



UNIVERSITÀ
DEGLI STUDI
DI MILANO



DIPARTIMENTO
di SCIENZE
AGRICOLE &
AMBIENTALI

Assessing and Monitoring forest biodiversity

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DIP. AGRICOLTURA AMBIENTE E ALIMENTI



DIPARTIMENTO
AGRICOLTURA
AMBIENTE E ALIMENTI



UNIVERSITÀ
DEGLI STUDI
DEL MOLISE

07-05-2024

Agenda



Introduction



Tree-related
Microhabitats

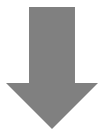


Monitoring
tool

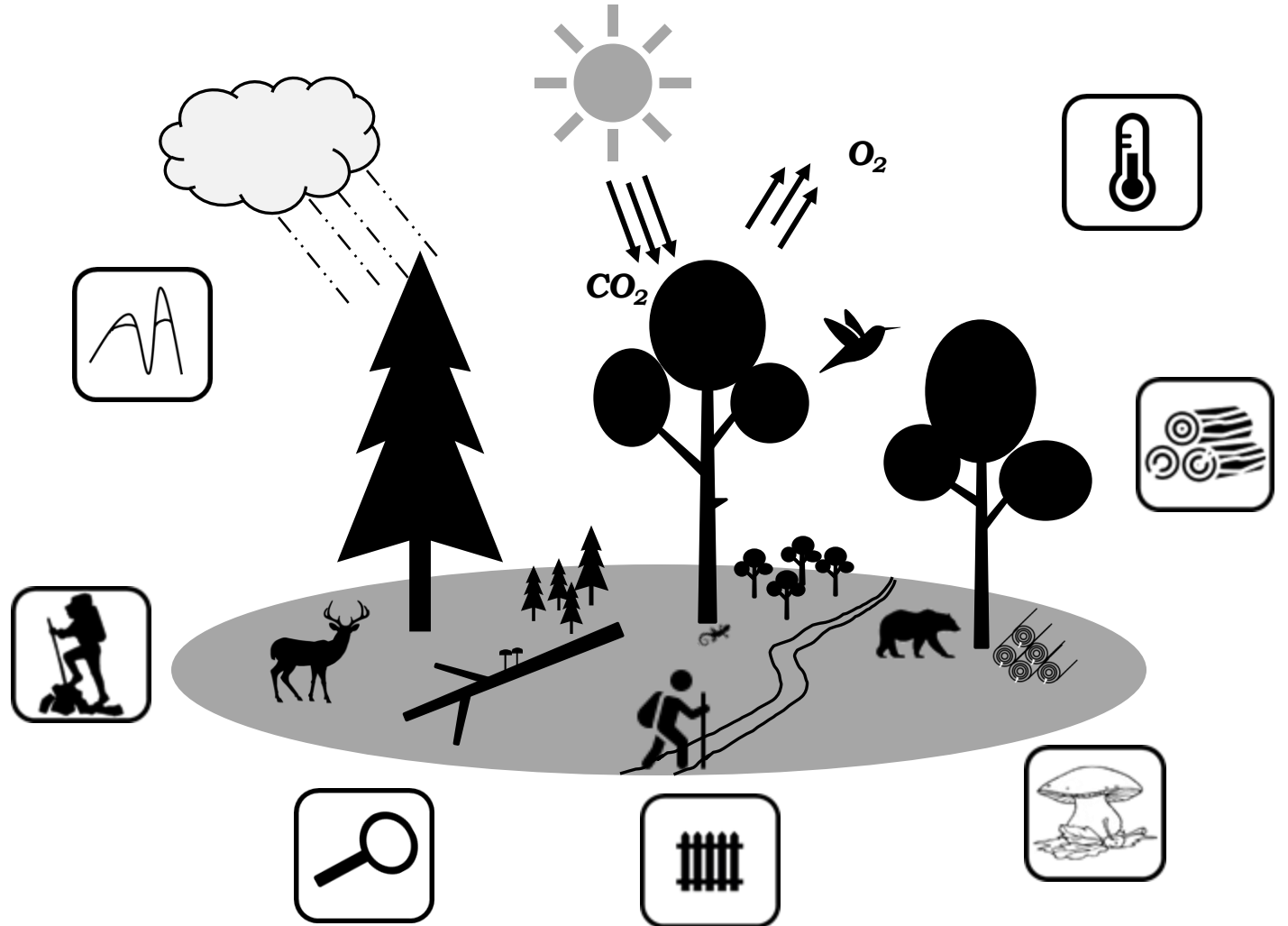
Why is forest monitoring important?



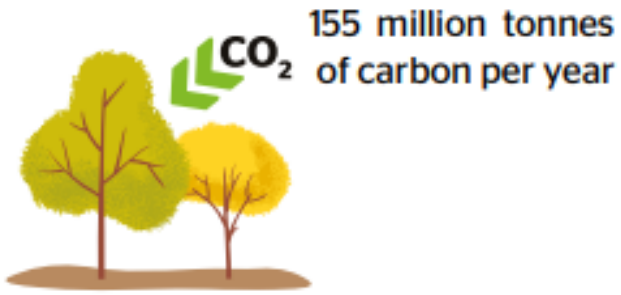
Sustainable Forest Management



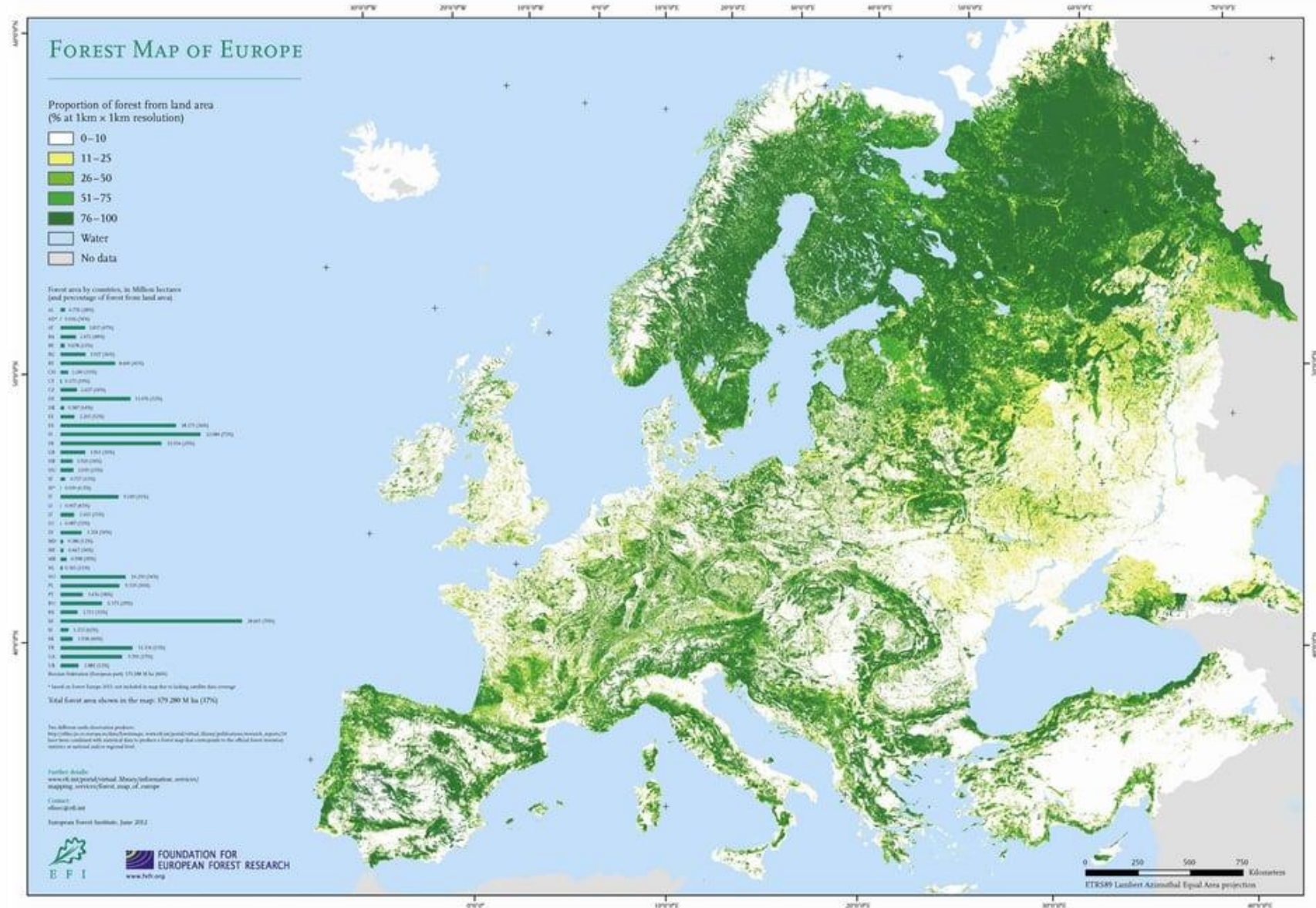
Numerous benefits to society

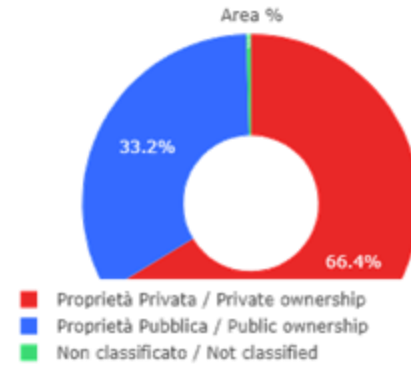


Forest resources and benefits



The forest sector contributed about **0.7%** to GDP in Europe

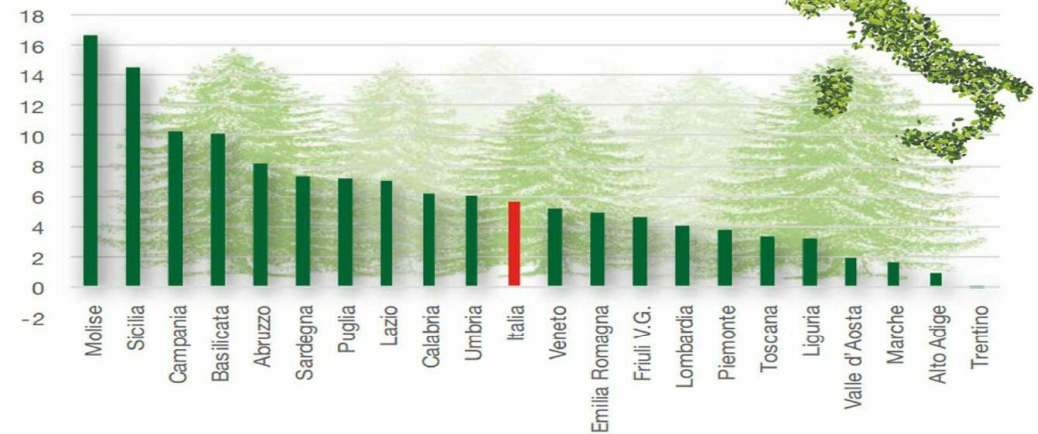




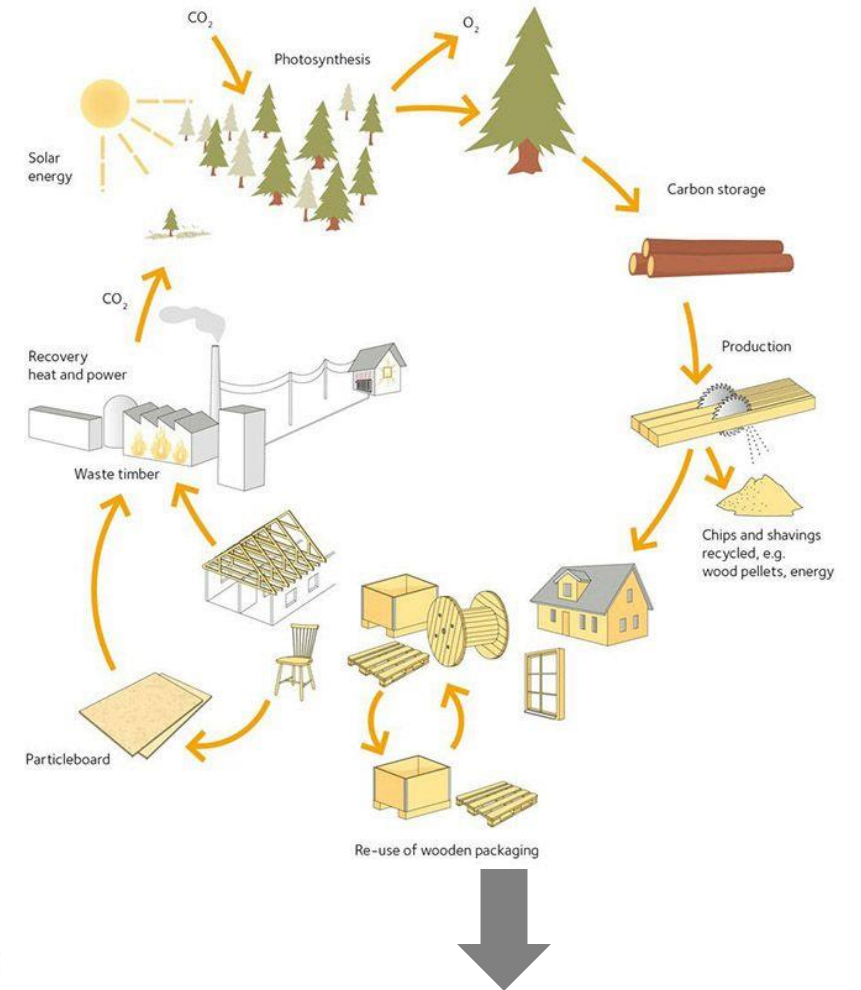
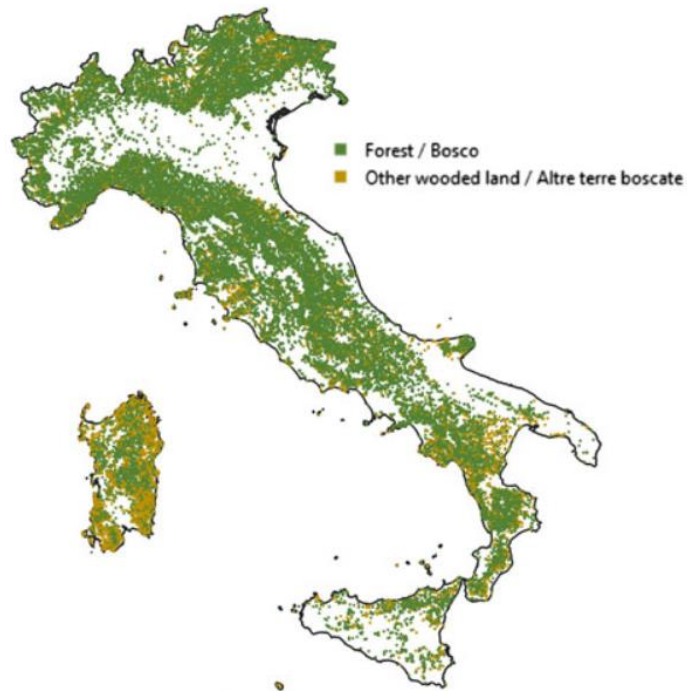
In Italy
~ 12 Millions ha
~36% sup. national



Crescita percentuale della superficie boscata nelle regioni italiane



The forest sector is an important source of income for mountains and inner areas



Durable wood products
Low quality timber for energy

Main threats to forests

LETTERS
PUBLISHED ONLINE: 3 AUGUST 2014 | DOI: 10.1038/NCLIMATE2318

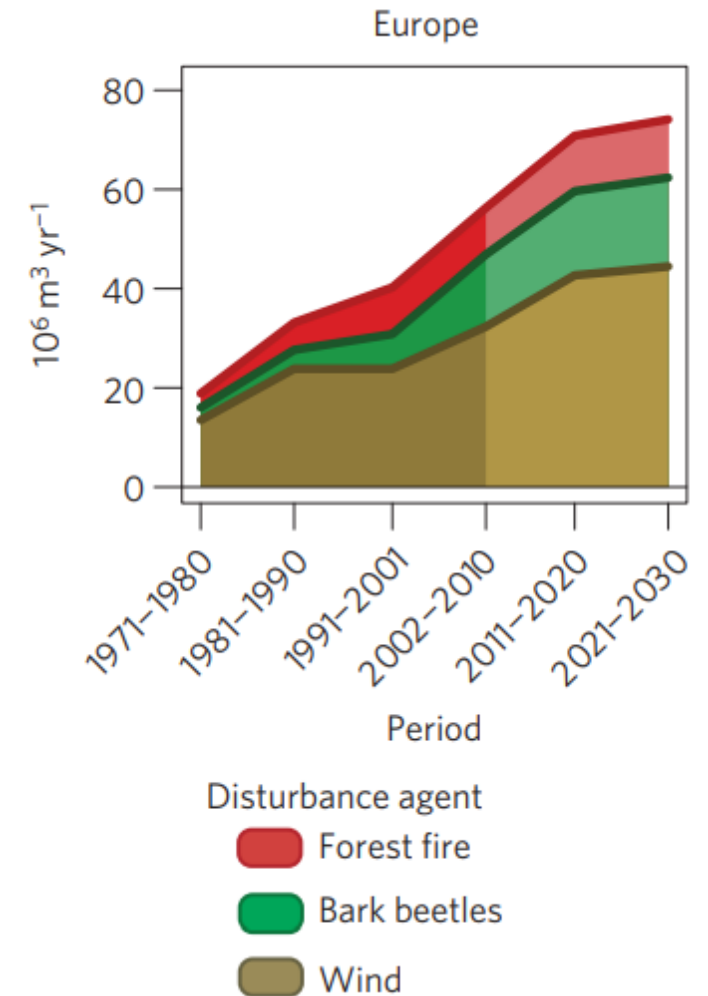
nature
climate change

Increasing forest disturbances in Europe and their impact on carbon storage

Rupert Seidl^{1*}, Mart-Jan Schelhaas², Werner Rammer¹ and Pieter Johannes Verkerk³

Disturbances from wind, bark beetles and wildfires have increased in Europe's forests throughout the twentieth century¹. Climatic changes were identified as a key driver European forest C sink recently⁵. A further increase in disturbance damage in the future might thus pose a major risk for Europe's climate change mitigation efforts, as it could counteract the efforts

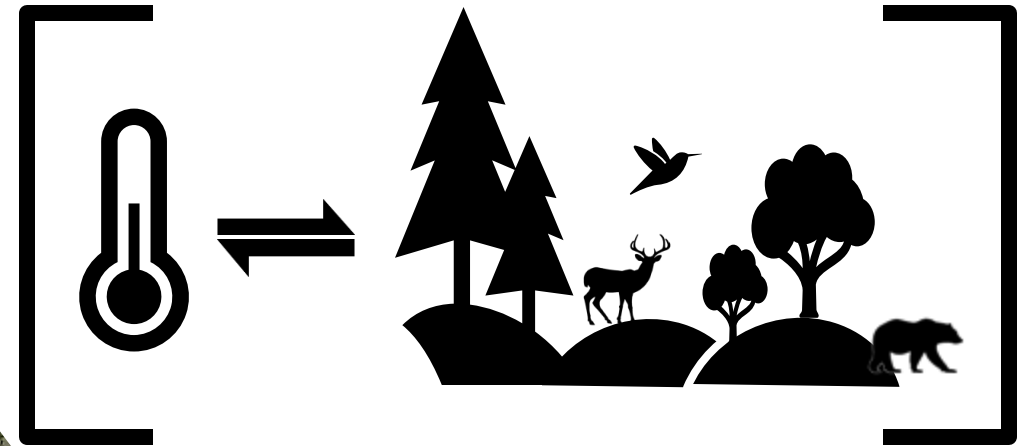
Not only carbon storage, but also loss of biodiversity and other ecosystem services



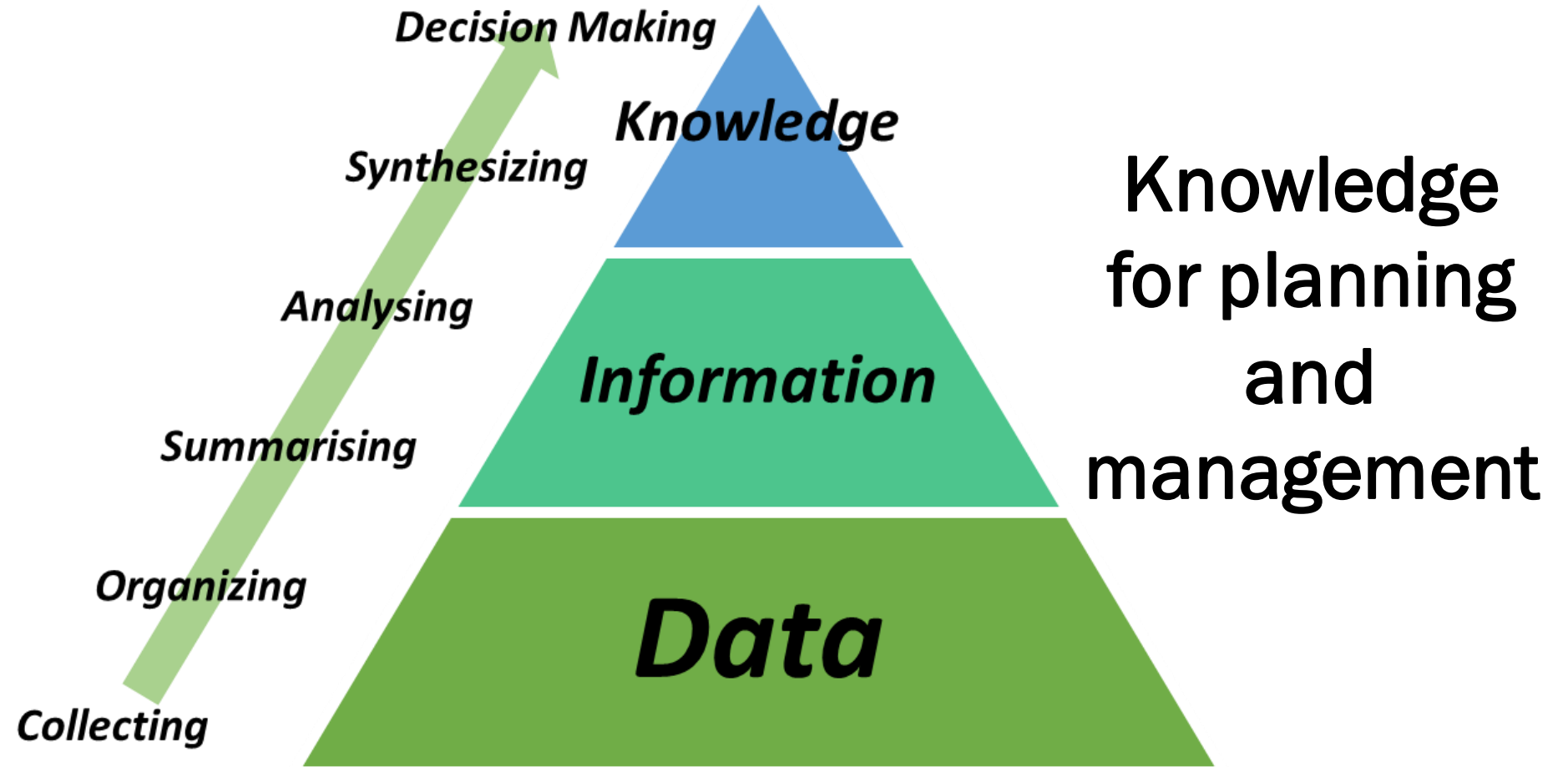
HUMAN WELLBEING



TO HALT CURRENT THREATS



To reduce the loss of ecosystem services



Tools for monitoring SFM

C6 - Socioeconomic Functions

- 6.1 - Forest holdings
- 6.2 - Contribution of forest sector to GDP
- 6.3 - Net revenue
- 6.4 - Investments in forests and forestry
- 6.5 - Forest sector workforce
- 6.6 - Occupational safety and health
- 6.7 - Wood consumption
- 6.8 - Trade in wood
- 6.9 - Wood energy
- 6.10 - Recreation in forests



C5 - Protective Functions (Soil & Water)

- 5.1 - Protective forests - soil, water and other ecosystem functions - infrastructure and managed natural resources



- 4.6 - Genetic resources
- 4.7 - Forest fragmentation
- 4.8 - Threatened forest species
- 4.9 - Protected forests
- 4.10 - Common forest bird species



C1 - Forest Resources & Global Carbon Cycles

- 1.1 - Forest area
- 1.2 - Growing stock
- 1.3 - Age structure and/or diameter distribution
- 1.4 - Carbon stock



C2 - Forest Ecosystem Health and Vitality

- 2.1 - Deposition of air pollutants
- 2.2 - Soil condition
- 2.3 - Defoliation
- 2.4 - Forest damage
- 2.5 - Forest land degradation



C3 - Productive Functions of Forests

- 3.1 - Increment and felling
- 3.2 - Roundwood
- 3.3 - Non-wood goods
- 3.4 - Services



C4 - Forests Biological Diversity

- 4.1 - Diversity of tree species
- 4.2 - Regeneration
- 4.3 - Naturalness
- 4.4 - Introduced tree species
- 4.5 - Deadwood



State of Europe's Forests (SoEF)

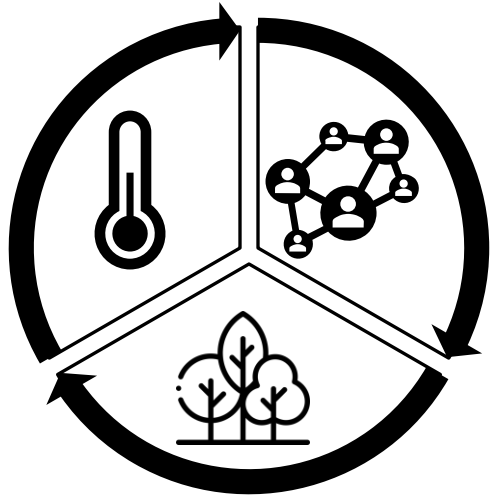
This report provides comprehensive information on the status and trends in forests and forestry in the pan-European region, based on the criteria for sustainable forest management.

Tools for monitoring SFM

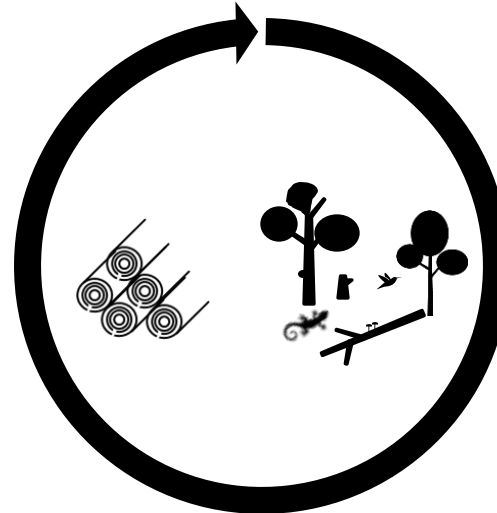


Sustainable Forest Management

Climate-Smart Forestry



Integrative Forest Management



Bosco Roccamandolfi, Molise

10/05/2024

Climate – Smart Forestry



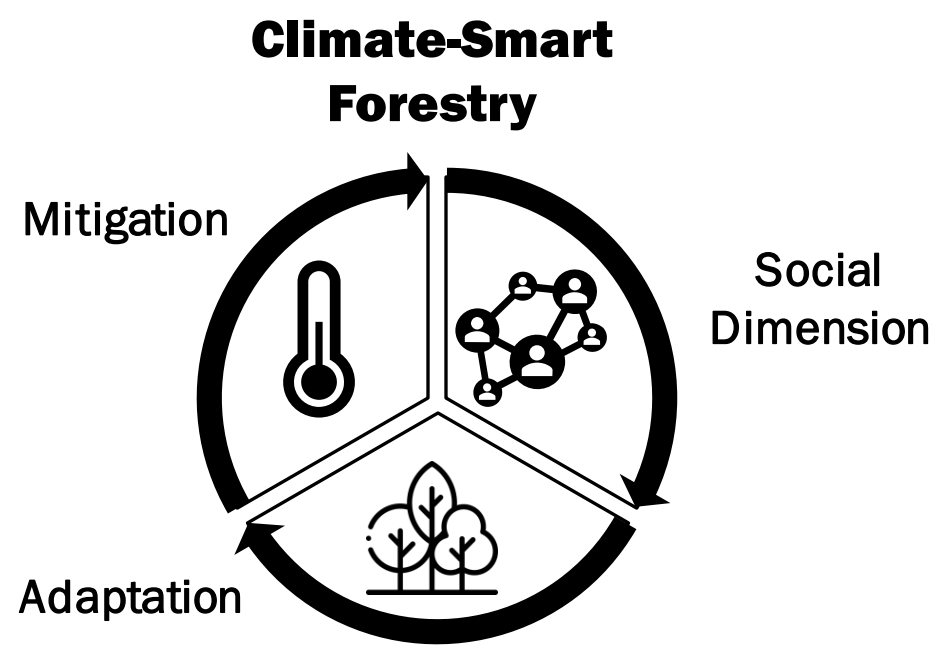
CLiMate-Smart Forestry in Mountain Regions

Managing Forest Ecosystems

Roberto Tognetti
Melanie Smith
Pietro Panzacchi *Editors*

Climate-Smart Forestry in Mountain Regions

OPEN ACCESS



Ecosystem Services 43 (2020) 101113



ELSEVIER

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser



What is Climate-Smart Forestry? A definition from a multinational collaborative process focused on mountain regions of Europe

Euan Bowditch^a, Giovanni Santopuoli^{b,c,*}, Franz Binder^d, Miren del Río^{e,f}, Nicola La Porta^{g,h}, Tatiana Kluvankovaⁱ, Jerzy Lesinski^j, Renzo Motta^k, Maciej Pach^l, Pietro Panzacchi^{c,m}, Hans Pretzschⁿ, Christian Temperli^o, Giustino Tonon^m, Melanie Smith^a, Violeta Velikova^p, Andrew Weatherall^q, Roberto Tognetti^{b,c,h}



Climate-Smart Forestry is sustainable adaptive forest management and governance to protect and enhance the potential of forests to adapt to, and mitigate climate change. The aim is to sustain ecosystem integrity and functions and to ensure the continuous delivery of ecosystem goods and services, while minimising the impact of climate-induced changes on mountain forests on well-being and nature's contribution to people.

Adaptation measures of forests that maintain or improve their ability to grow under current and projected climatic conditions and increase their resistance and resilience. The adaptive capacity to changes in climate and to the timing and size of climate-induced disturbances (e.g., fire, extreme storm events, pests and diseases) can be enhanced by promoting genetic, compositional, structural, and functional diversity at both stand and landscape scales. This includes facilitating natural regeneration and planting of native as well as non-native tree species, genetic variants and individuals that are considered to be adapted to future conditions. Increased connectivity assists the migration of forest species.

Mitigation of climate change by forests is a combination of carbon sequestration by trees, carbon storage by forest ecosystems, especially soils, and forest derived products, such as structural timber, and by carbon substitution - directly by replacing fossil fuels with bioenergy and indirectly through use of wood to substitute for higher carbon footprint materials.

The **social dimension** of forestry holds many aspects, from the involvement of stakeholders from local communities, and their conflicts over land use or for the access to skills and technology, to global forest governance challenges. Climate change may jeopardize forest ecosystem functioning and brings social and economic consequences for people, which may modify priorities of ecosystem services at various scales. Assessment for ecosystem services could be a tool making this process more efficient with respect to indicators relevant for governance regime and actors involved.

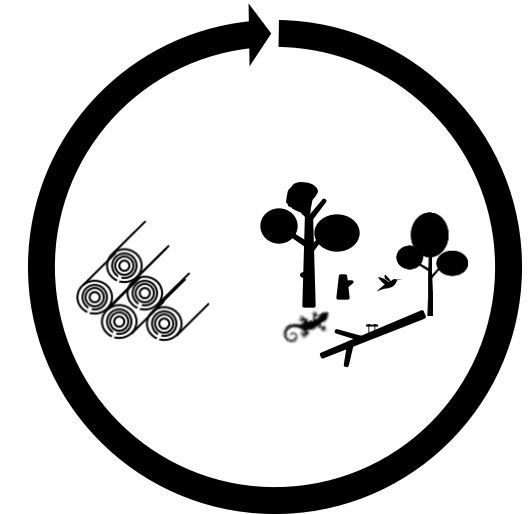
In summary, **Climate-Smart Forestry** should enable both forests and society to transform, adapt to and mitigate climate-induced changes.

Integrative Forest Management

Integrative forest management means combining the **provision** of several **ecosystem services** in one forest landscape. The Integrate Network focuses on one critical dimension of this integration: how to align ***biodiversity conservation and sustainable wood production***.



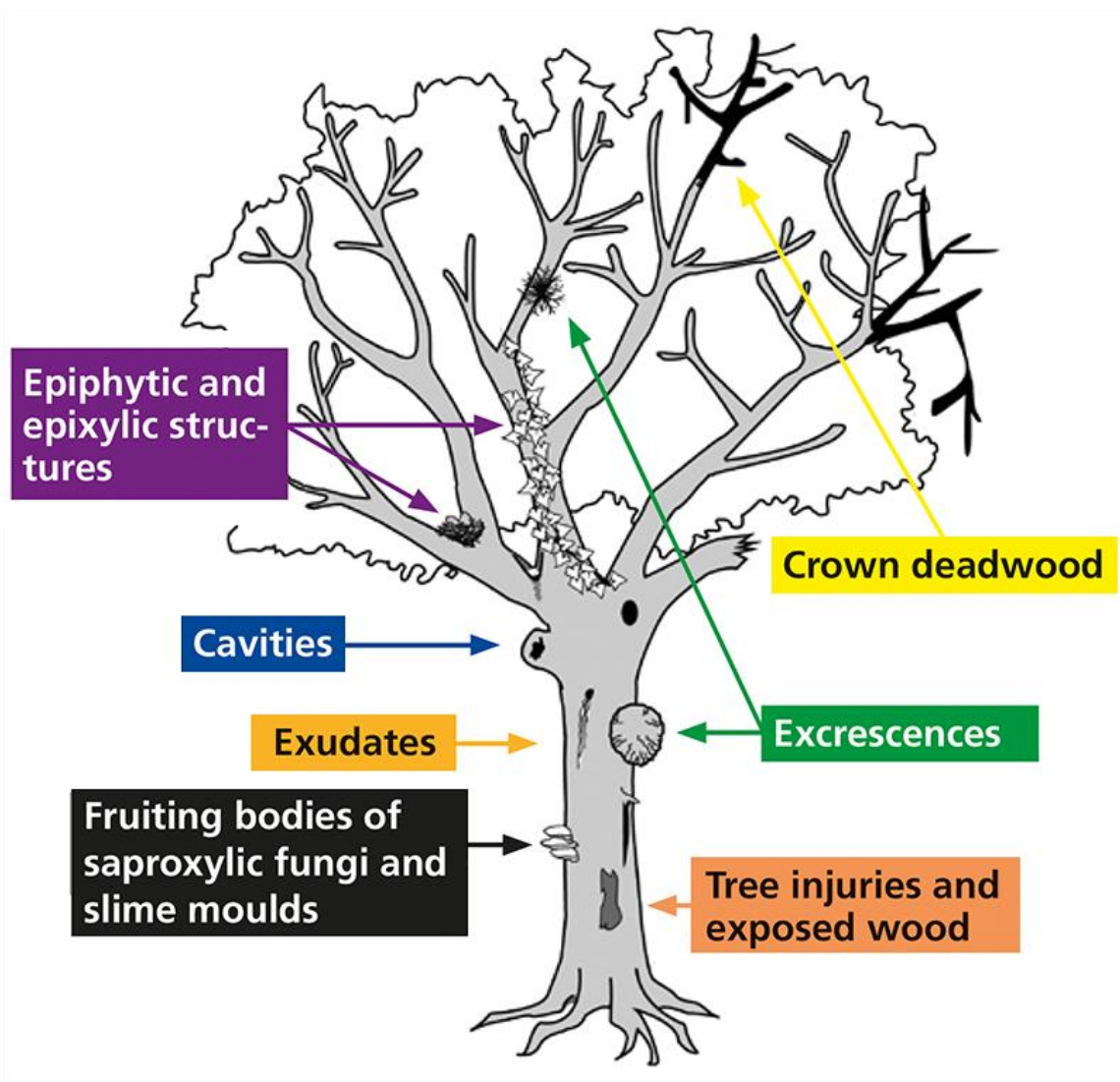
Integrative Forest Management



Timber production

Biodiversity

Tree-related microhabitats



Integrative Forest Management - TreMs

Kraus et al., 2016

Catalogue of tree microhabitats

Reference field list



64
TreMs

Microhabitat saproxilici	Cavità	CV1	Cavità formate da picidi: CV11, CV12, CV13, CV14, CV15
		CV2	Cavità del tronco con rosura: CV21, CV22, CV23, CV24, CV25, CV26
		CV3	Cavità dei rami: CV31, CV32, CV33
		CV4	Dendrotelmi: CV41, CV42, CV43, CV44
		CV5	Gallerie scavate da insetti e fori di uscita: CV51, CV52
	Lesioni e Ferite	IN1	Scortecciamento, alborno esposto: IN11, IN12, IN13, IN14
		IN2	Fratture sul tronco e nella chioma: IN21, IN22, IN23, IN24
		IN3	Fessure e cicatrici: IN31, IN32, IN33, IN34
	Corteccia	BA1	Tasche nella corteccia: BA11, BA12
		BA2	Struttura corteccia: BA21
Legno morto	DE1	Legno morto nella chioma: DE11, DE12, DE13, DE14, DE15	
Microhabitat epixilici	Deformazione/ forme di crescita	GR1	Cavità nei contrafforti: GR11, GR12, GR13
		GR2	Scopazzi e riscoppi: GR21, GR22
		GR3	Cancri: GR31, GR32
	Epifite	EP1	Corpi fruttiferi: EP11, EP12, EP13, EP14
		EP2	Mixomiceti: EP21
		EP3	Fanerogame e crittogame: EP31, EP32, EP33, EP34, EP35
	Nidi	NE1	Nidi: NE11, NE12, NE21
	Altro	OT1	Fuoriuscite di linfa e resina: OT11, OT12
		OT2	Microsuolo: OT21, OT22

Integrative Forest Management - TreMs

Form	Group	Types					
Cavities I.s.	Woodpecker breeding cavities	Small woodpecker breeding cavity Entrance ø < 4cm	Medium-sized woodpecker breeding cavity Entrance ø = 4-7cm	Large woodpecker breeding cavity Entrance ø > 10cm	Woodpecker flute Entrance ø > 3cm		
	Rot holes	Trunk base rot-hole (closed top, ground contact) Opening ø > 10cm	Trunk rot-hole (closed top, no ground contact) Opening ø > 10cm	Semi-open trunk rot-hole Opening ø > 30cm	Chimney trunk base rot-hole Opening ø > 30cm	Chimney trunk rot-hole Opening ø > 30cm	Hollow branch Opening ø > 10cm
	Insect galleries	Insect galleries and bore holes Hole ø > 2cm or area > 30cm²					
	Concavities	Dendrotelm ø > 15cm	Woodpecker foraging excavation Depth > 10cm, ø > 10cm	Trunk bark-lined cavity Depth > 10cm, ø > 10cm	Root-buttruss concavity Entrance ø > 10cm		
Tree injuries and exposed wood	Exposed sapwood only	Bark loss Area > 300cm²	Fire scar Area > 600cm²	Bark shelter Gap > 1cm, depth > 10cm, height > 10cm	Bark pocket Gap > 1cm, width > 10cm, height > 10cm		
	Exposed sapwood and heartwood	Stem breakage ø > 10cm at break point	Limb breakage Exposed heartwood > 300cm²	Crack Length > 30 cm, width > 1 cm, depth > 10 cm	Lightning scar Length > 30 cm, width > 1 cm, depth > 10 cm	Fork split at insertion Length > 30 cm	
	Crown deadwood	Dead branches Branch ø > 10cm, or branches ø > 3cm and > 10% of the crown is dead	Dead top ø > 10cm at the base of the piece of deadwood	Remaining broken limb broken end ø > 20cm, length of the remaining piece > 5m			

Form	Group	Types				
Excrecences	Twig tangles	Witch broom Largest ø > 50cm	Epicormic shoots > 5 twig clusters			
	Burns and cankers	Burr Largest ø > 20cm	Canker Largest ø > 20cm or large part of the trunk covered			
Fruiting bodies of saproxylic fungi and slime moulds	Perennial fungal fruiting bodies	Perennial polypore Largest ø > 5cm				
	Ephemeral fungal fruiting bodies	Annual polypore Largest ø > 5cm or cluster of > 10 fruiting bodies	Pulpy agaric Largest ø > 5cm or cluster of > 10 fruiting bodies	Large Pyrenomycete Stroma ø > 3cm or stroma cluster covering > 100cm²	Myxomycetes Largest ø > 5cm	
Epiphytic and epixylic structures	Epiphytic and parasitic crypto- and phanerogams	Bryophytes > 10% of the trunk area covered	Foliose and fruticose lichens > 10% of the trunk area covered	Ivy and lianas > 10% of the trunk area covered	Ferns > 5 fronds	Mistletoe Largest ø > 20cm
	Nests	Vertebrate nest ø > 10cm	Invertebrate nest			
	Microsites	Bark microsoil Presence	Crown microsoil Presence			
Exudates	Exudates	Sap run Cumulative length > 10 cm	Heavy resinosis Cumulative length > 10 cm			

Ecological Indicators 84 (2018) 194–207

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

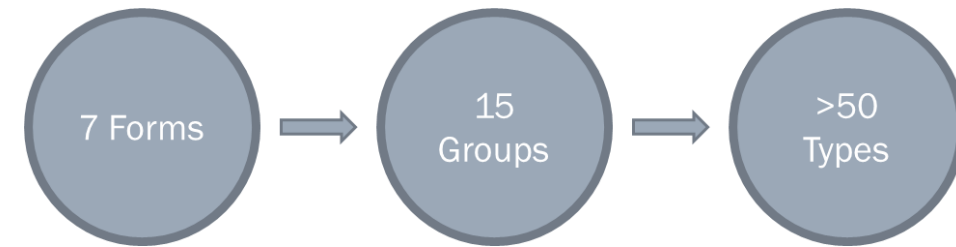



Tree related microhabitats in temperate and Mediterranean European forests: A hierarchical typology for inventory standardization



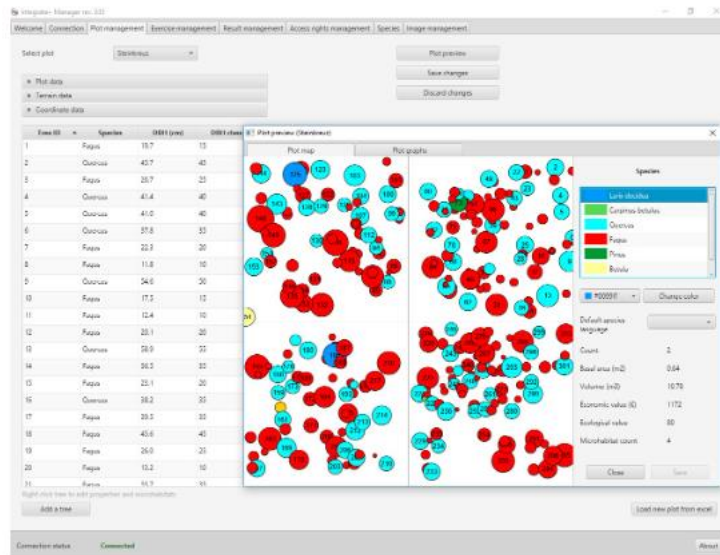
Laurent Larrieu^{a,b,*}, Yoan Paillet^{c,1}, Susanne Winter^{d,1}, Rita Büttler^e, Daniel Kraus^f, Frank Krumm^g, Thibault Lachat^{h,i}, Alexa K. Michel^l, Baptiste Regnery^{j,k}, Kris Vandekerkhove^l

Larrieu et al., 2018



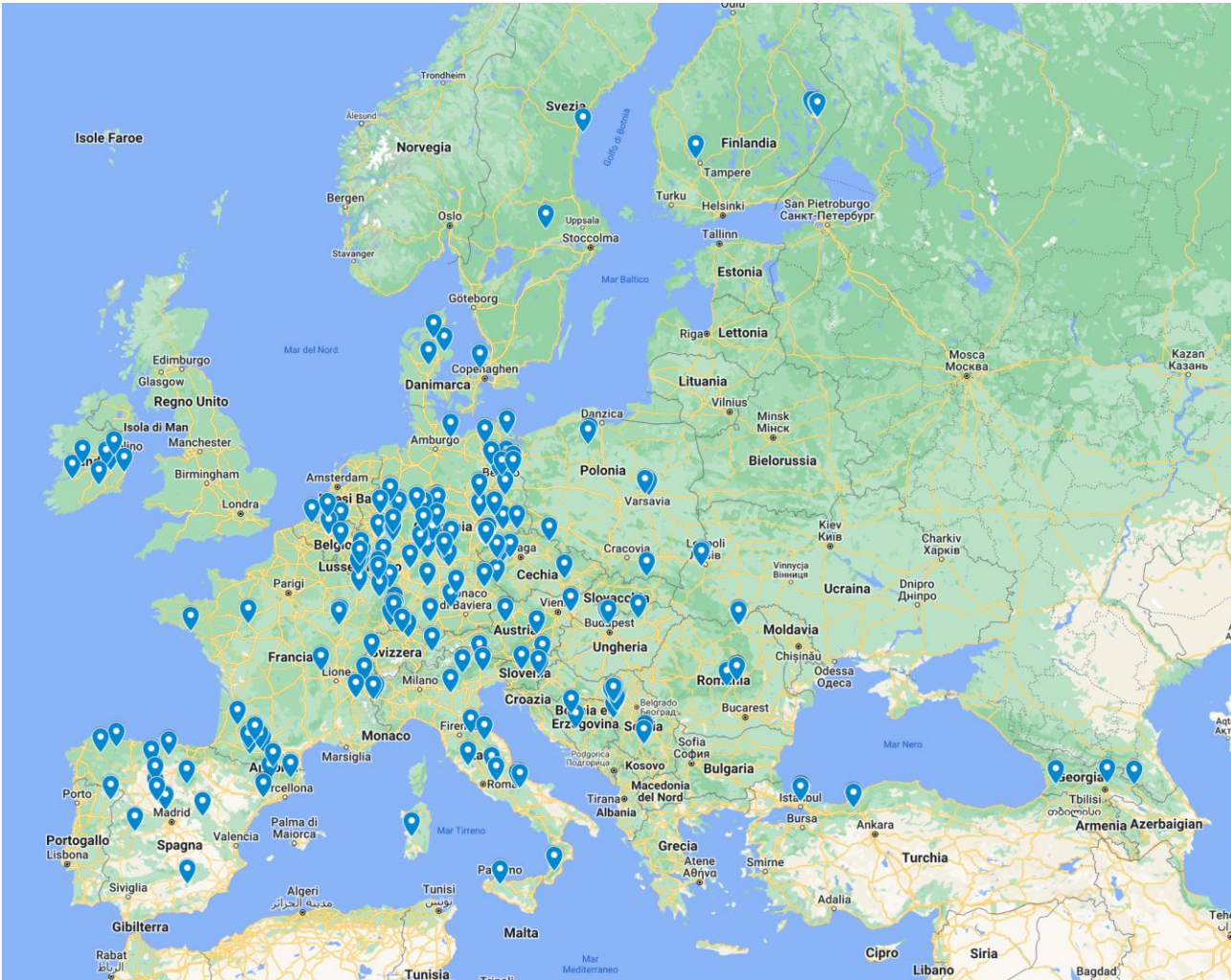
Marteloscopes as learning lab

https://youtu.be/drRIEhYK4_0



<http://iplus.efi.int/>

Marteloscoptes network



Italian network of Martelloscopes



Marteloscopes as living lab



IN24



GR12



IN11



CV51



EP31



CV14



BA21



CV25



BA12



CV51



EP33



DE11



NE12



CV41



CV32



EP32



EP11



CV42

Marteloscopes as living lab

Il Martelloscopio di Collemeluccio



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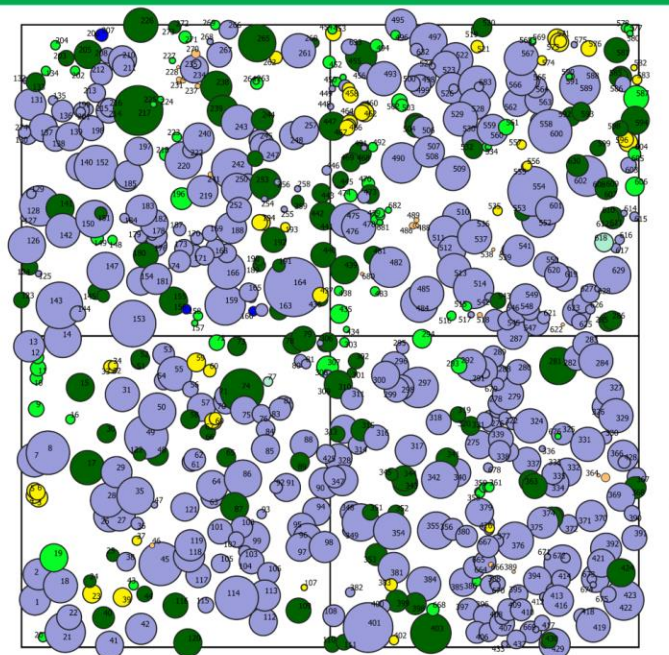


RISERVAMAB
Collemeluccio - Montedimezzo
AL TOMOLISE

mipaaf
ministero delle politiche
agricole alimentari e forestali

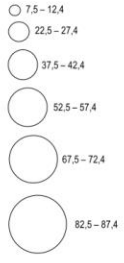


Integrate
Network
facilitated by EFI

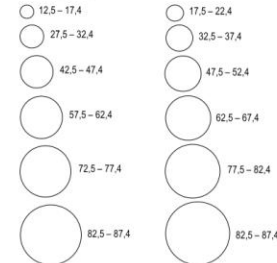


Specie [N.piante]

- Abete bianco [370]
- Acer campestre [84]
- Carpino bianco [25]
- Faggio [4]
- Frassino [49]
- Pero selvatico [2]
- Cerro [119]

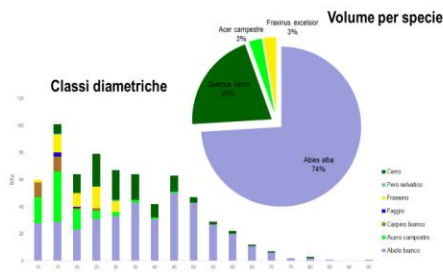


DBH (cm)



Il nome "martelloscopio" deriva dal termine "martellata" che è l'operazione effettuata dal dottore forestale per indicare le piante che dovranno cadere al taglio. Il martelloscopio è una porzione di foresta, con superficie di 1 ha, in cui per ogni pianta sono noti posizione, caratteristiche biometriche come diametro a 1,30m (DBH), altezza e volume, stato vegetativo e microhabitat. È uno strumento valido per attività di formazione per simulare interventi selvicolturali e valutarne gli effetti in termini di produzione legnosa, tutela della biodiversità ed erogazione dei servizi ecosistemici. Inoltre può essere utilizzato per la divulgazione a supporto della gestione forestale sostenibile.

	Numero	Area basimentrica m ²	Volume m ³
Alberi	140	11	73
Alberi Habitat	543	58	790
Totale	683	69	863



I **Tree-Talker** sono strumenti innovativi, non invasivi, per il monitoraggio continuo ed in tempo reale della salute degli alberi.

Si tratta di strumenti dotati di sensori che montati sul tronco delle piante riescono a trasmettere informazioni sulle principali funzionalità delle piante come l'attività fotosintetica, l'evapotraspirazione, il trasporto dell'acqua dalle radici alle foglie. Le informazioni, sottoforma di numeri, vengono trasmesse automaticamente, con una frequenza oraria, ad un server dalla quale è possibile scaricarle in ogni momento e da qualsiasi parte del mondo.



I **Tree-Talker** montati in questo sito fanno parte di una rete di monitoraggio nazionale che vede coinvolti oltre al Molise, anche Trentino Alto Adige, la Toscana, il Lazio, la Campania e la Sicilia. Confrontare lo stato di salute delle piante in diverse parti di Italia ci aiuta a comprendere gli impatti del clima sui nostri boschi al fine di definire strategie di gestione forestale (**Climate-smart forestry**) adatte a contrastare il cambiamento climatico, mantenere i boschi in un buon stato di salute e garantire l'erogazione dei servizi ecosistemici.

Marteloscopes as living lab



Integrate Marteloscopes 

Technical information

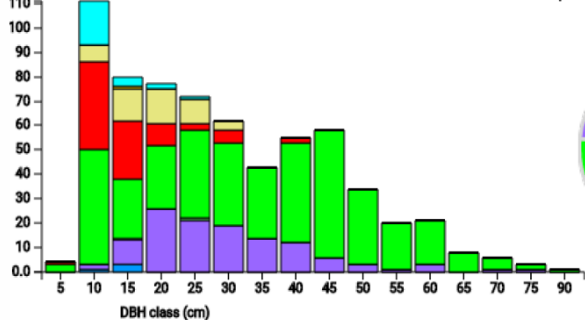
IT

Name: **Collemeluccio**

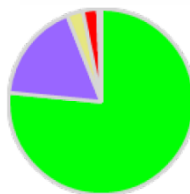
Forest type: **Silver fir forests of the Italian Apennine**

State / Region	Owner	Establishment	Size
Italy / Molise	State	2021	1.0 ha
Altitude [m.a.s.l.]	Mean annual precipitation [mm]	Mean annual temperature [°C]	Natural forest community
960	920	8.5	Pulmonario apenninae-Abietetum albae
Number of trees [N/ha]	Basal area [m²/ha]	Volume [m³/ha]	Habitat value [points/ha]
655	64.3	842.5	3339

N/ha DBH distribution

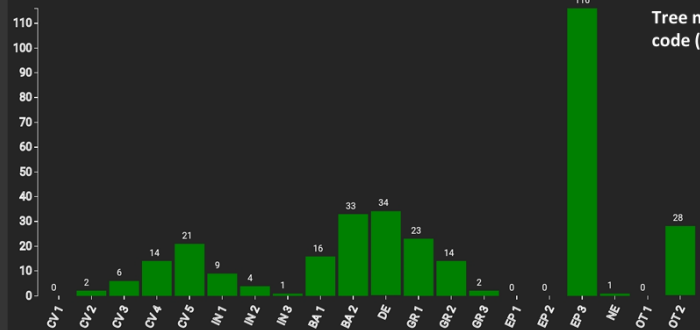


Tree species distribution (% Volume)



- silver fir: 76.5 %
- Turkey oak: 17.4 %
- common ash: 2.8 %
- field maple: 2.6 %
- hornbeam: 0.4 %
- common beech: 0.1 %
- maritime pine: 0.1 %
- mannan ash: 0 %

Tree microhabitat distribution by code (Total: 324)

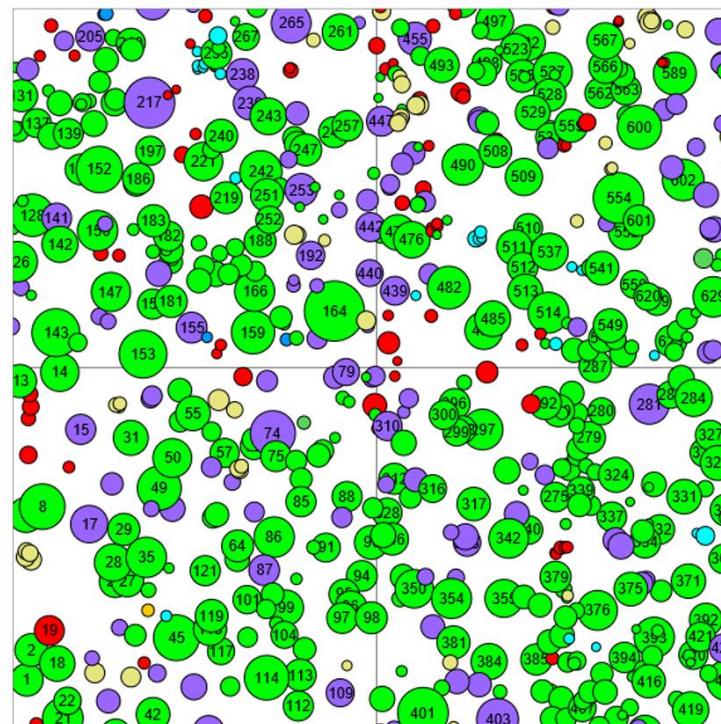


1

Collemeluccio

<http://iplus.efi.int/marteloscopes-data.html>

Marteloscope map (1.0 ha):



Contact:

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Campobasso, 86100
giovanni.santopuoli@unimol.it

2



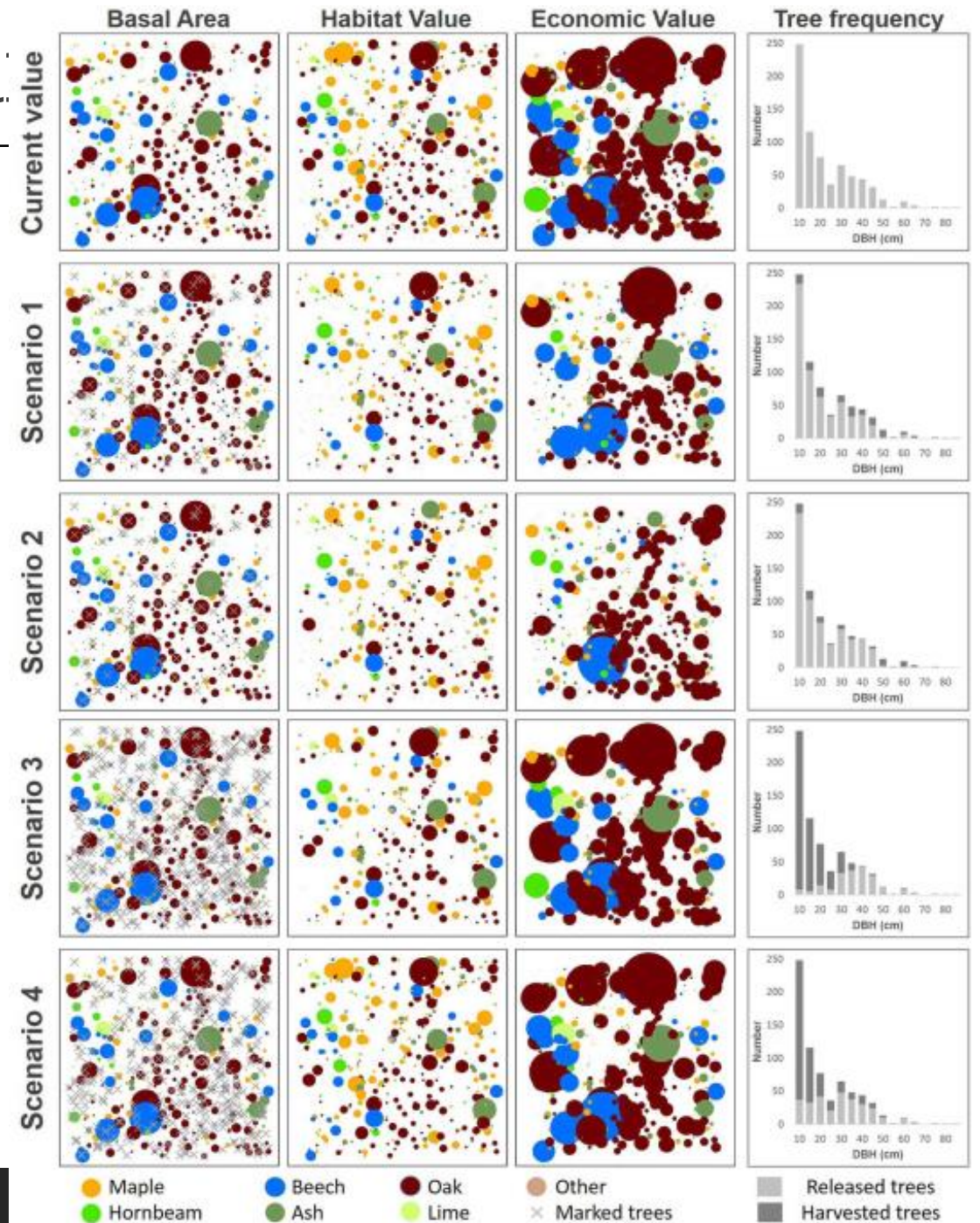
Italian network of Ma



Biodiversity conservation and wood production in a Natura 2000 Mediterranean forest. A trade-off evaluation focused on the occurrence of microhabitats

Giovanni Santopuoli⁽¹⁻²⁻³⁾,
Marco di Cristofaro⁽²⁾,
Daniel Kraus⁽⁴⁾,
Andreas Schuck⁽⁵⁾,
Bruno Lasserre⁽²⁾,
Marco Marchetti⁽¹⁻²⁾

The most significant European forest-related strategies highlight the importance of multifunctional forests for human wellbeing, due to the provision of a wide range of goods and services. However, managing competing aims, such as timber production, economic drivers and biodiversity conservation is often difficult for practitioners. In order to assess the loss and gain of ecosystem services caused by forestry, trade-off evaluation has been increasingly used to aid decision-making. In this study, four silvicultural scenarios are simulated using the Marteloscope approach to evaluate the trade-offs between biodiversity



Case study

Forest management impacts on abundance and diversity of TreMs





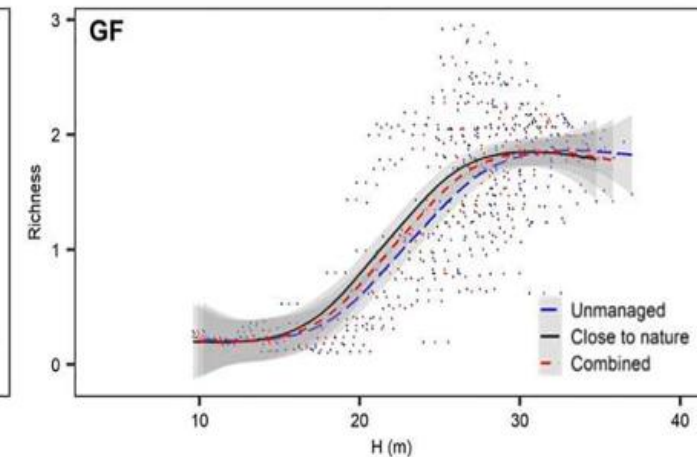
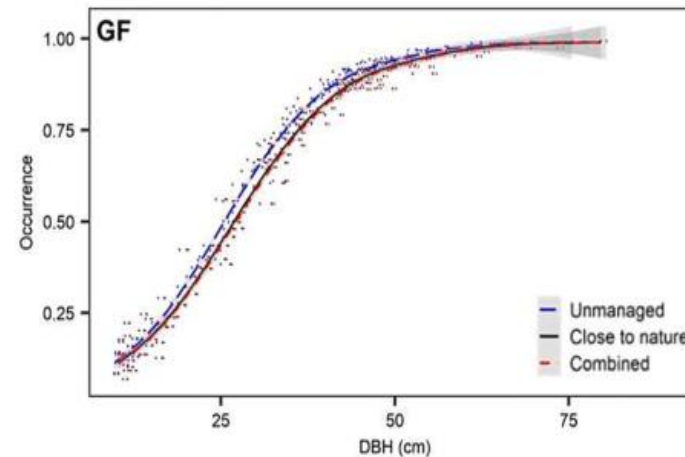
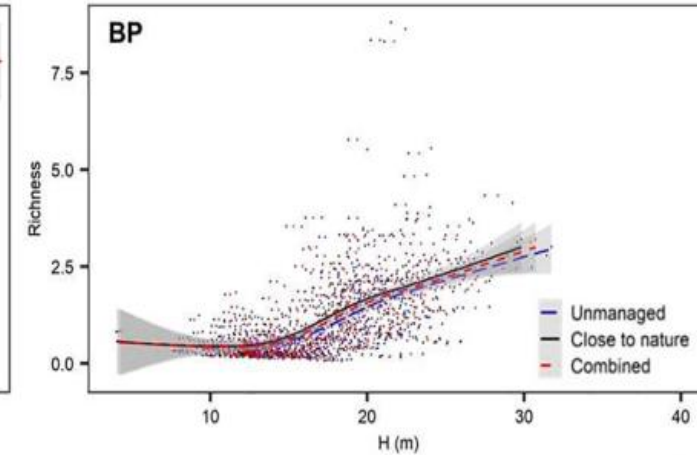
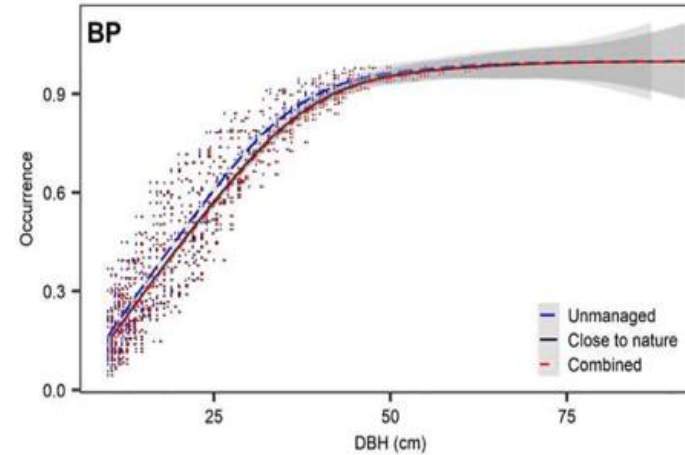
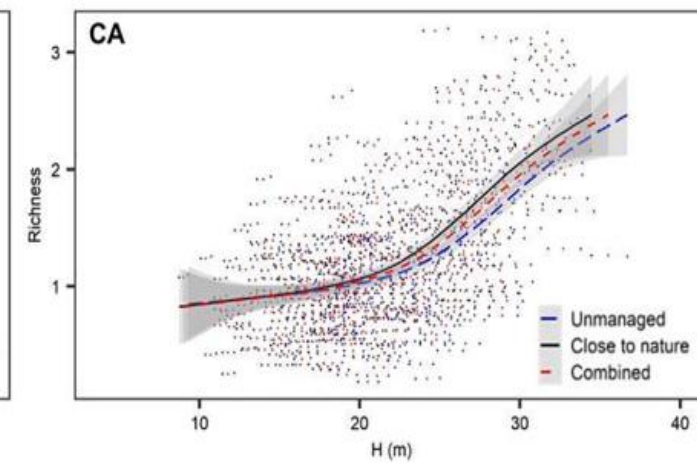
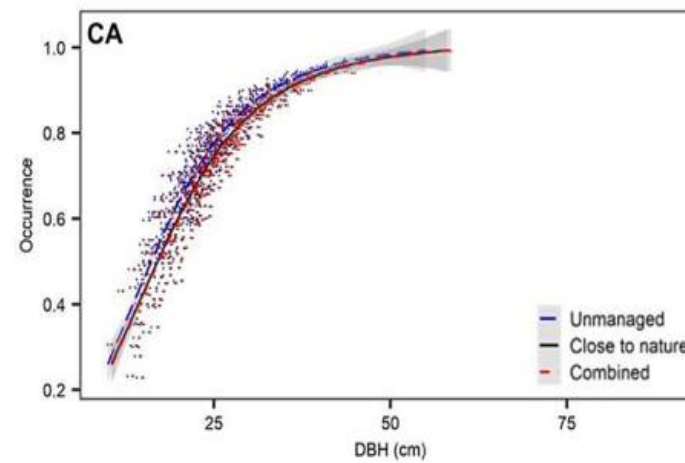
Forest Ecology and Management

Volume 503, 1 January 2022, 119780



How individual tree characteristics and forest management influence occurrence and richness of tree-related microhabitats in Mediterranean mountain forests

Giovanni Santopuoli ^a  , Matteo Vizzarri ^b, Pierdomenico Spina ^c,
Mauro Maesano ^d, Giuseppe Scarascia Mugnozza ^d, Bruno Lasserre ^c



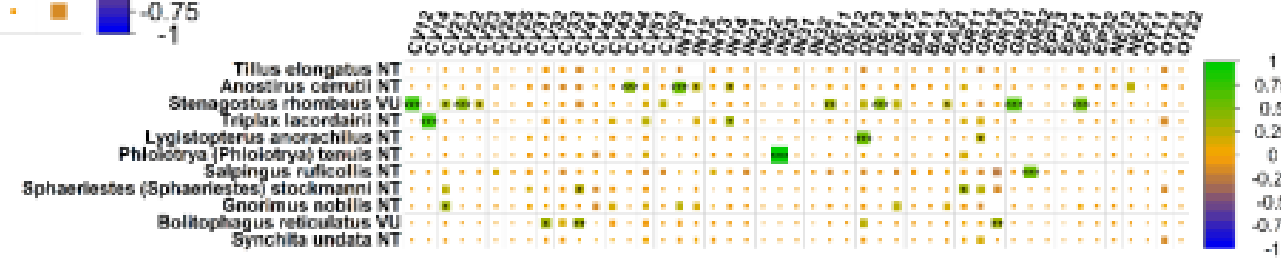
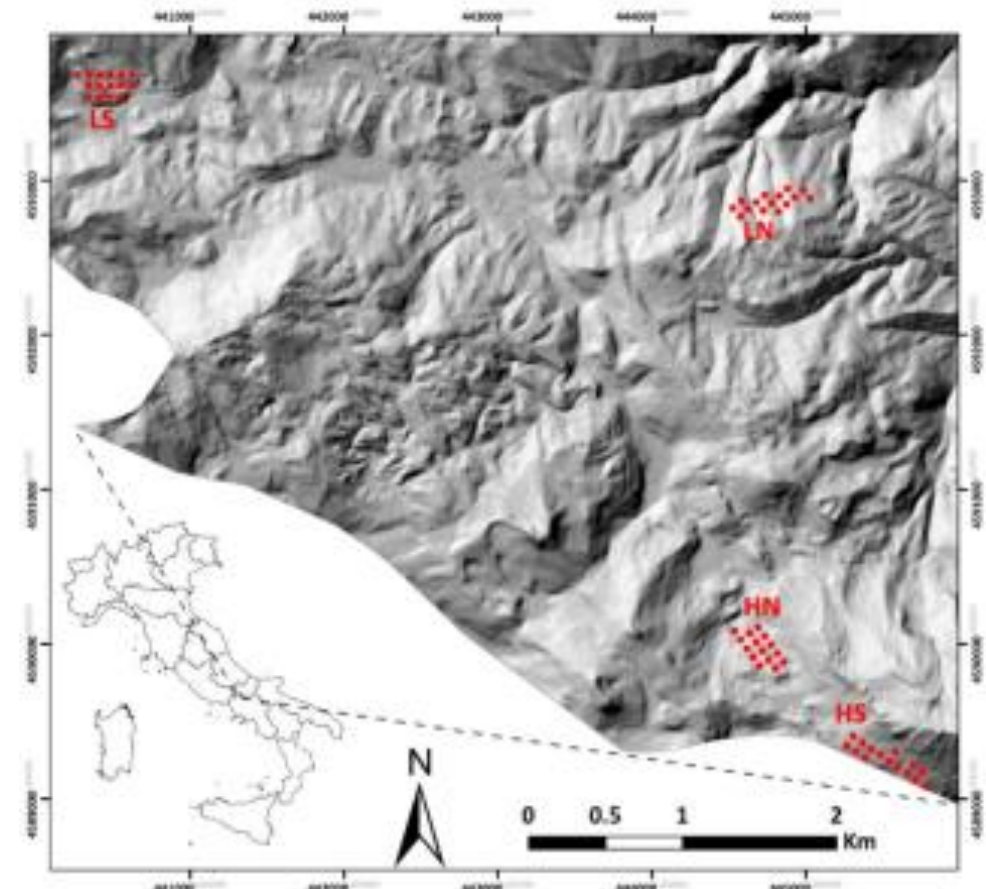
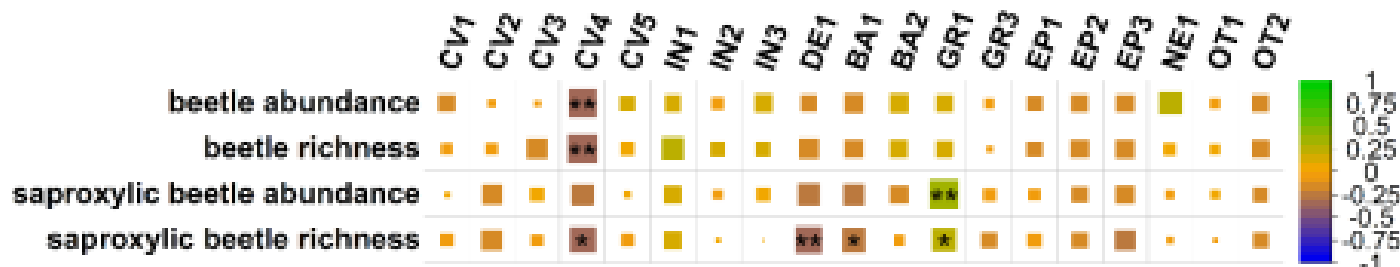
Tree-related microhabitat diversity as a proxy for the conservation of beetle communities in managed forests of *Fagus sylvatica*

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Pierdomenico Spina ✉, Francesco Parisi, Serena Antonucci, Vittorio Garfi, Marco Marchetti, Giovanni Santopuoli

Forestry: An International Journal of Forest Research, Volume 97, Issue 2, April 2024, Pages 223–233, <https://doi.org/10.1093/forestry/cpad034>

Published: 13 July 2023 Article history ▾



TreMs Spatial Index (TSI)

$$TSI = \frac{\left(\frac{HT}{T}\right) + \left(\frac{O TreMs}{T TreMs}\right)}{2 + \left(\frac{dist T}{dist HT}\right)}$$

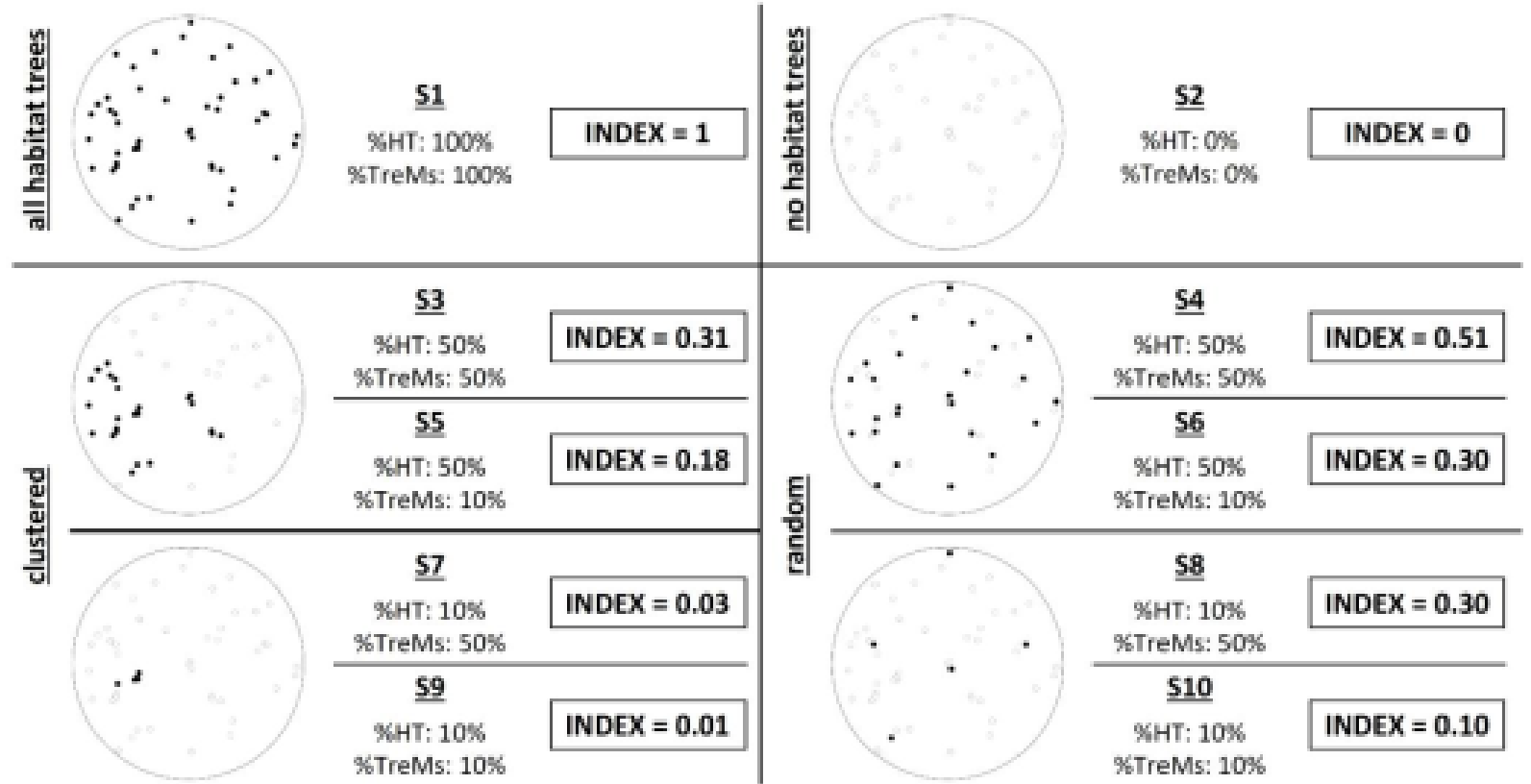


Figure 4.1. TreMs Spatial Index scenarios. The solid dots represent habitat trees, while the empty dots are the trees without TreM. %HT and %TreMs represent, respectively, the percentage of habitat trees and Tree-related Microhabitats for each scenario. The clustered distribution of habitat trees is represented on the left, while the random distribution is on the right. The average Euclidean distances of HT are: 0.51m (S7, S9), 3.37m (S3, S5), 5.41m (S8, S10), and 5.57m (S4, S6). The average Euclidean distance among all trees is 5.47m.

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Innovative tools for



A screenshot of the QGIS 2.18.4 software interface. The main window displays a map of a forest plot area with various colored polygons representing tree crowns and points representing tree locations. The interface includes a menu bar (Progetto, Modifica, Visualizza, Layer, Impostazioni, Plugins, Vettore, Raster, Database, Web, Processing, Guida), a toolbar with various GIS tools, and a Layers Panel on the left. The Layers Panel shows the following layers: Cartel1 Foglio1 None, Trees_point, Trees_CrownProj_polyg, and Plots_polyg. The Plots_polyg layer is currently selected. On the right side, there is an 'Informazioni risultati' (Information results) panel with a table structure for 'Geometria' and 'Valore'. The status bar at the bottom shows the coordinates (12.85, 12.81), scale (1:21,342,921), magnifier (100%), and rotation (0.0). The top right corner of the window shows the title '2 (esercitazione2017)' and a green circle icon.

FieldMap → field
GIS

Innovative tools for monitoring SFM

Unmanned Aerial Vehicle

FRESH LIFE14 ENV/IT/000414

Demonstrating Remote Sensing integration
in sustainable forest management



Figure 4 - An example of partially and totally defoliated crowns identified by visual interpretation of the RGB orthomosaic of the study area of Caprarola

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Unmanned Aerial Vehicle

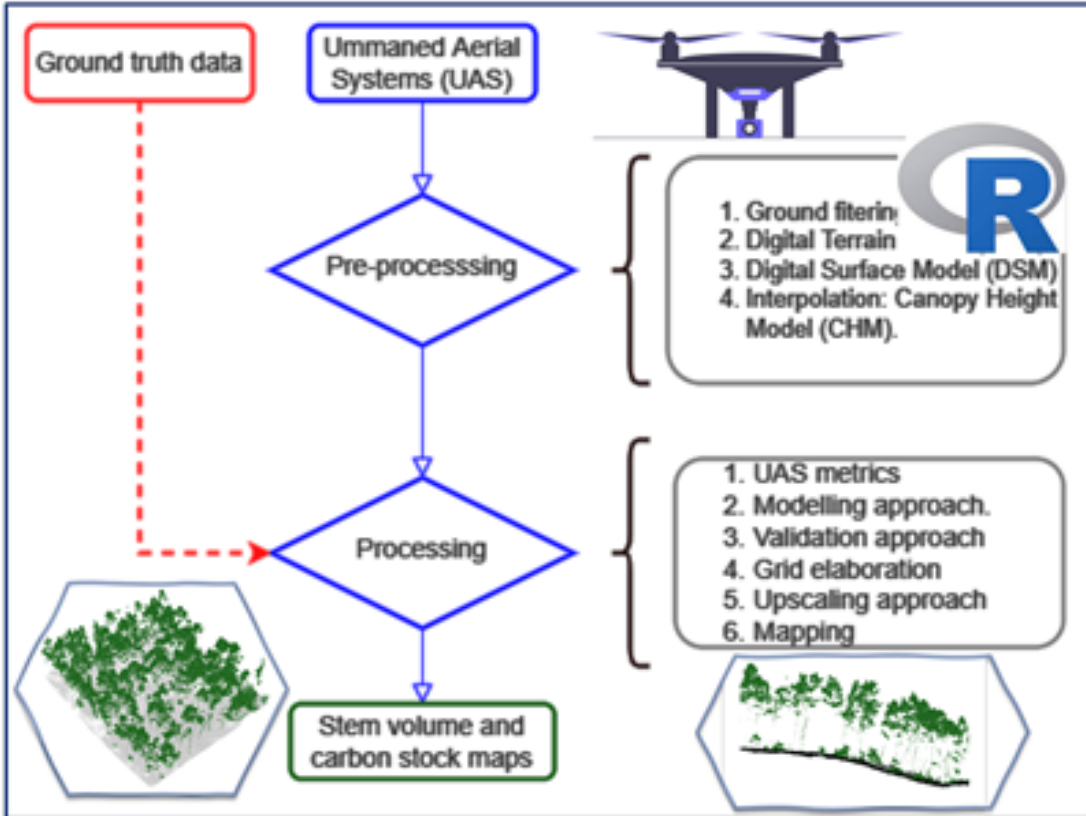


Figura 2: Approccio metodologico per l'analisi dei dati LiDAR (Light Detection and Ranging). La tecnologia LiDAR usata per la raccolta di dati attraverso un drone è comunemente definita UAS (Unmanned Aerial Systems)

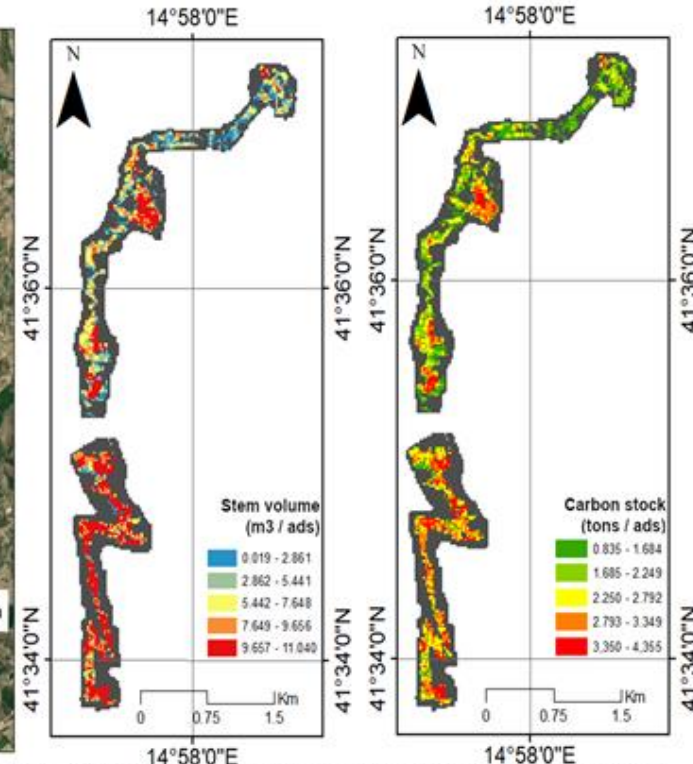


Figura 3: Da sinistra a destra, la mappa della foresta coperta dai dati LiDAR (Light Detection and Ranging) e la mappa della stima della biomassa (Stem volume m3/ads) e dello stock di carbonio (Carbon stock tons/ads) di tale foresta. Le aree di saggio 'ads' erano di 529m2.

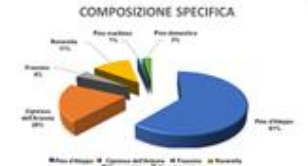


Figura 4: Composizione specifica del popolamento.

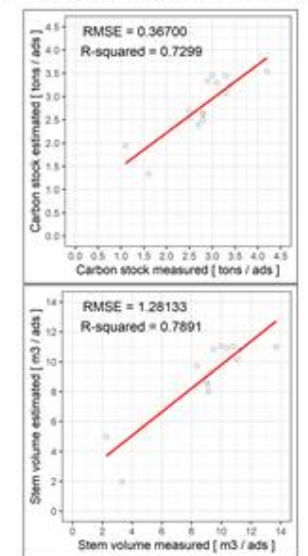


Figura 5: Confronto tra variabile osservata e predetta.

Forest management plan

Innovative tools for monitoring SFM

Airborne Laser Scanning to detect Tree-related Microhabitats



remote sensing



Article

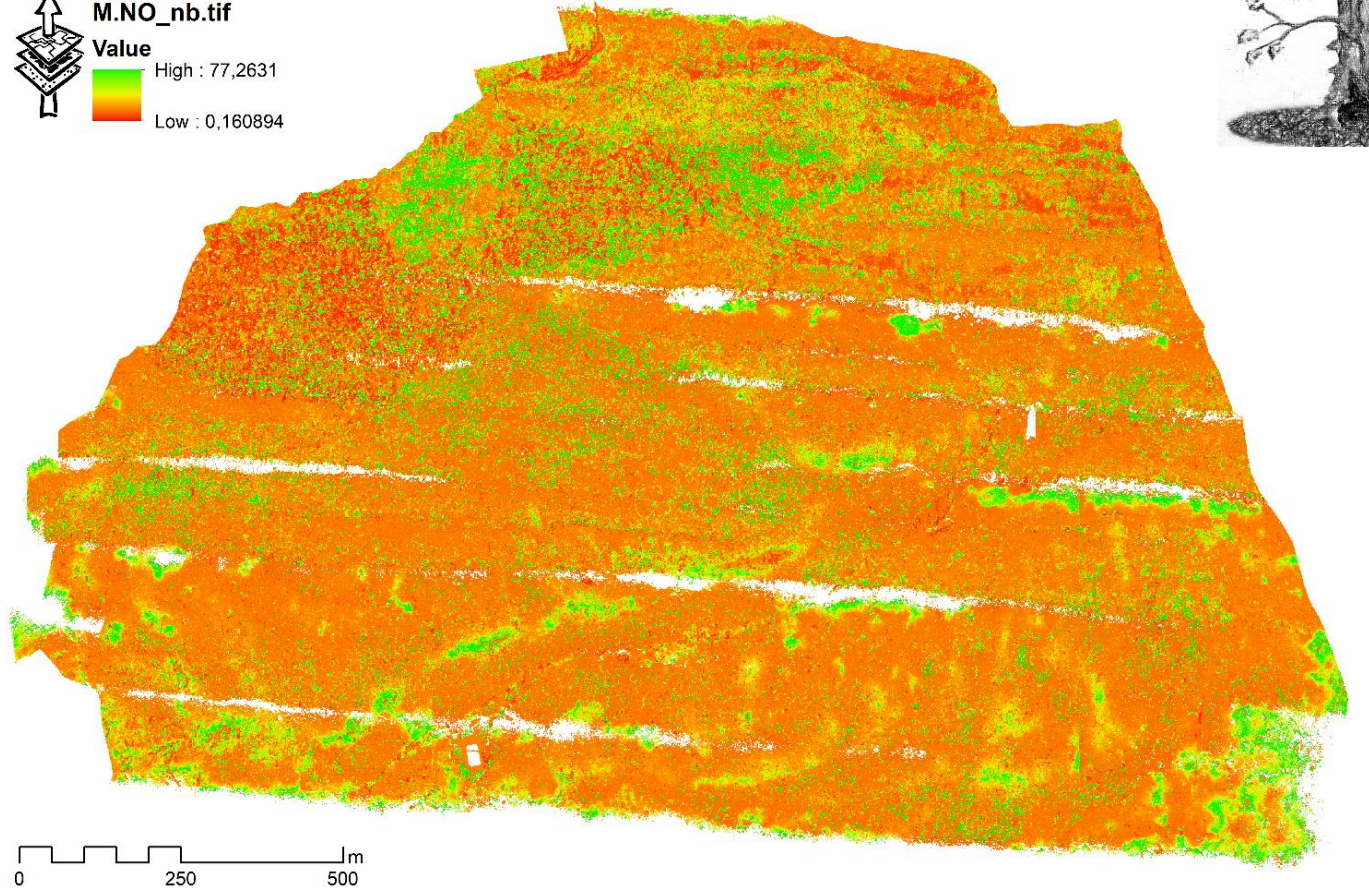
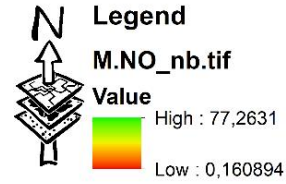
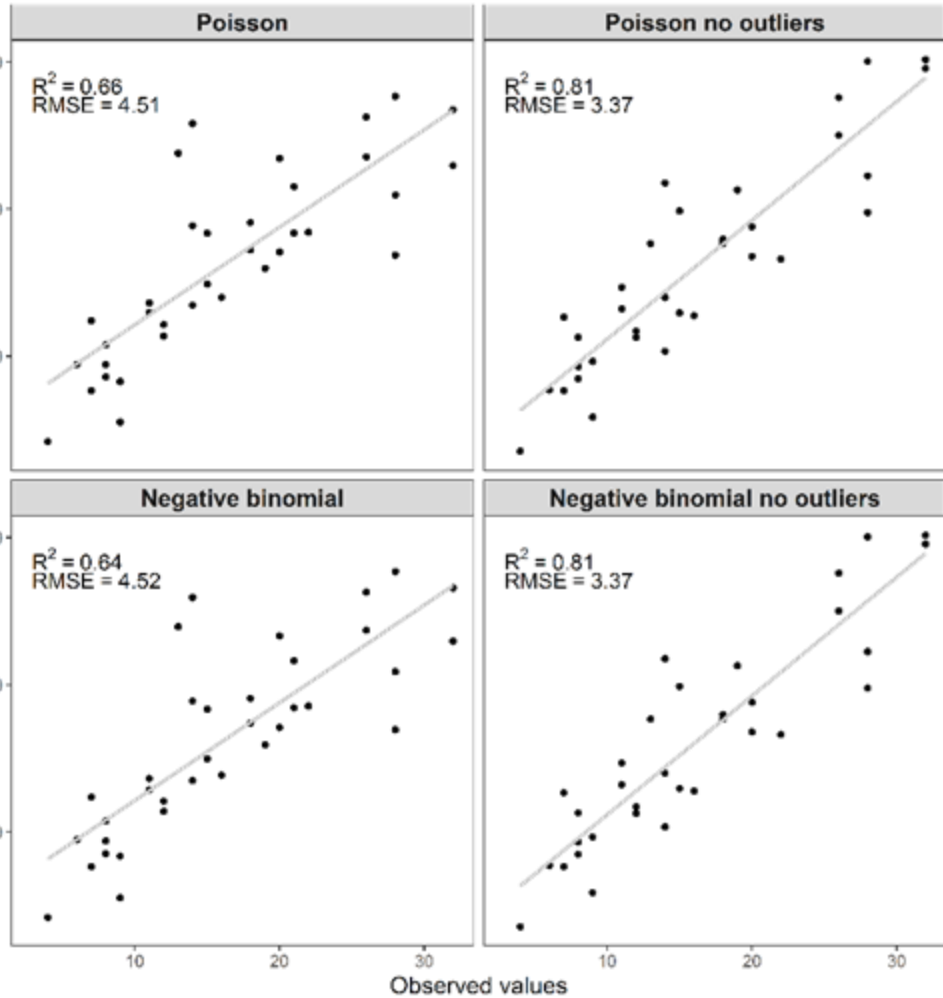
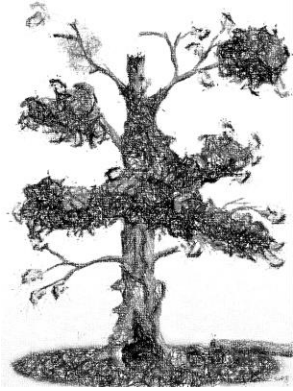
Machine Learning Algorithms to Predict Tree-Related Microhabitats using Airborne Laser Scanning

Giovanni Santopuoli ^{1,*}, Mirko Di Febbraro ², Mauro Maesano ³, Marco Balsi ⁴,
Marco Marchetti ² and Bruno Lasserre ²



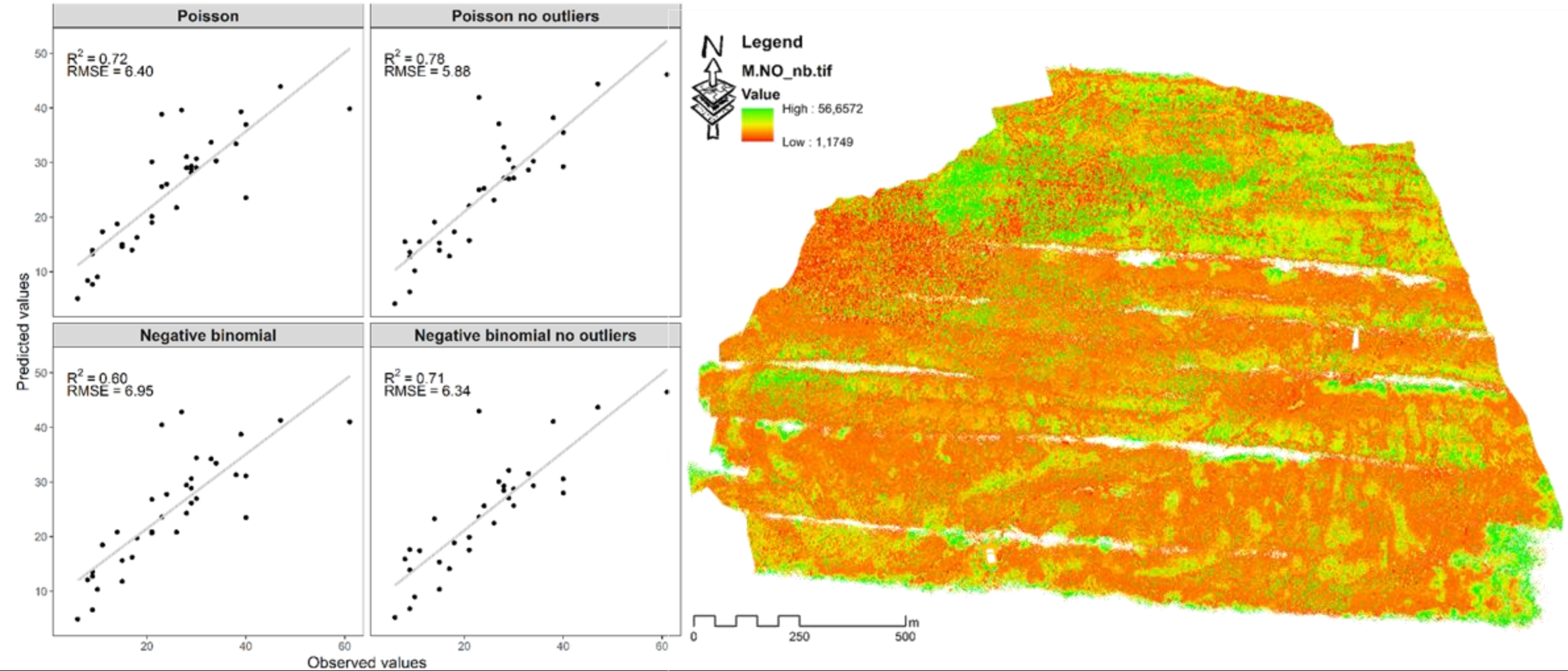
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TREES WHICH PRESENT ONE OR MORE TREMS (I.E., HABITAT TREE)



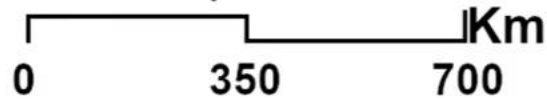
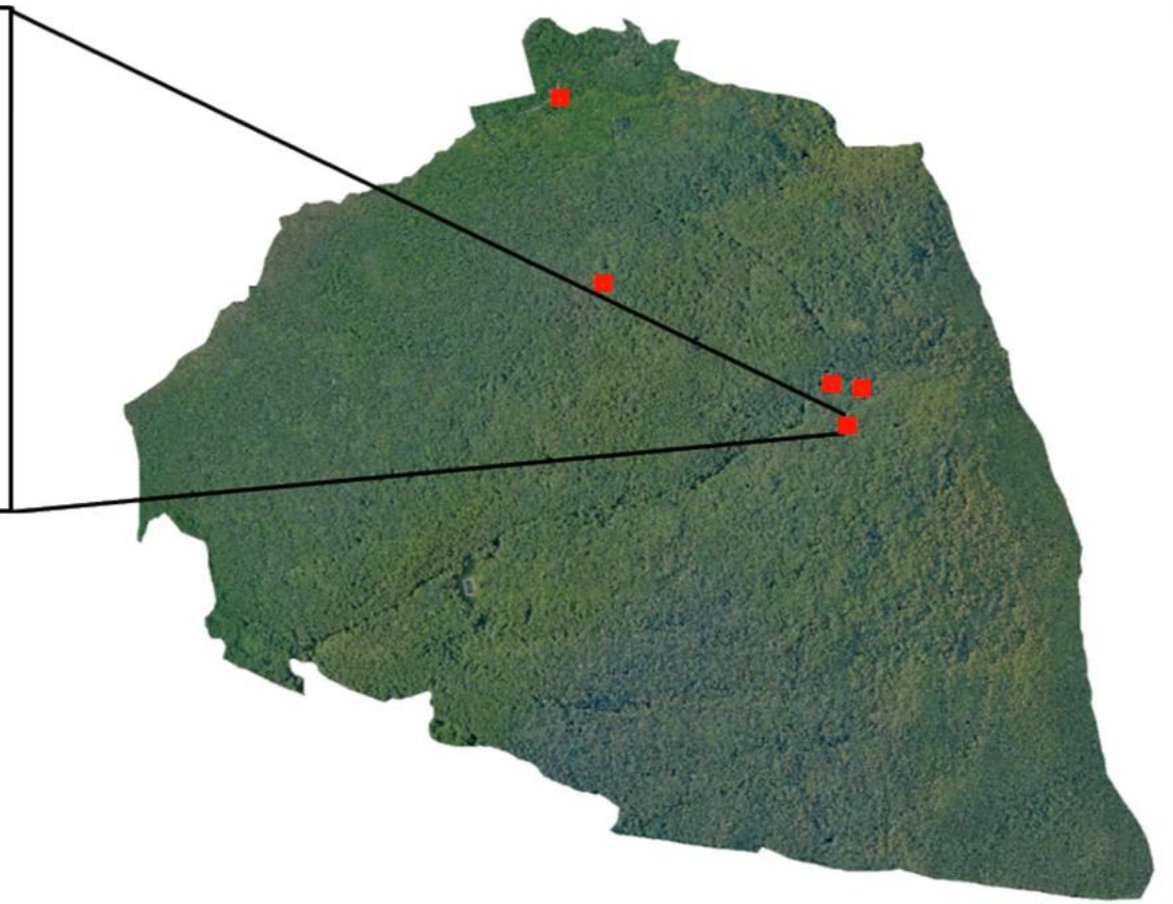
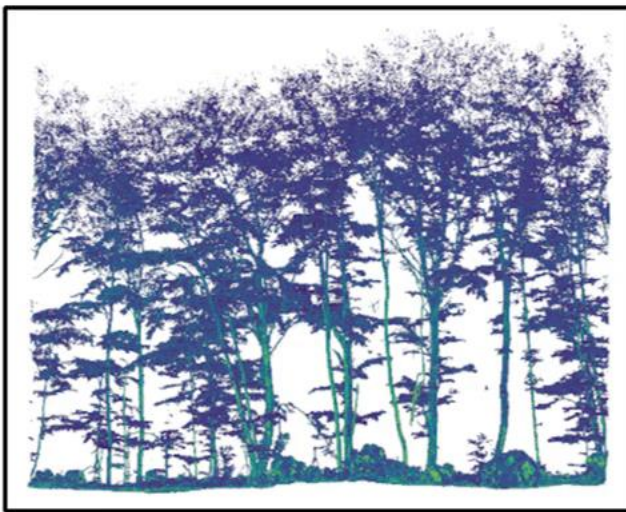
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ABUNDANCE OF TREMS

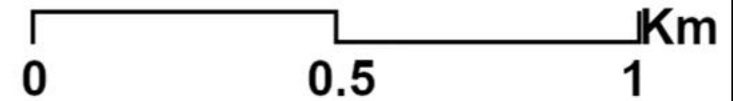


Innovative tools for monitoring SEM

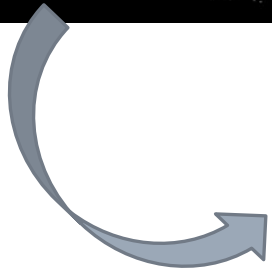




Legend
■ ADS



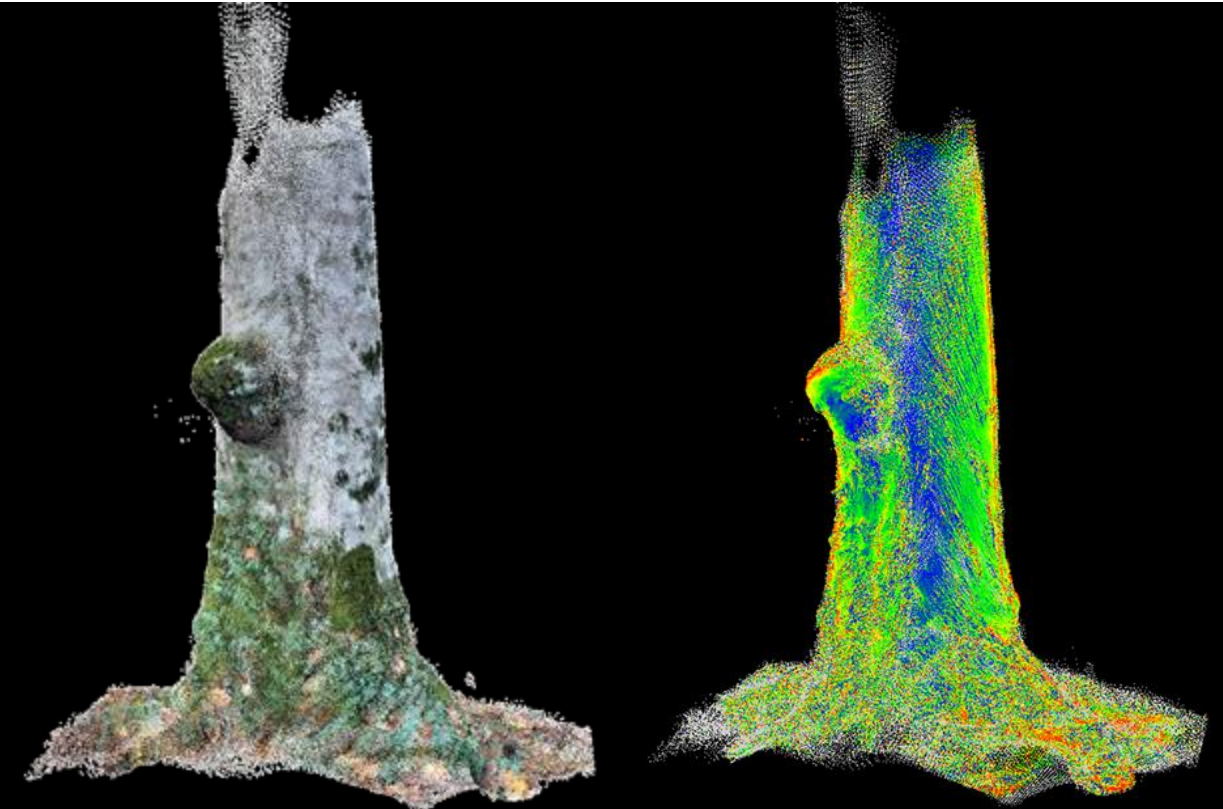
Bosco Pennataro



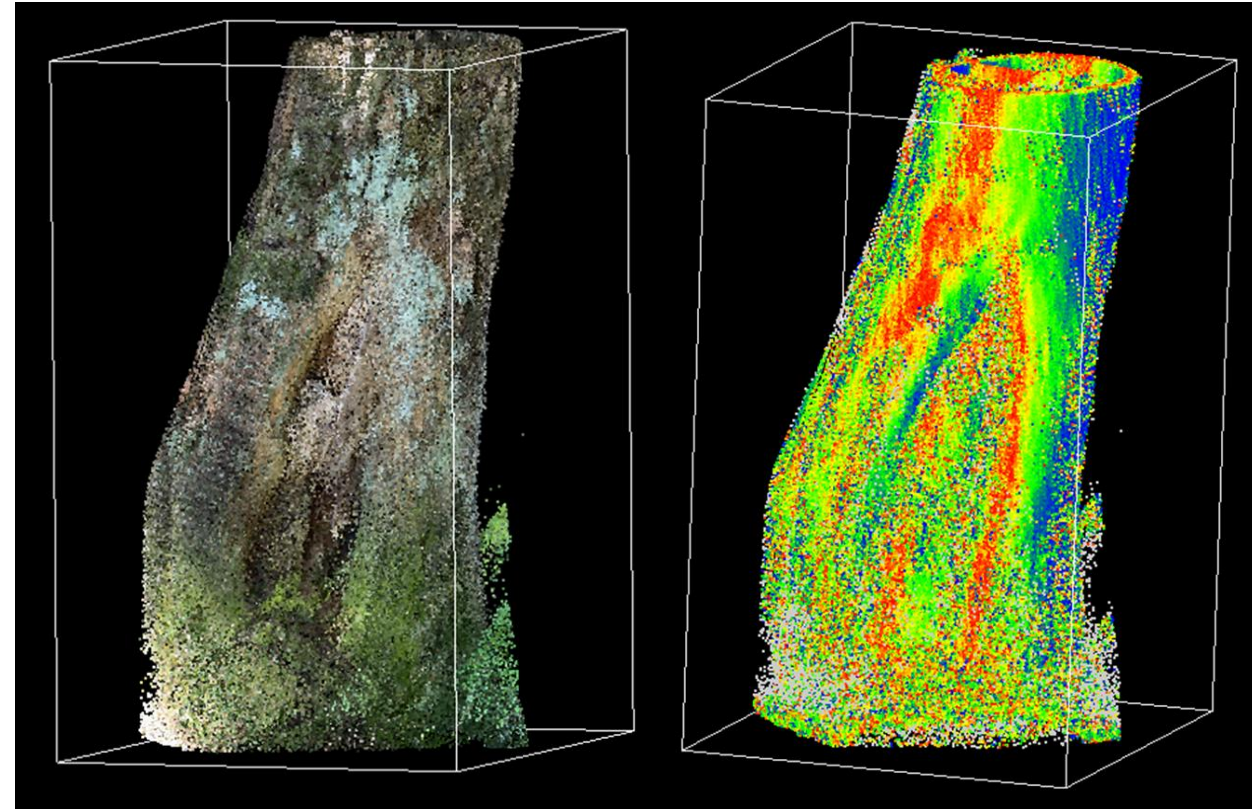
Deadwood and TreMs

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GR31

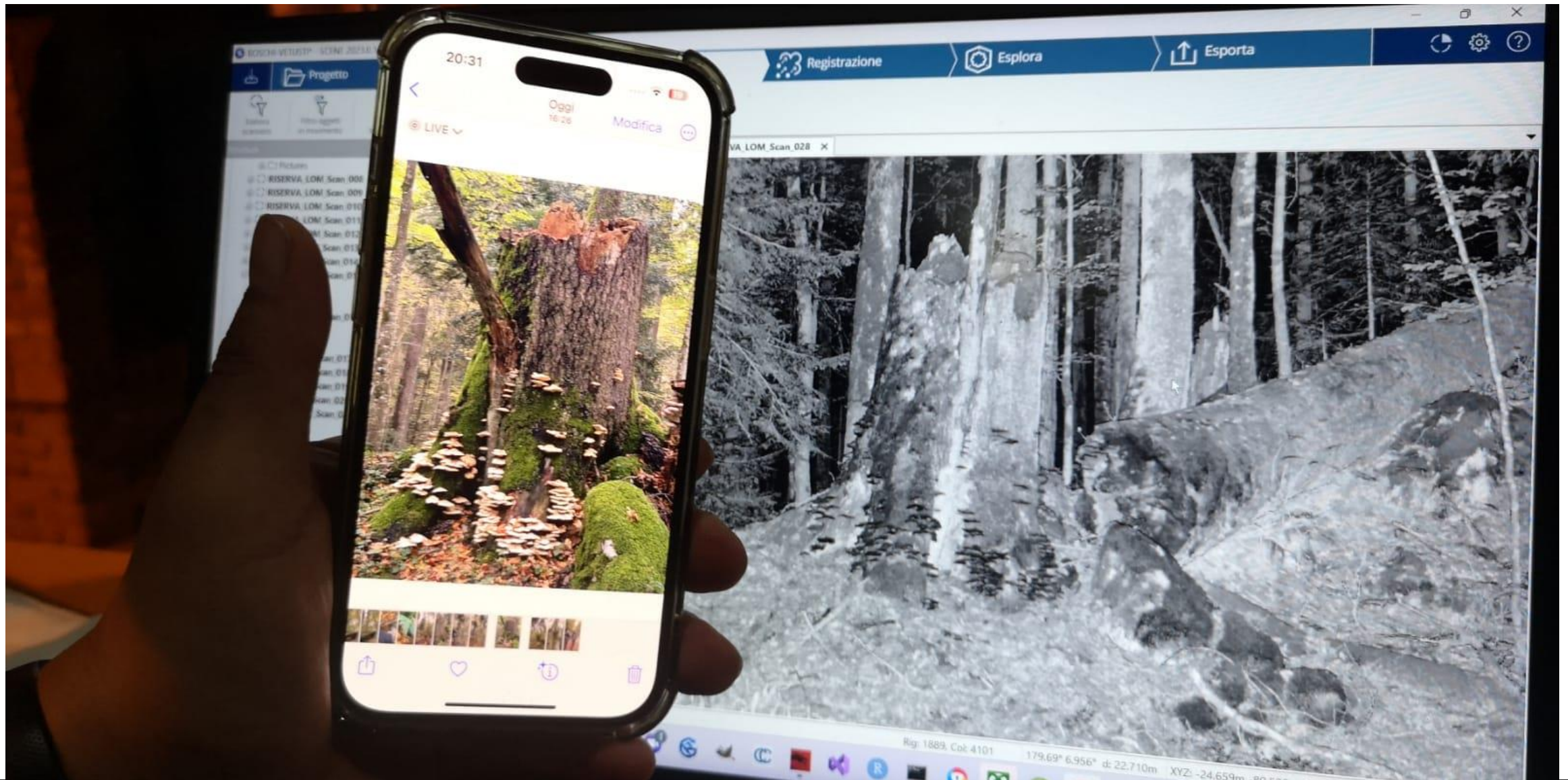


CV24



TreMs

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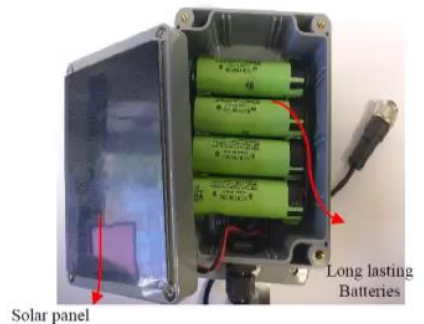
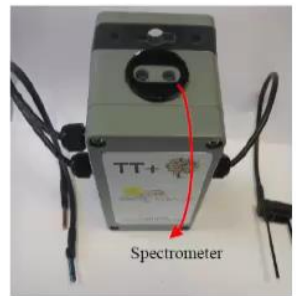
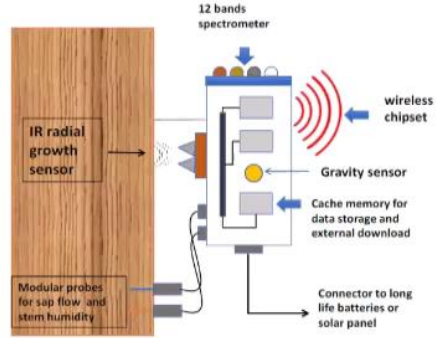


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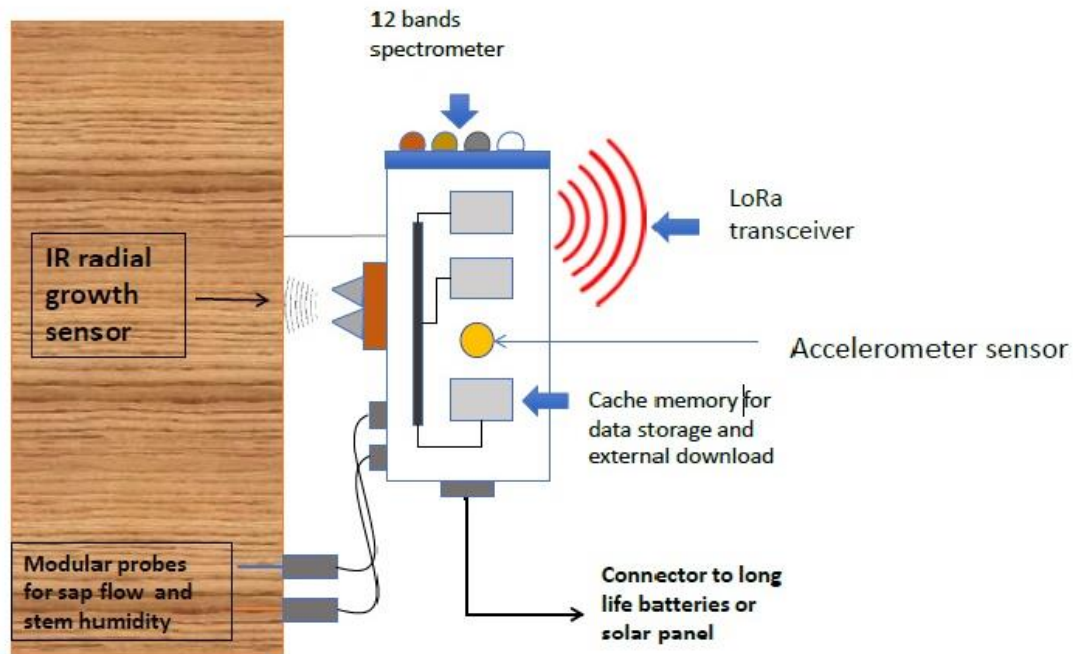


Innovative tools for monitoring SEM

Il Tree Talker
è uno
strumento
che
consente di
monitorare le
"attività
vitali delle
piante" in
continuo...



Innovative tools for monitoring SFM



1 hour sampling rate

Transpiration (sap-flow)

Stem humidity (SWC)

Multispectral signature of light transmitted through the canopy

Tree radial growth

Accelerations along a 3D coordinate system used to detect tree movements

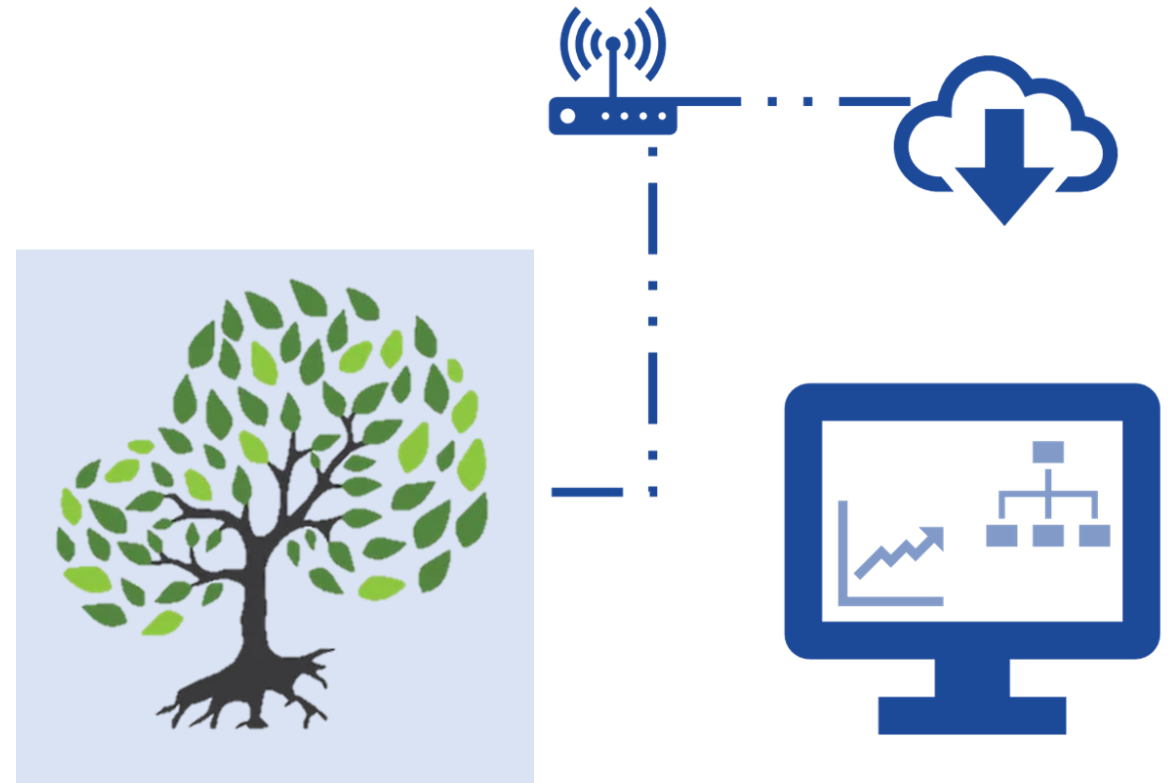
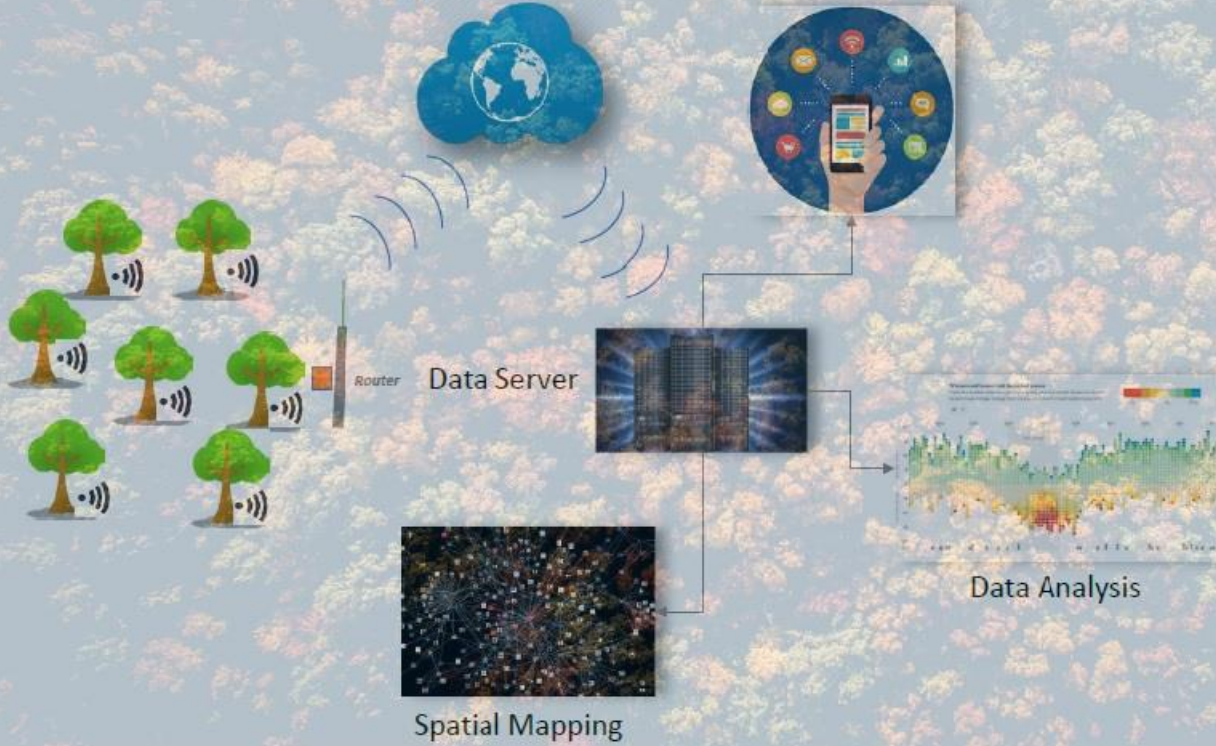
Air temperature and relative humidity

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The Network

LoRa Technology

Dedicated APPS and WEB visualization

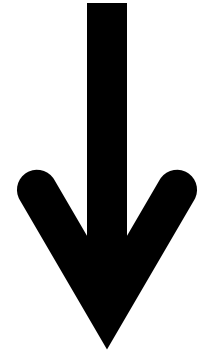


TT-Cloud is in turn connected to the internet via the GPRS network and sends data to a computer server

Innovative tools for monitoring SFM

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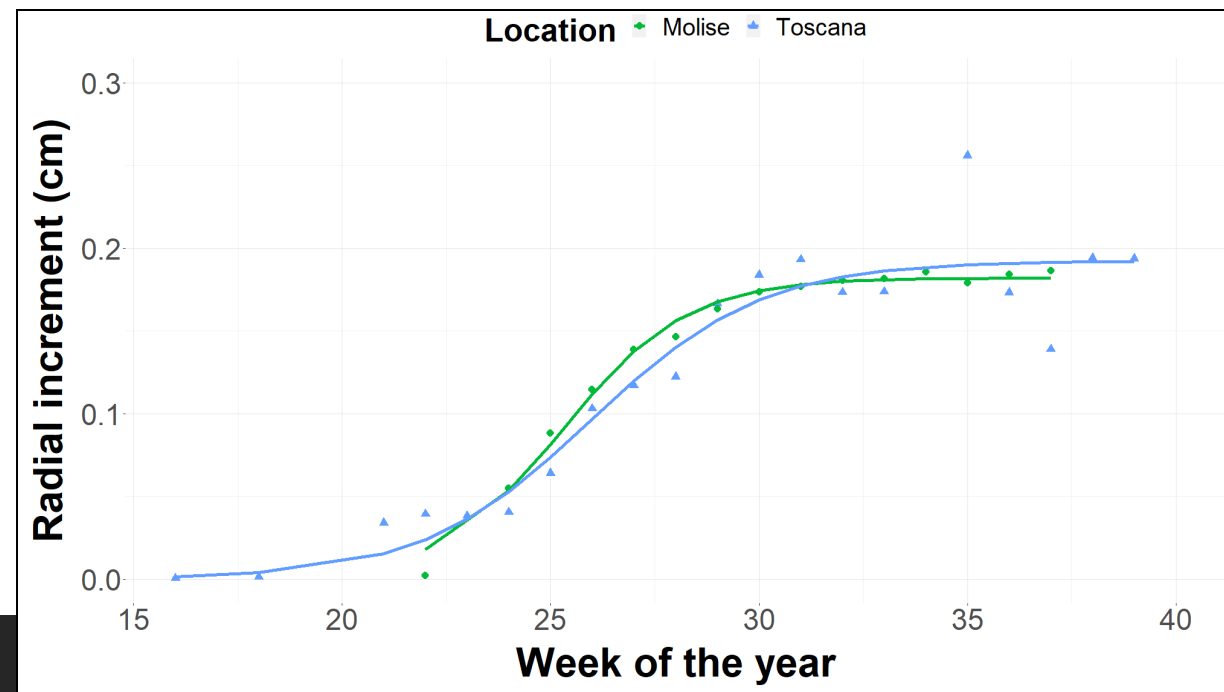
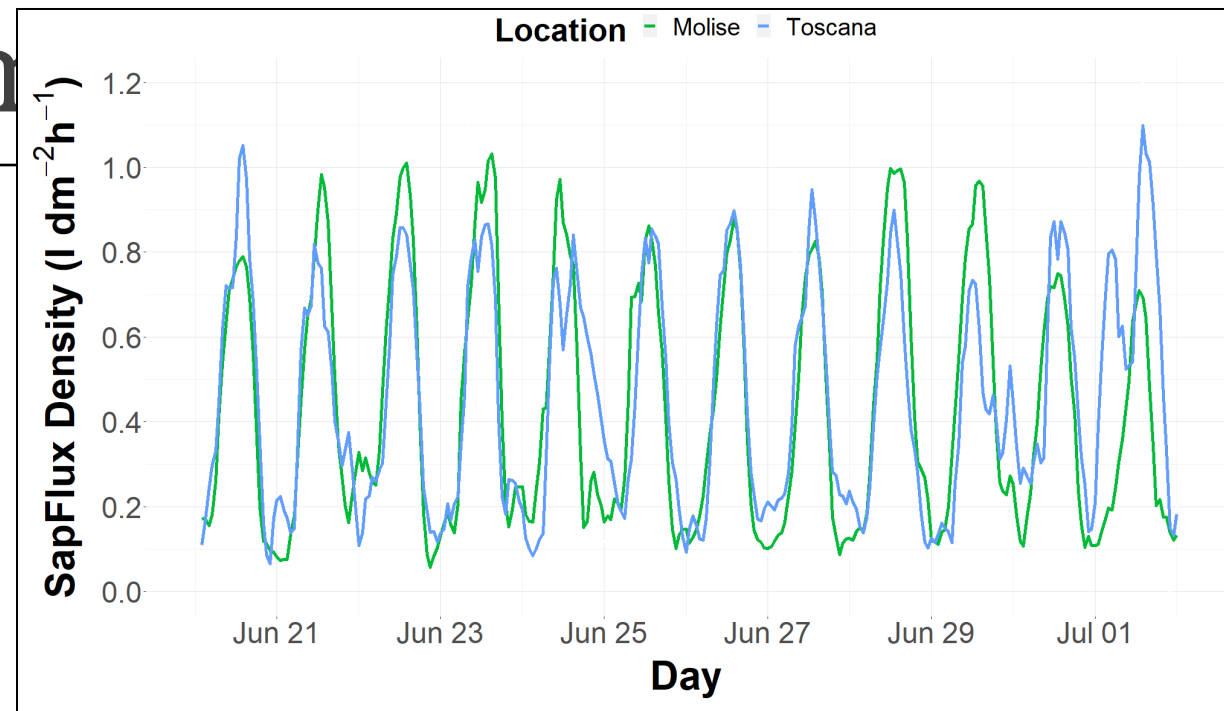
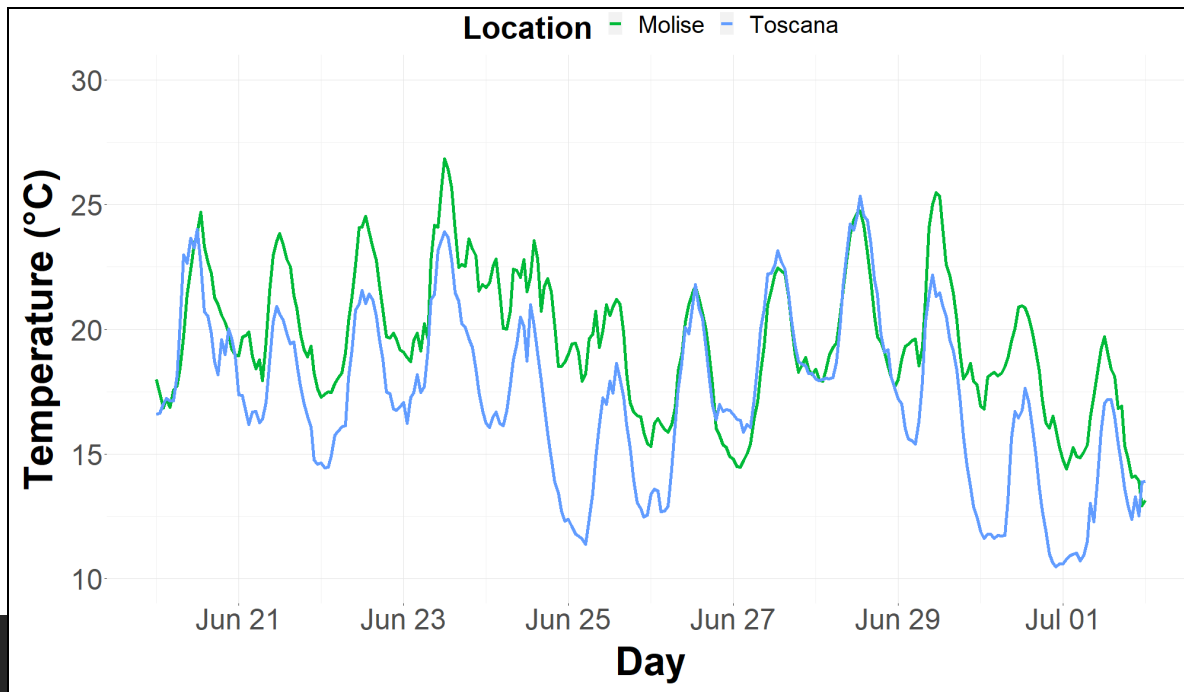
Data server



Innovative tools for n

Comparison between two sites in Italy

- *Temperature,*
- *SapFlux,*
- *radial growth.*



Innovative tools for monitoring SFM

Water



Damaged sensors

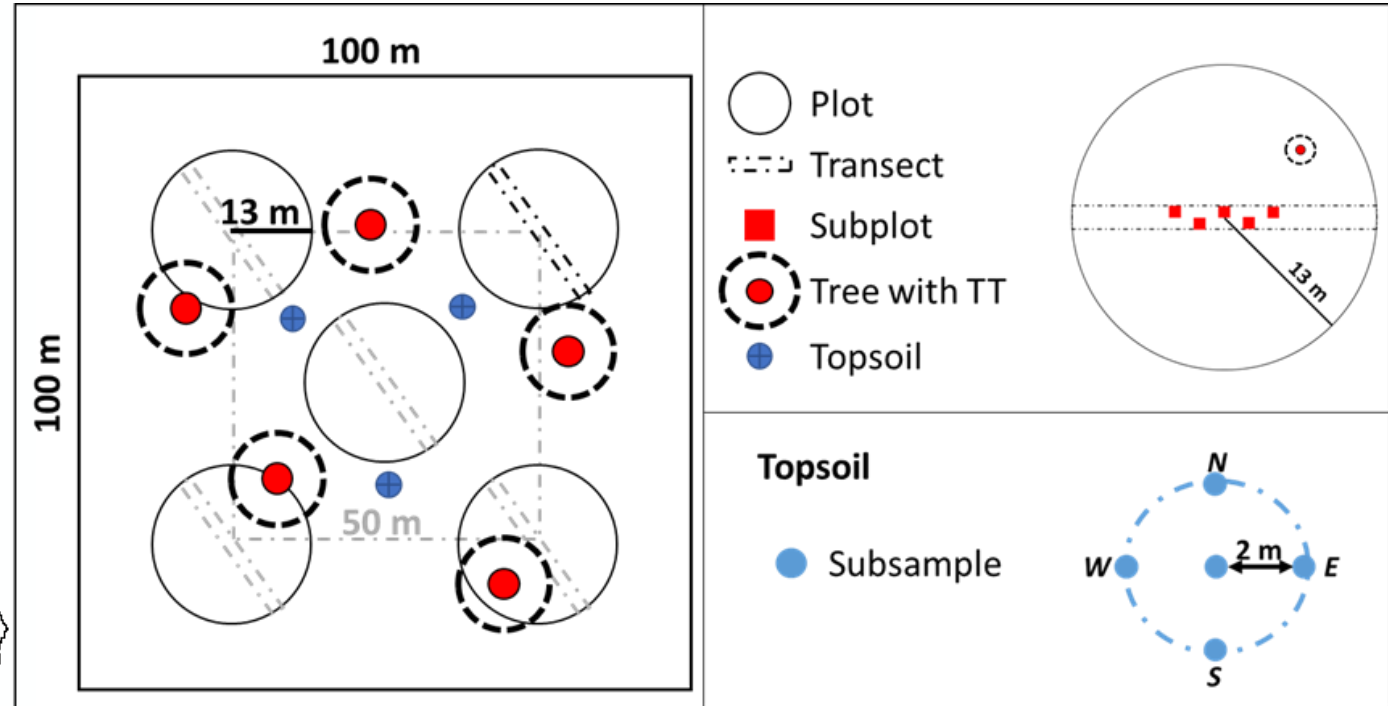


Replaced sensors/TTs



Innovative tools for monitoring SFM

Lanuvaretaliana di TreeTalker



Innovative tools for monitoring SFM



Field activities

G. Santopuoli – Montenegro 2021



<http://www.integrateplus.org/Demo-Sites/What-is-a-Marteloscope/table.html>



Integrate Tree Microhabitat App

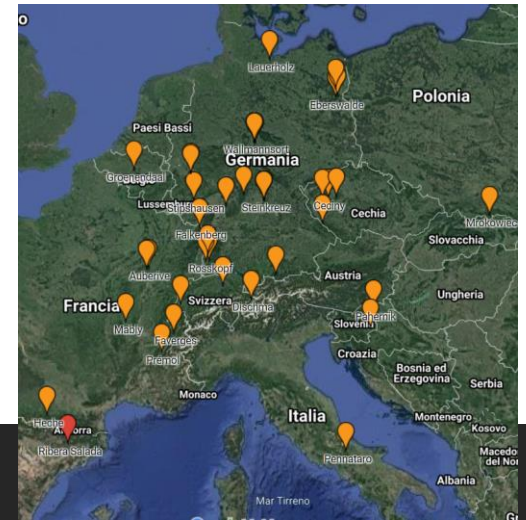
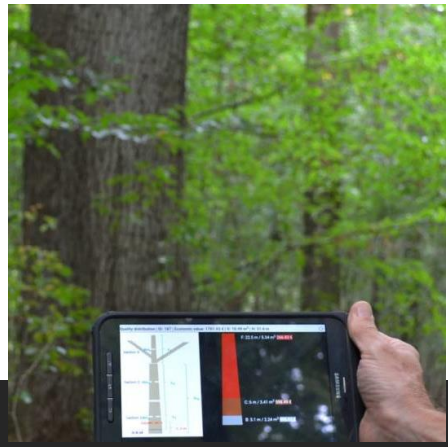
European Forest Institute Istruzione ★★★★★

PEGI 3

L'app è compatibile con tutti i tuoi dispositivi

Aggiungi alla lista desideri

Installa



PhD. Serena Antonucci



PhD. Cesar Alvites



Ph.D Tiziana Panichella



Ph.D student Diana Alfieri



Ph.D student Pierdomenico Spina



Ph.D student Concetta Lisella



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G. Santopuoli – PNALM (Italy) 2019

Thank you!



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**DIPARTIMENTO
AGRICOLTURA,
AMBIENTE E ALIMENTI**