **Local-scale Data (LsD)**
 - Finer, non-exhaustive data
 - Update frequency issues
 - Leverages local knowledge
 - Rapid in-situ analysis, visual & usable
 - Qualitative indicators & local weighting easy to include



FEV Insights (3): mapping and indicators to answer to WWW.WWW.org !

- **Strategic Level: What, Why & Who?**
 - Identify a territory's SEF portfolio, associated indicators, and key actors
- **Operational: Where & When?**
 - Use available data
 - Map = Data + Indicators
 - Prioritize: Urgency? Opportunity? Planning?
- **Tactical Level: Way (how)?**
 - Adaptive forestry based on SEF, accessibility and available budget
- **Communication: .org!**
 - Making Methods, Tools & Documents Accessible

The Forest Ecosystem Services Fresk

