Assessing and Monitoring forest biodiversity

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07-05-2024

Agenda

Introduction

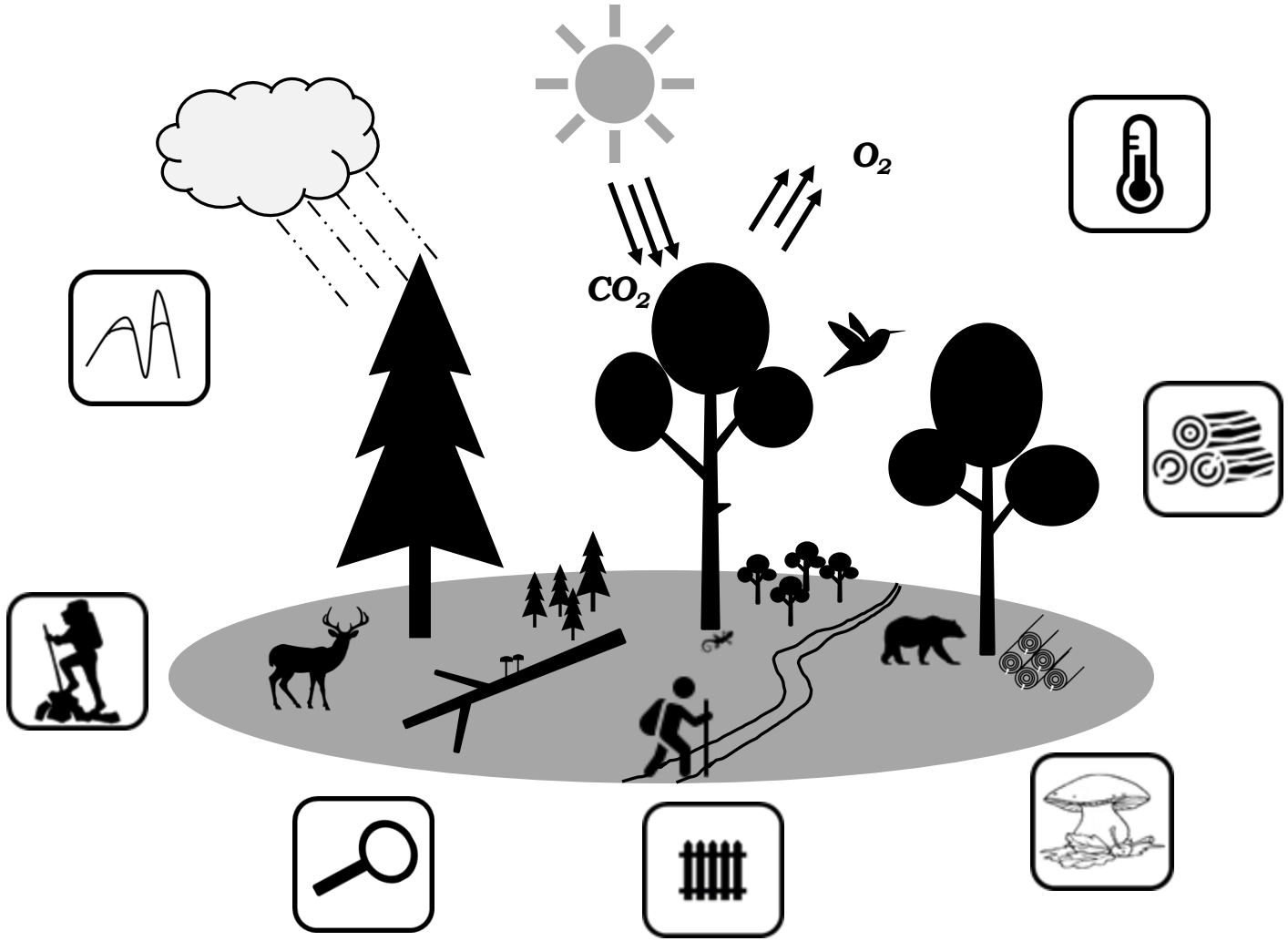
Tree-related Microhabitats

Monitoring tool

Why is forest monitoring important?

Sustainable Forest Management

Numerous benefits to society



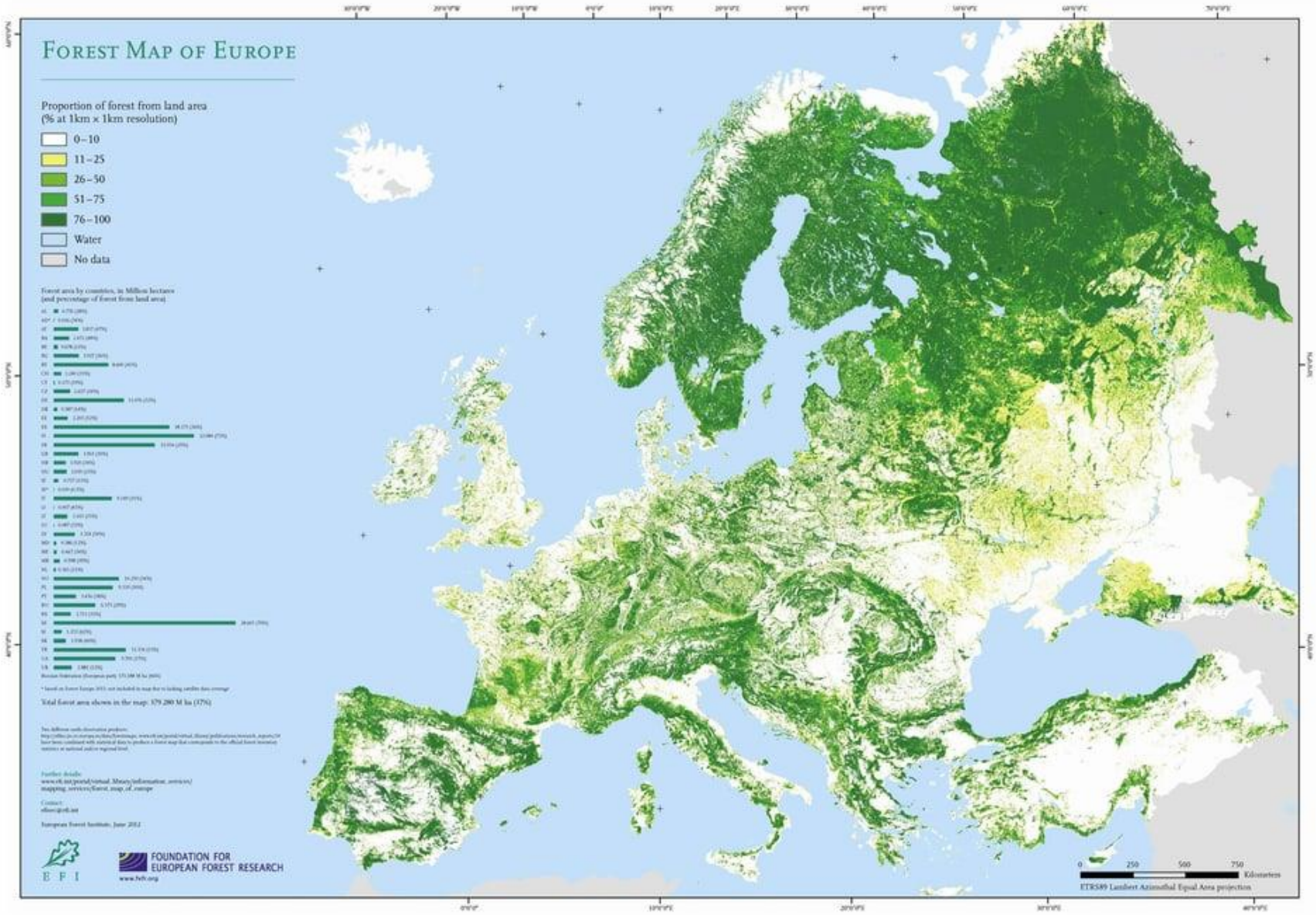
Forest resources and benefits

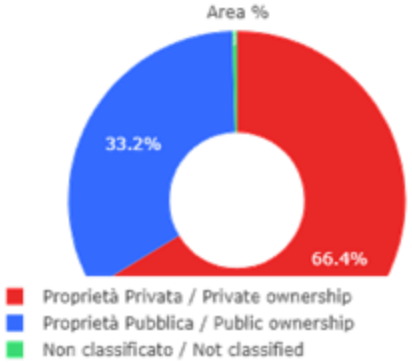
Forests cover
35%
of Europe's total land area

155 million tonnes
of carbon per year

The forest sector contributed about 0.7% to GDP in Europe

Forest Europe growing life





In Italy

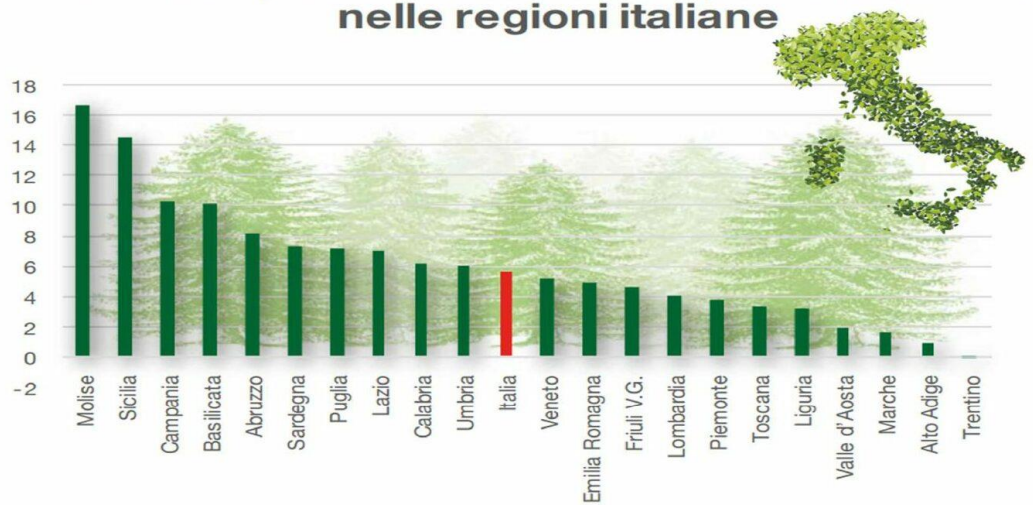
~ 12 Millions ha

~36% sup. national

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

CARABINIERI

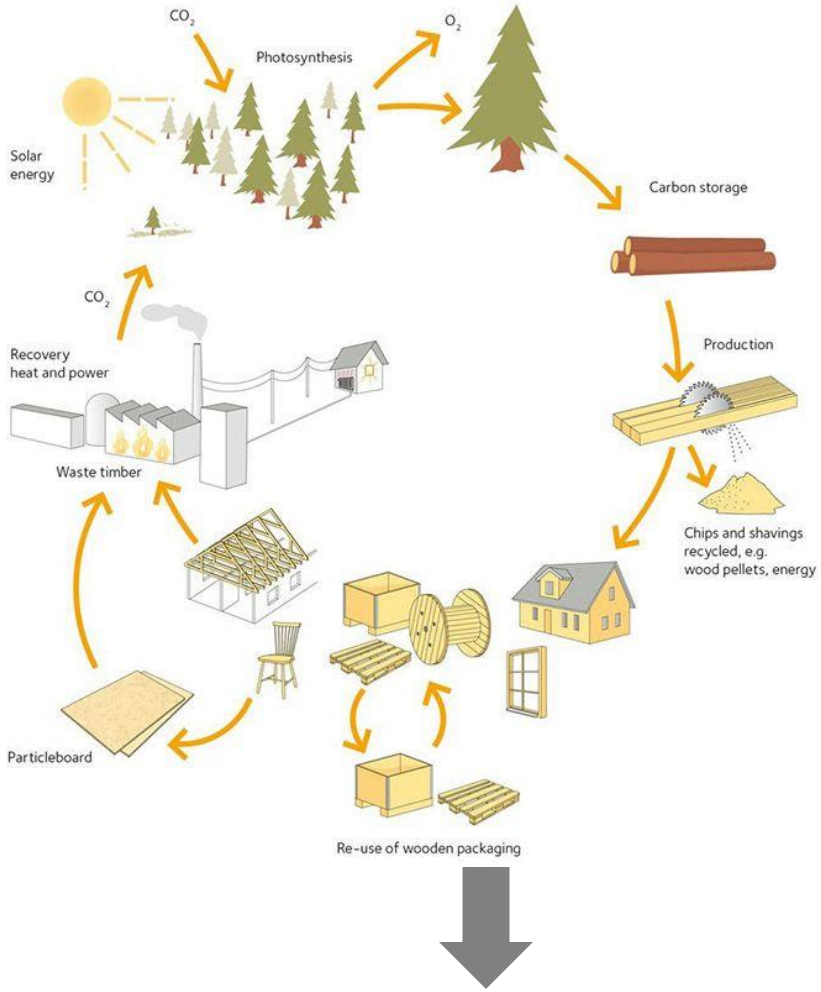
Crescita percentuale della superficie boscata nelle regioni italiane



INFC 2015

https://www.sian.it

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



Durable wood products
Low quality timber for energy

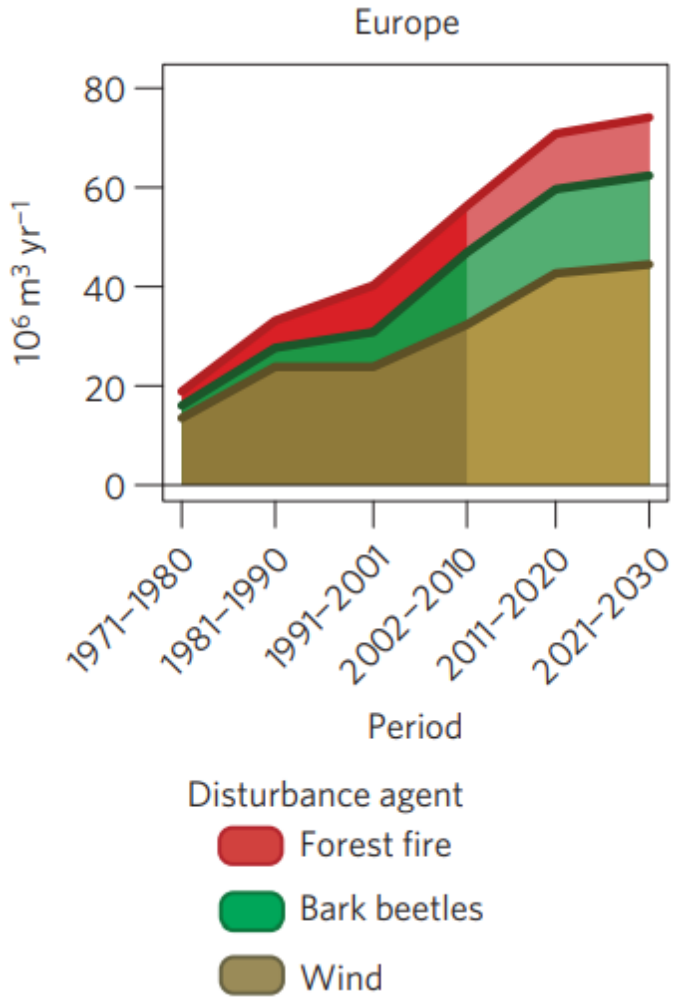
Main threats to forests

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 Schelhaas[2], Werner Rammer[1] and Pieter Johannes Verkerk[3]

Disturbances from wind, bark beetles and wildfires have increased in Europe's forests throughout the twentieth century[1]. Climatic changes were identified as a key driver European forest C sink recently[5]. 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

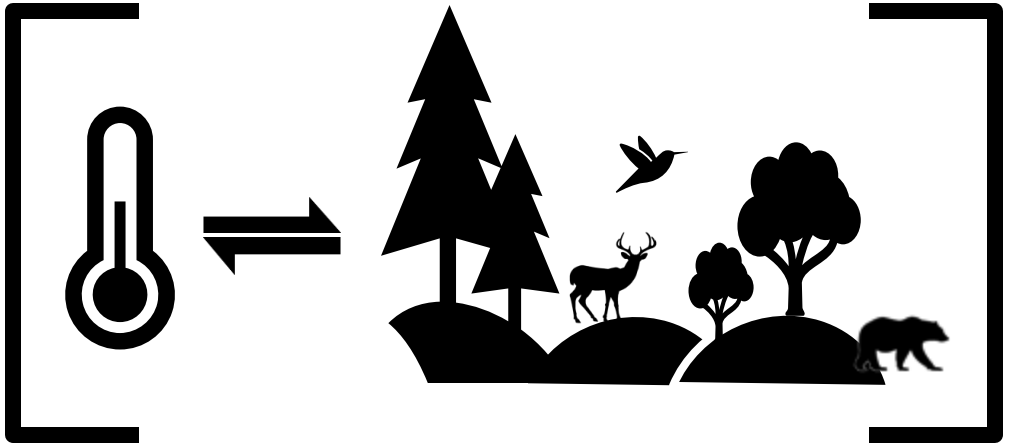


Not only carbon storage, but also loss of biodiversity and other ecosystem services

Bosnia Herzegovina

Human wellbeing

To halt current threats

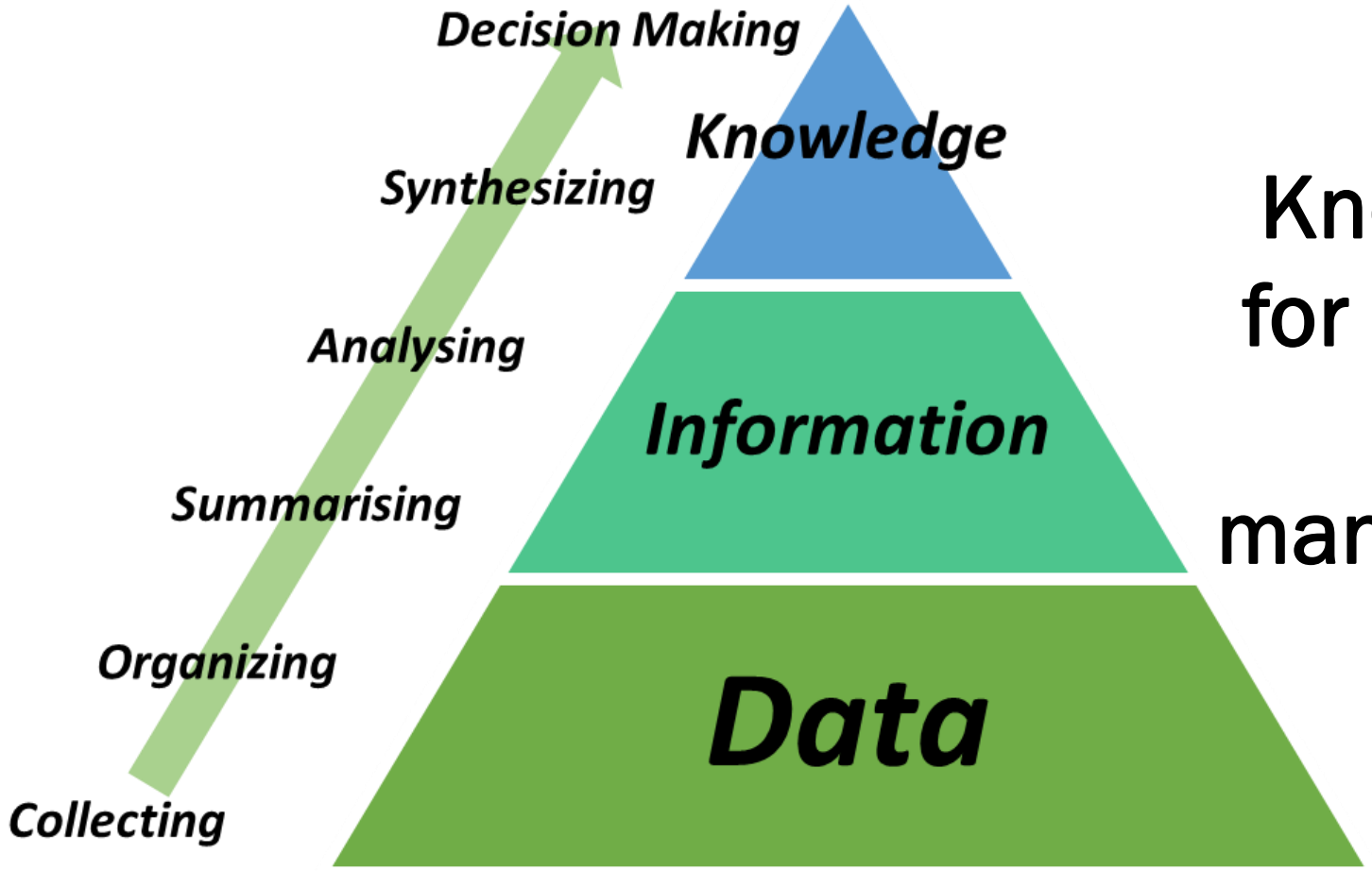


To reduce the loss of ecosystem services

Monitoring forest variables

Promote resilience of forests

Enhance forest biodiversity



Knowledge for planning and management

Tools for monitoring SFM

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

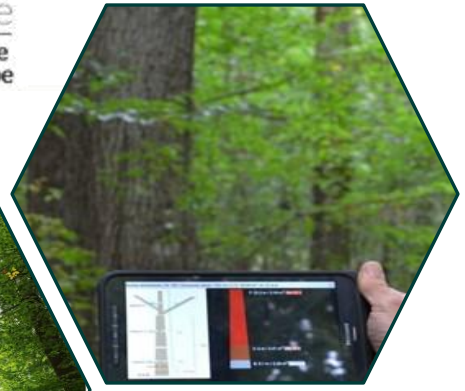
C6 - Socioeconomic Functions

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

Forest Europe growing life
Ministerial Conference on the Protection of Forests in Europe

C5 - Protective Functions (Soil & Water)

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



C3 - Productive Functions of Forests

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

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

C4 - Forests Biological Diversity

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

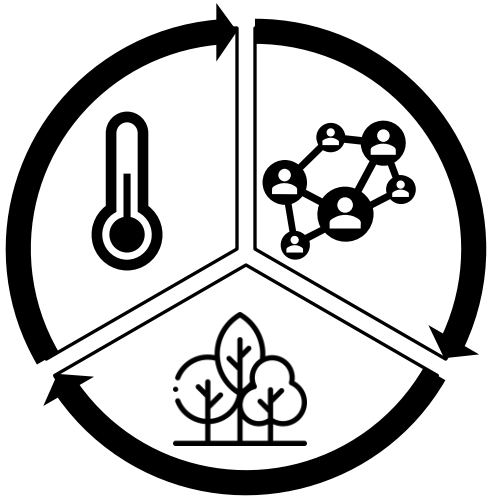
State of Europe's Forests (SoEF)

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.

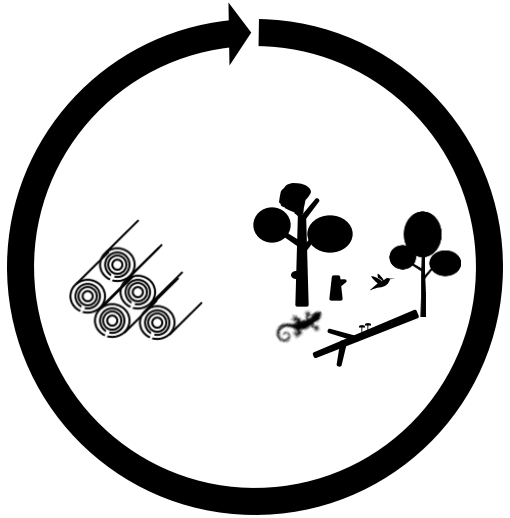
Tools for monitoring SFM

Sustainable Forest Management

Climate-Smart Forestry

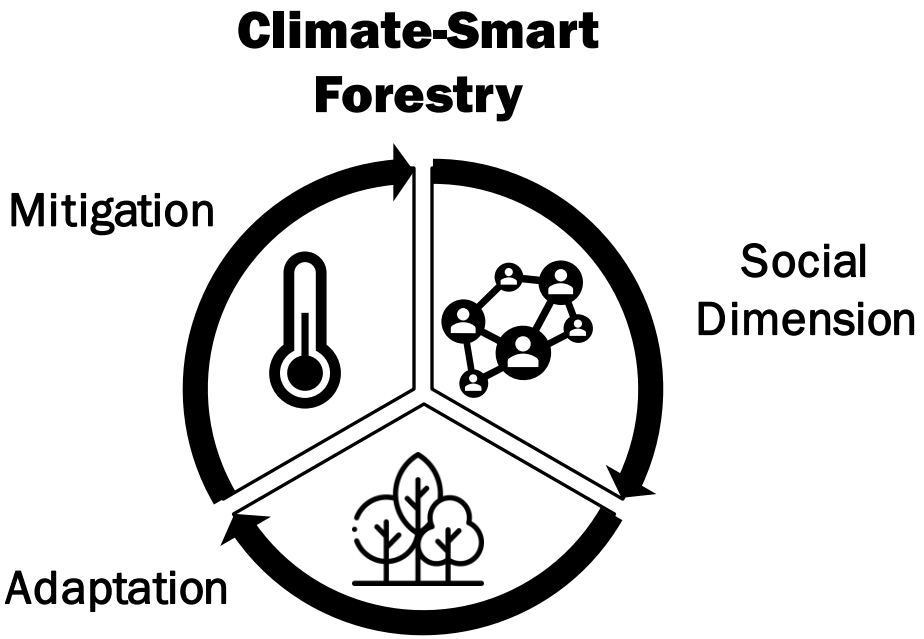


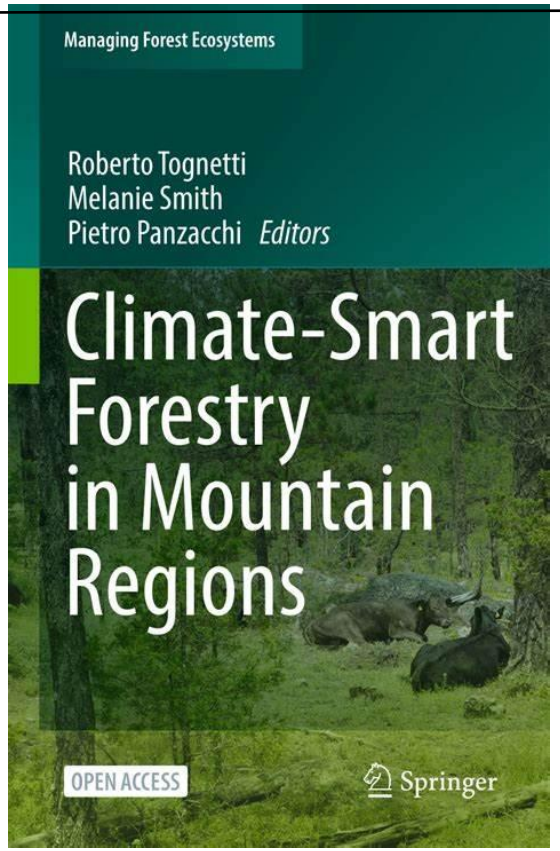
Integrative Forest Management



Bosco Roccamandolfi, Molise

Climate – Smart Forestry





CLIMO
CLImate-Smart Forestry in MOuntain Regions

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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.

Ecosystem Services 43 (2020) 101113

Contents lists available at ScienceDirect

Ecosystem Services

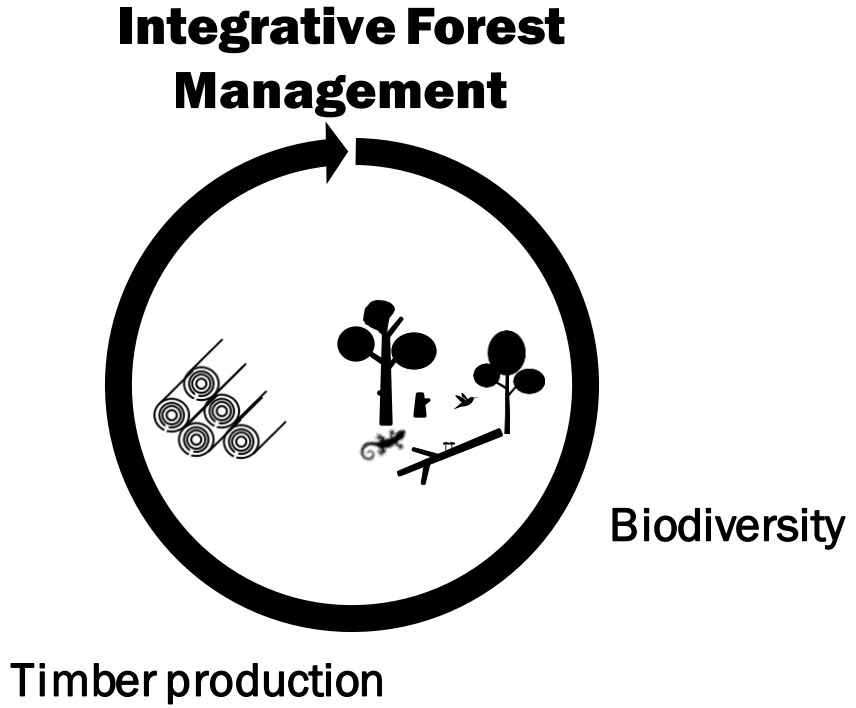
journal homepage: www.elsevier.com/locate/ecoser

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

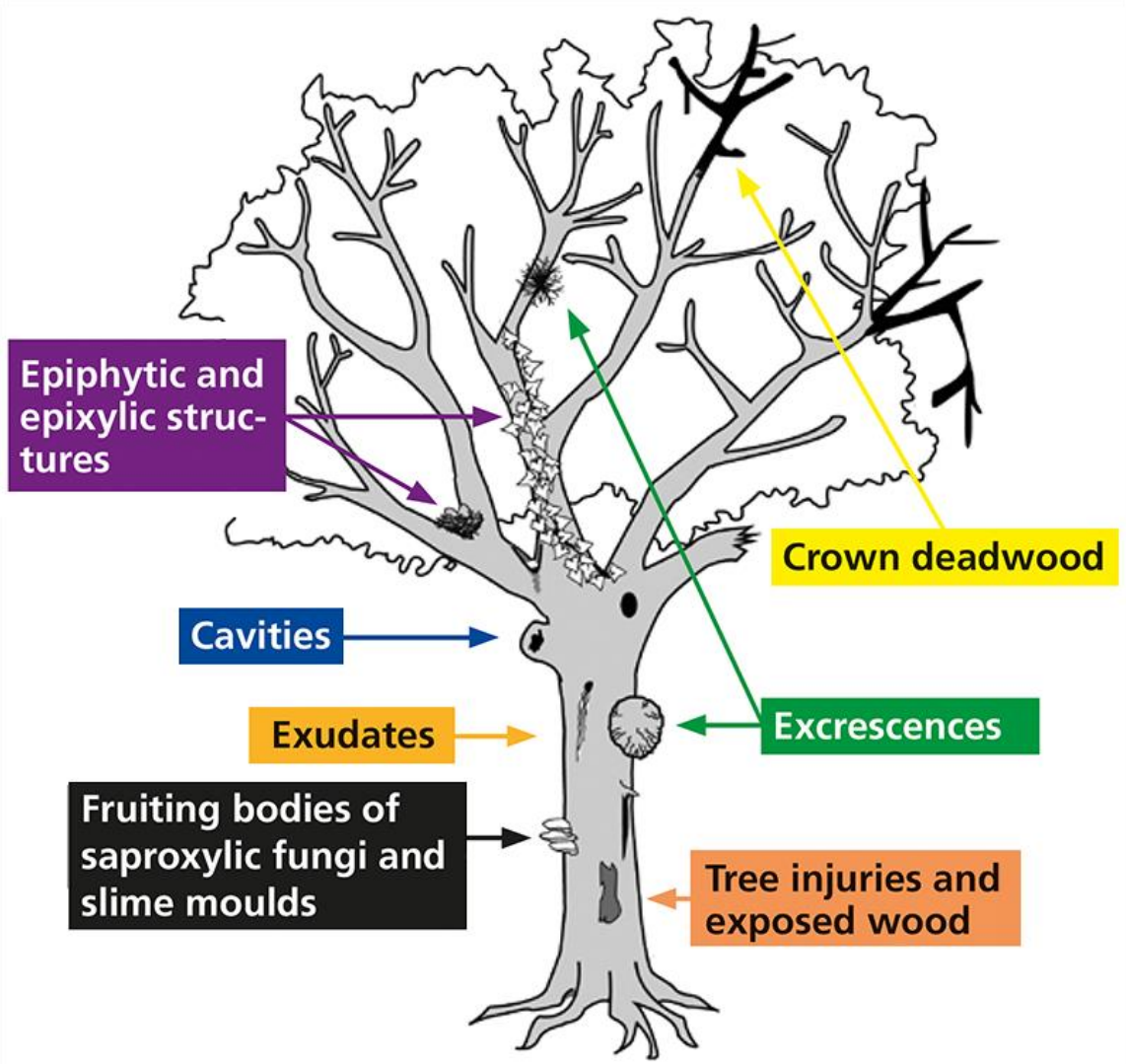
Euan Bowditch[a], Giovanni Santopuoli[b,c,*], Franz Binder[d], Miren del Río[e,f], Nicola La Porta[g,h], Tatiana Kluvankova[i], Jerzy Lesinski[j], Renzo Motta[k], Maciej Pach[l], Pietro Panzacchi[c,m], Hans Pretzsch[n], Christian Temperli[o], Giustino Tonon[m], Melanie Smith[a], Violeta Velikova[p],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

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***.



Tree-related microhabitats



Integrative Forest Management - TreMs

Kraus et al., 2016

Catalogue of tree microhabitats

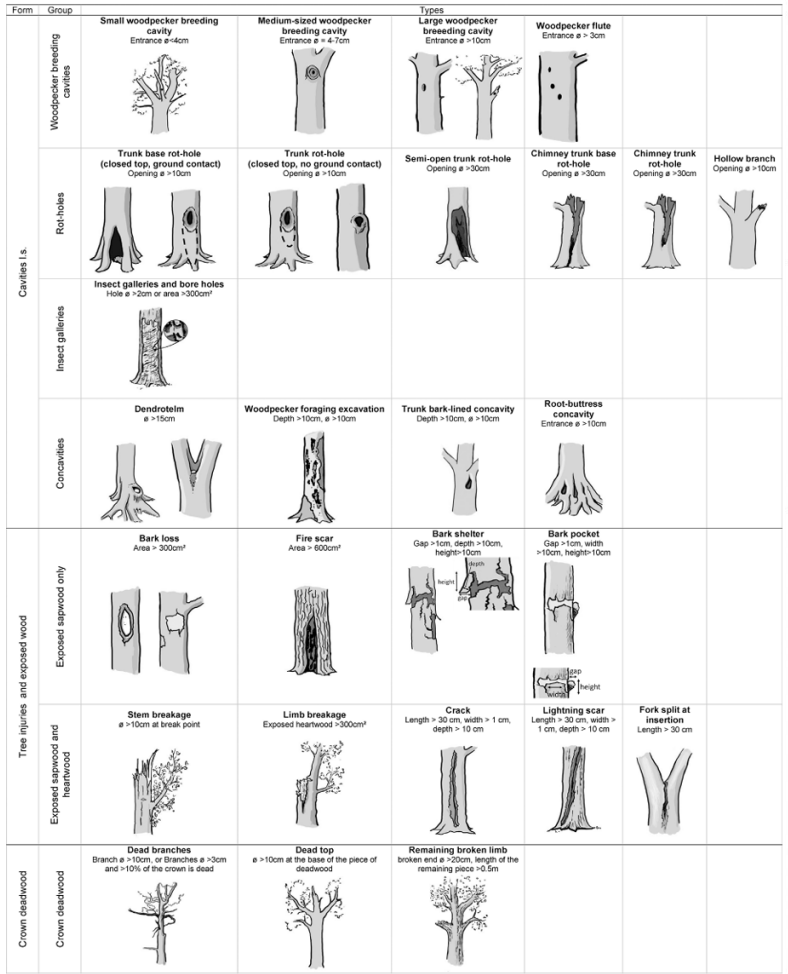
Reference field list

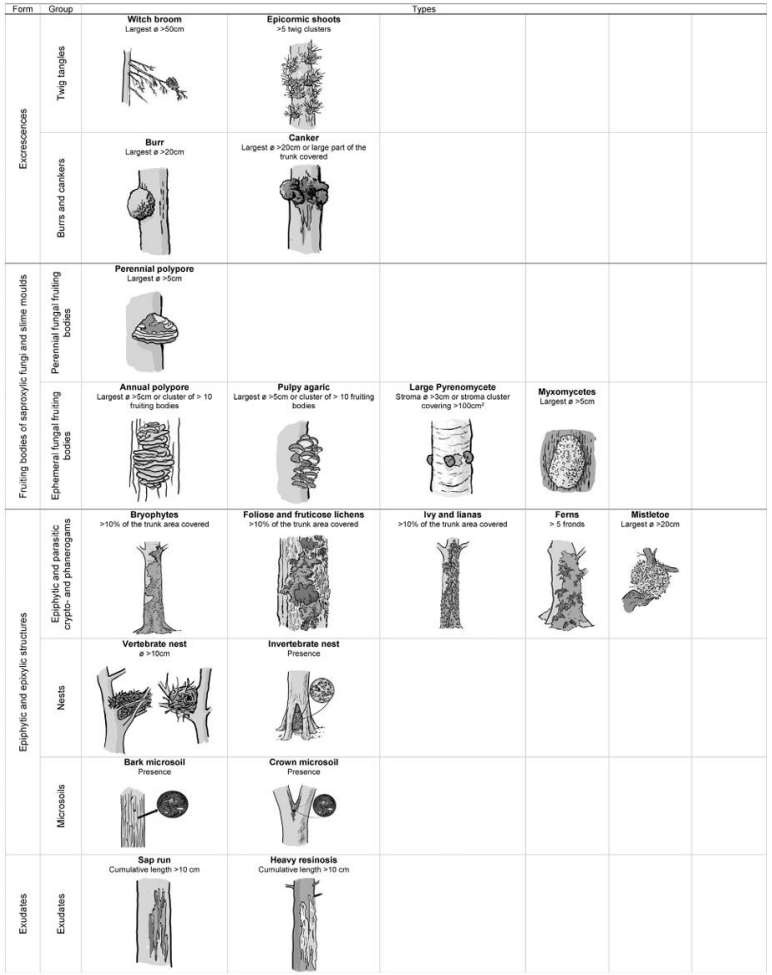
64 *TreMs*

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, alburno 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 epixilitici	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

https://doi.org/10.1016/j.ecolind.2017.08.051

Integrative Forest Management - TreMs





Ecological Indicators 84 (2018) 194–207

Contents lists available at ScienceDirect

Ecological Indicators

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

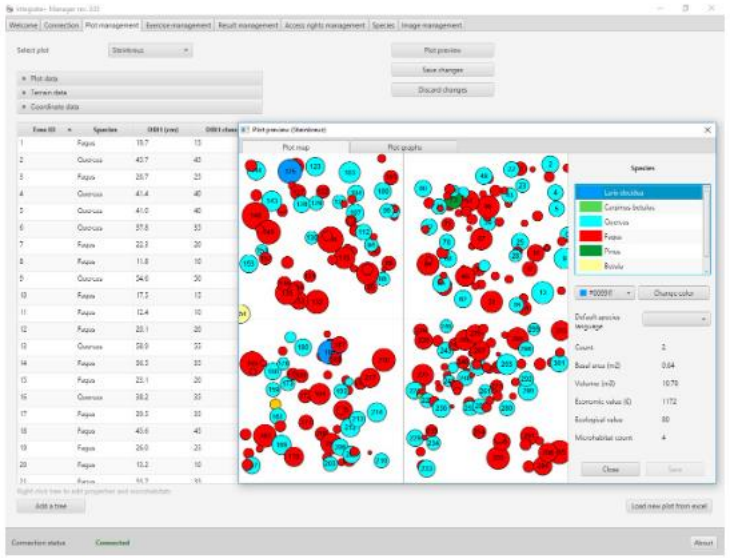
Tree related microhabitats in temperate and Mediterranean European forests: A hierarchical typology for inventory standardization

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

Larrieu et al., 2018

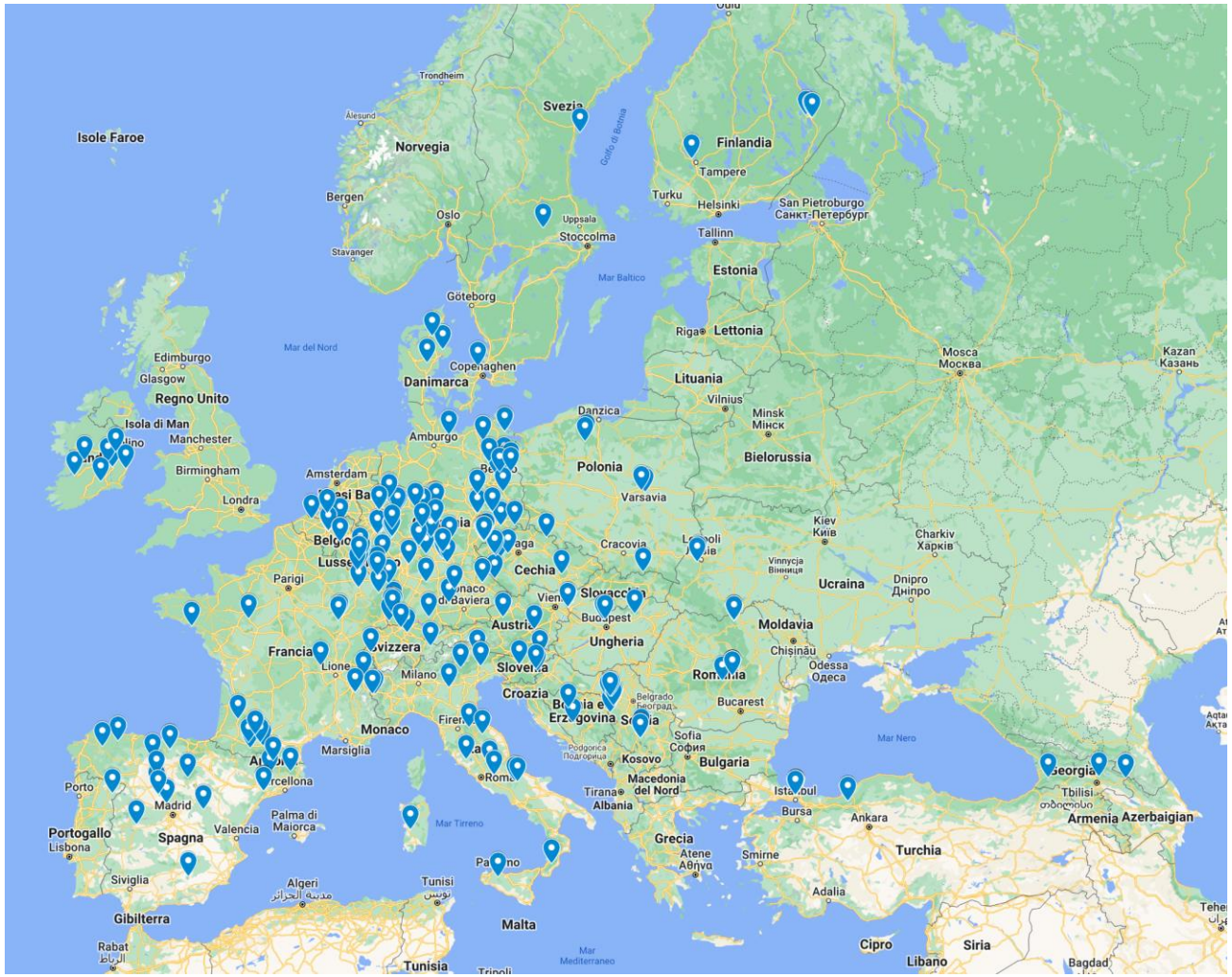
Marteloscopes as learning lab

https://youtu.be/drRIEhYK4_0



http://iplus.efi.int/

Marteloscopes network



Lussemburgo 2023

https://integratenetwork.org/

Italian network of Marteloscopes

Marteloscopes as living lab

Marteloscopes as living lab

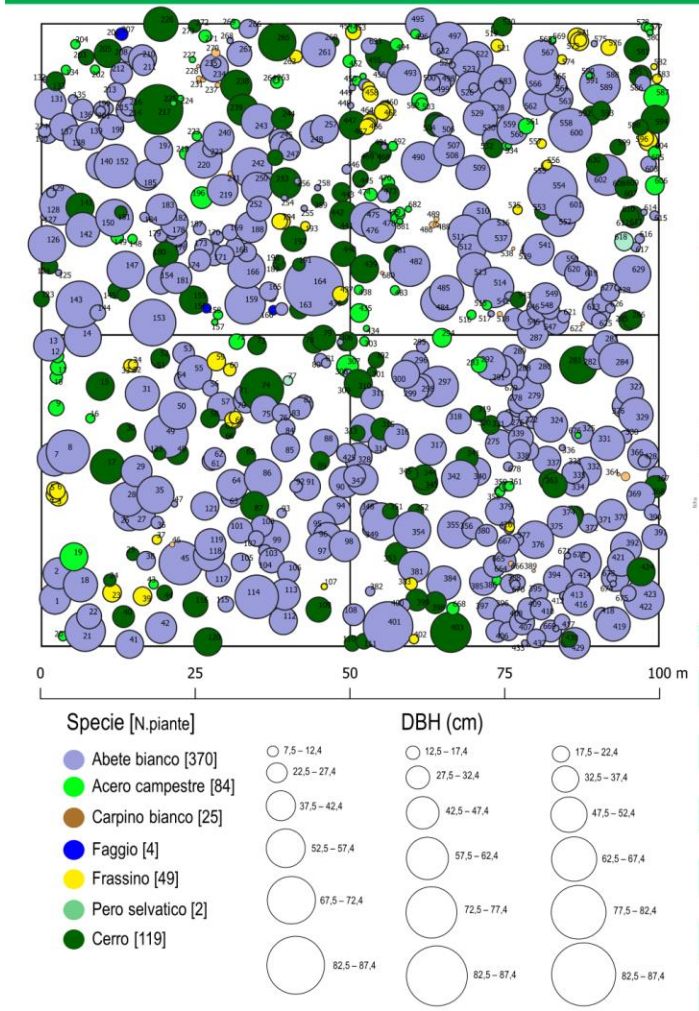
Il Martelloscopio di Collemeluccio

Università degli Studi del Molise

RISERVAMAB Collemeluccio - Montedimezzo ALTOMOLISE

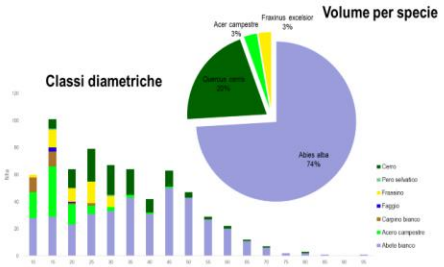
mipaaf ministero delle politiche agricole alimentari e forestali

Integrate Network facilitated by EFI



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 m²	Volume m³
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 Trenitno 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

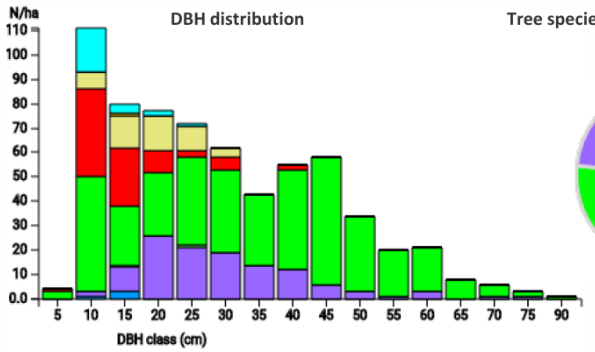
Integrate Marteloscopes

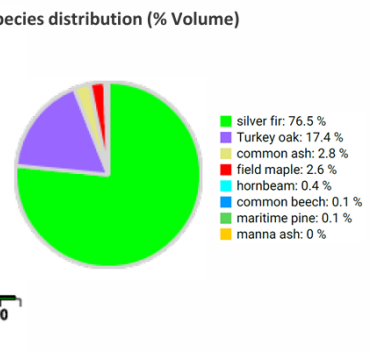
Technical information IT

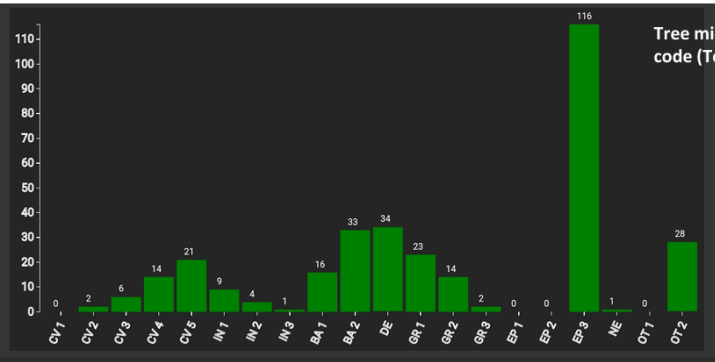
Name: Collemeluccio

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



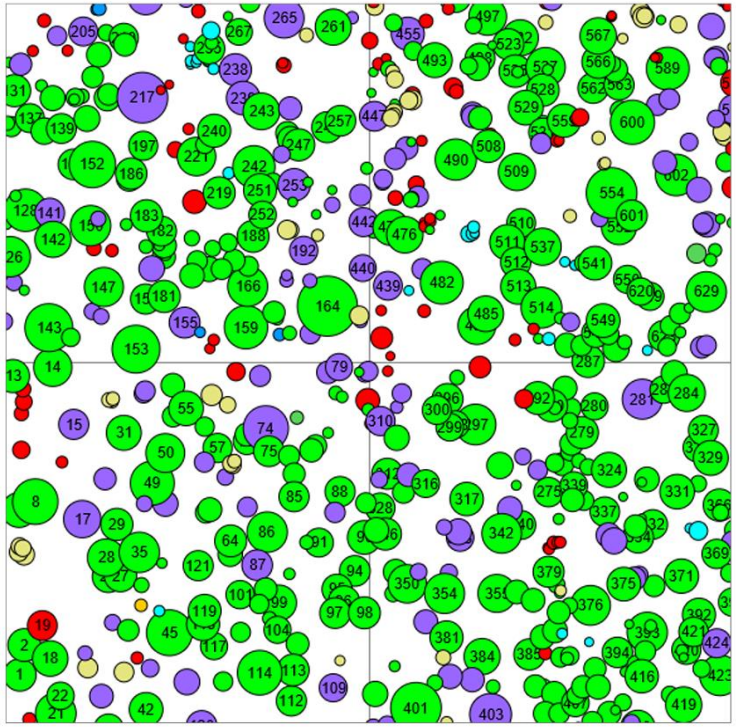




1

Collemeluccio http://iplus.efi.int/marteloscopes-data.html

Marteloscope map (1.0 ha):



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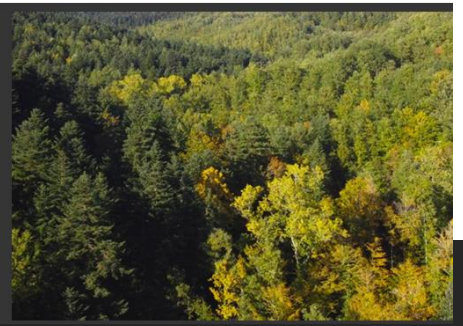


2

Italian network of Ma

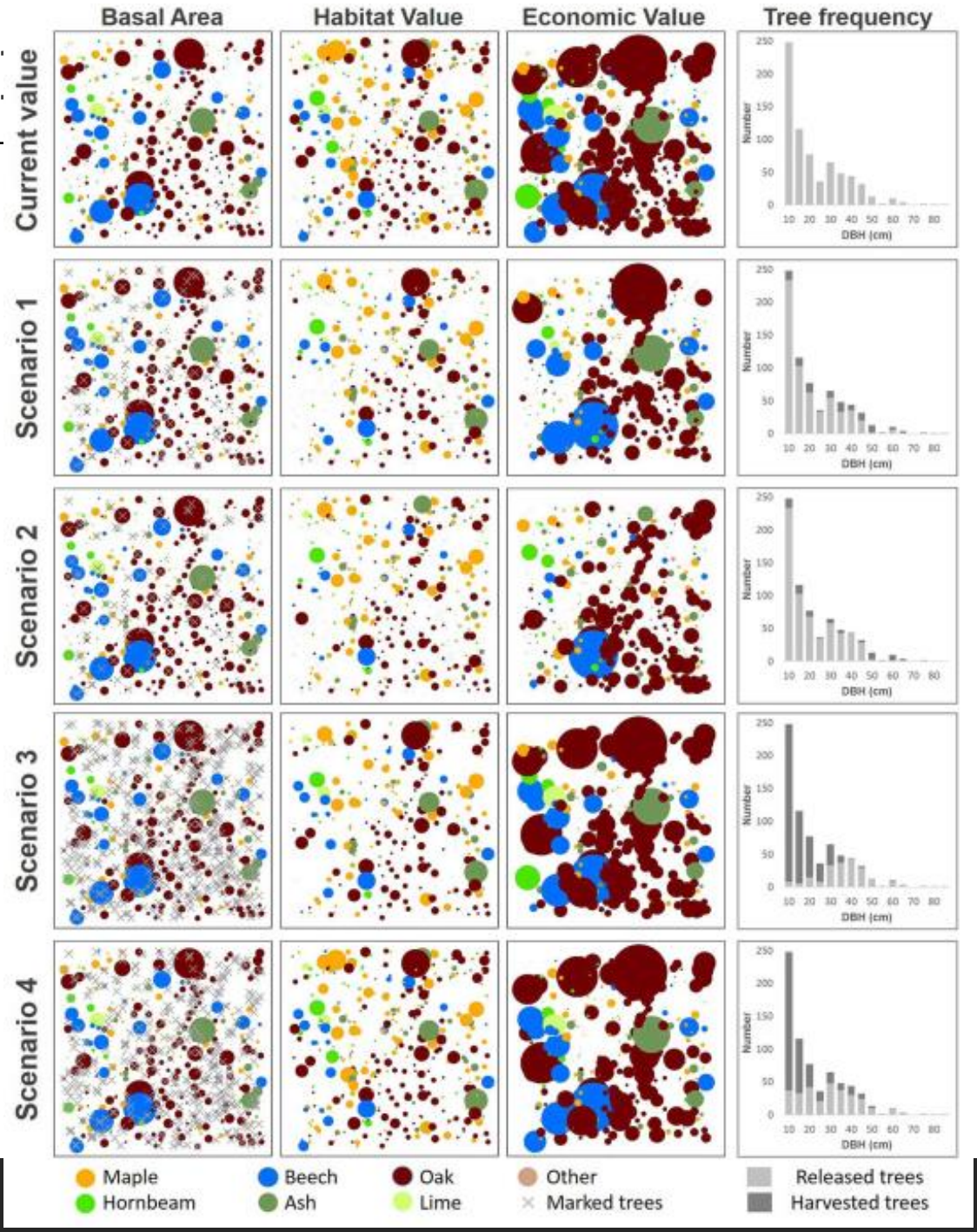
iForest
Biogeosciences and Forestry

Research Article
doi: 10.3832/ifor2617-011
vol. 12, pp. 76-84

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



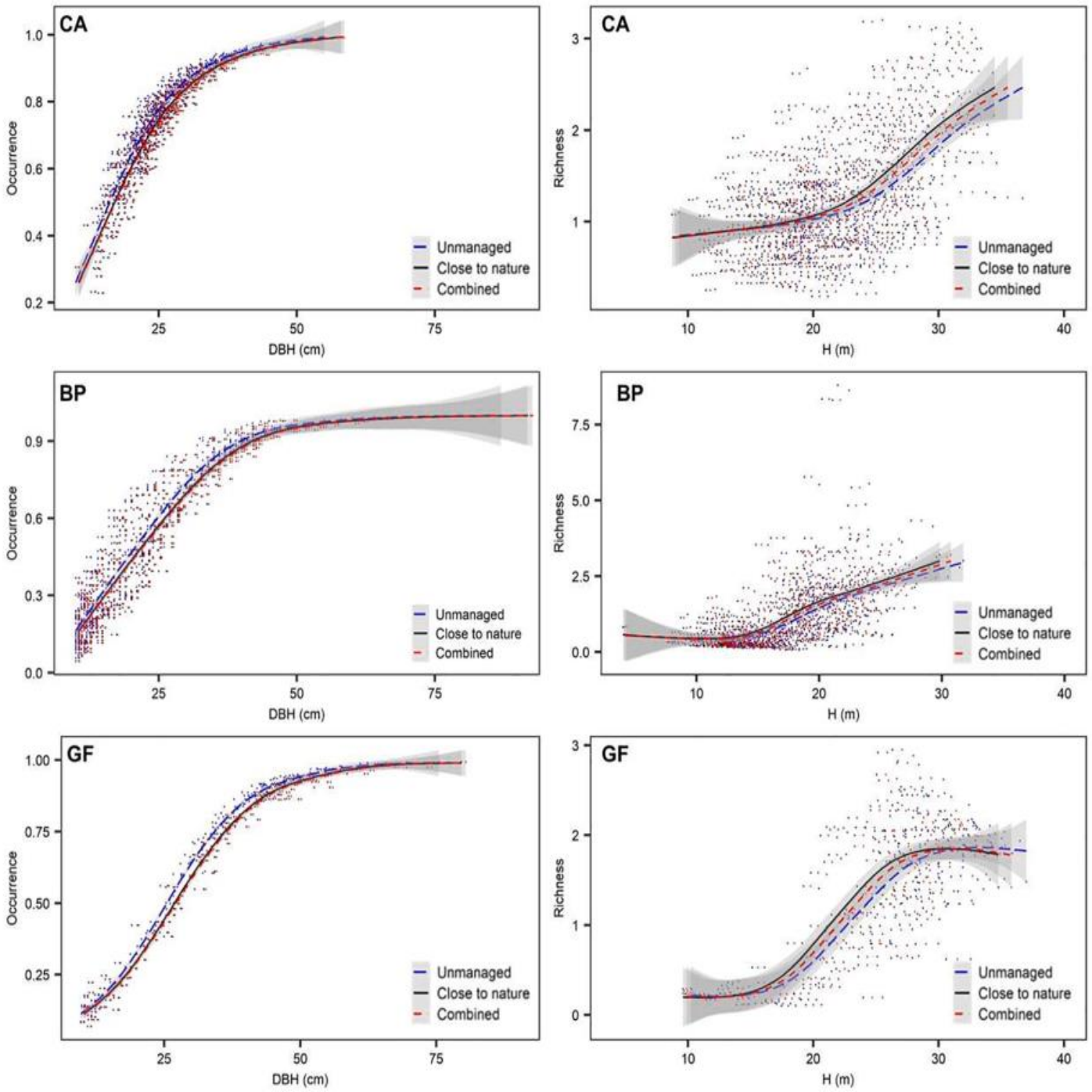
Case study

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]



JOURNAL ARTICLE

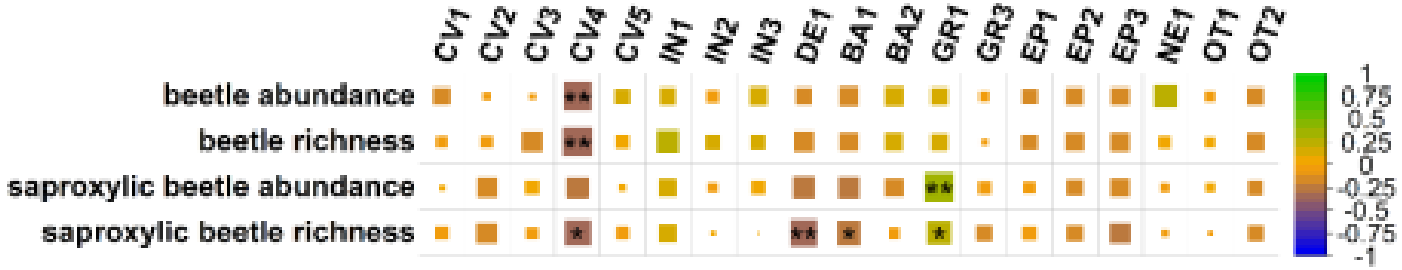
Tree-related microhabitat diversity as a proxy for the conservation of beetle communities in managed forests of *Fagus sylvatica*

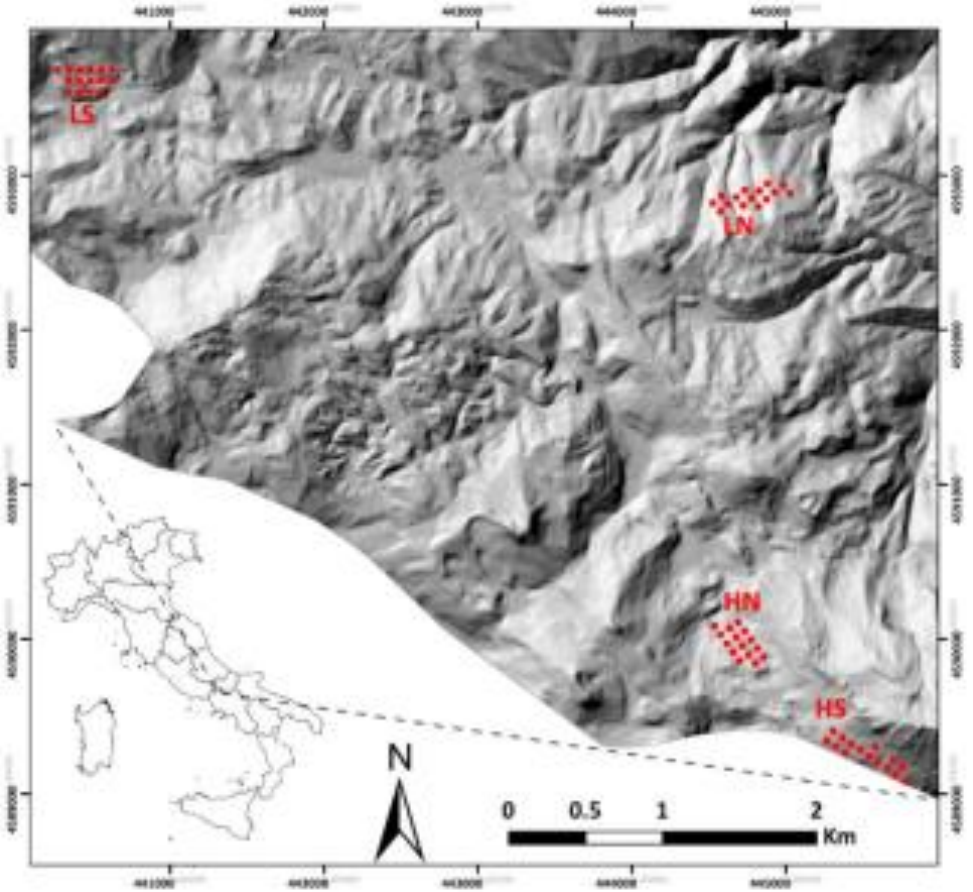
Get access

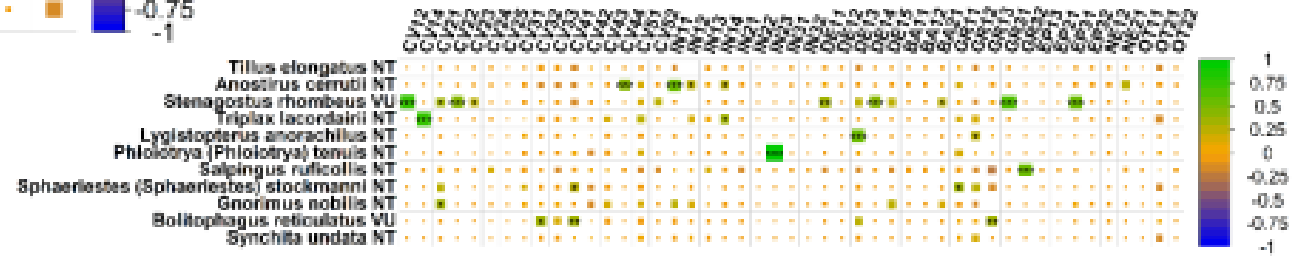
Pierdomenico Spina, Francesco Parisi, Serena Antonucci, Vittorio Garfì, Marco Marchetti, Giovanni Santopuoli

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)

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

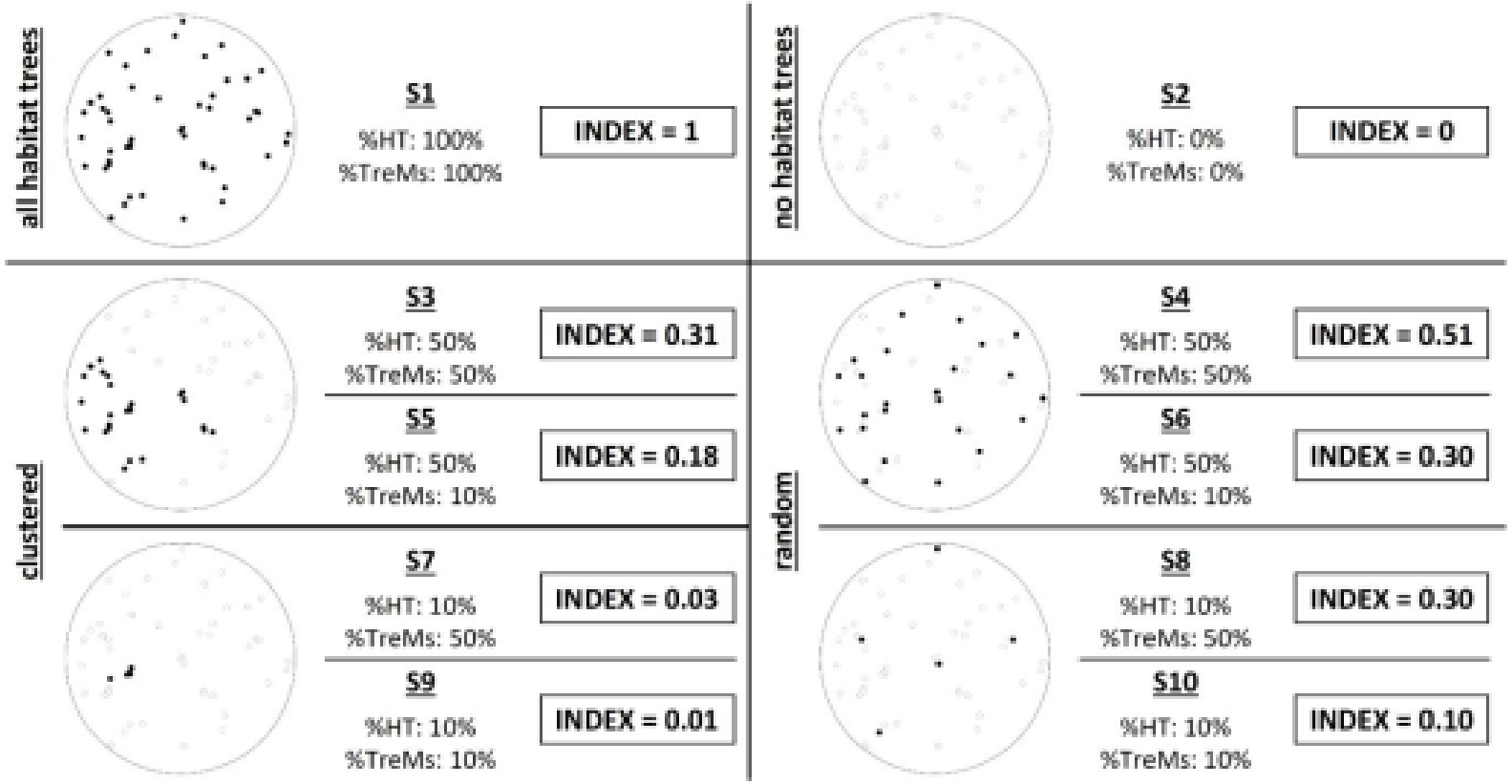


Figure 4.1. TreMs Spatial Index scenarios. The solid dots represent habitat trees, while the empty dots are the trees without TreM. %HT and %TreMs represent, respectively, the percentage of habitat trees and Tree-related Microhabitats for each scenario. The clustered distribution of habitat trees is 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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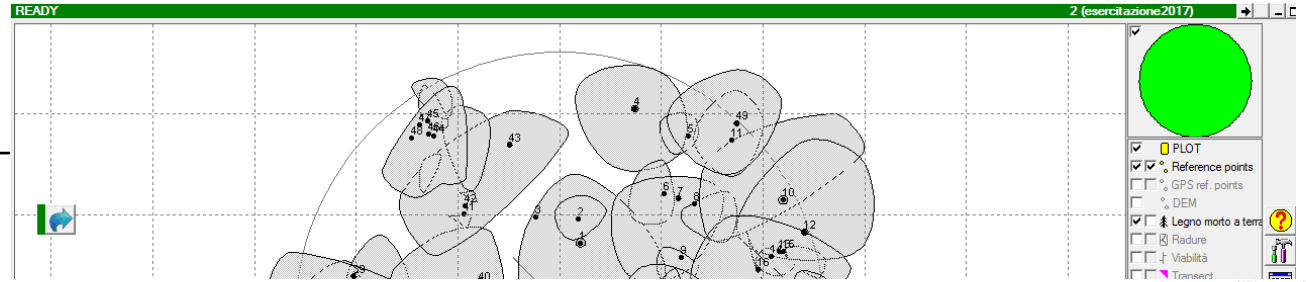

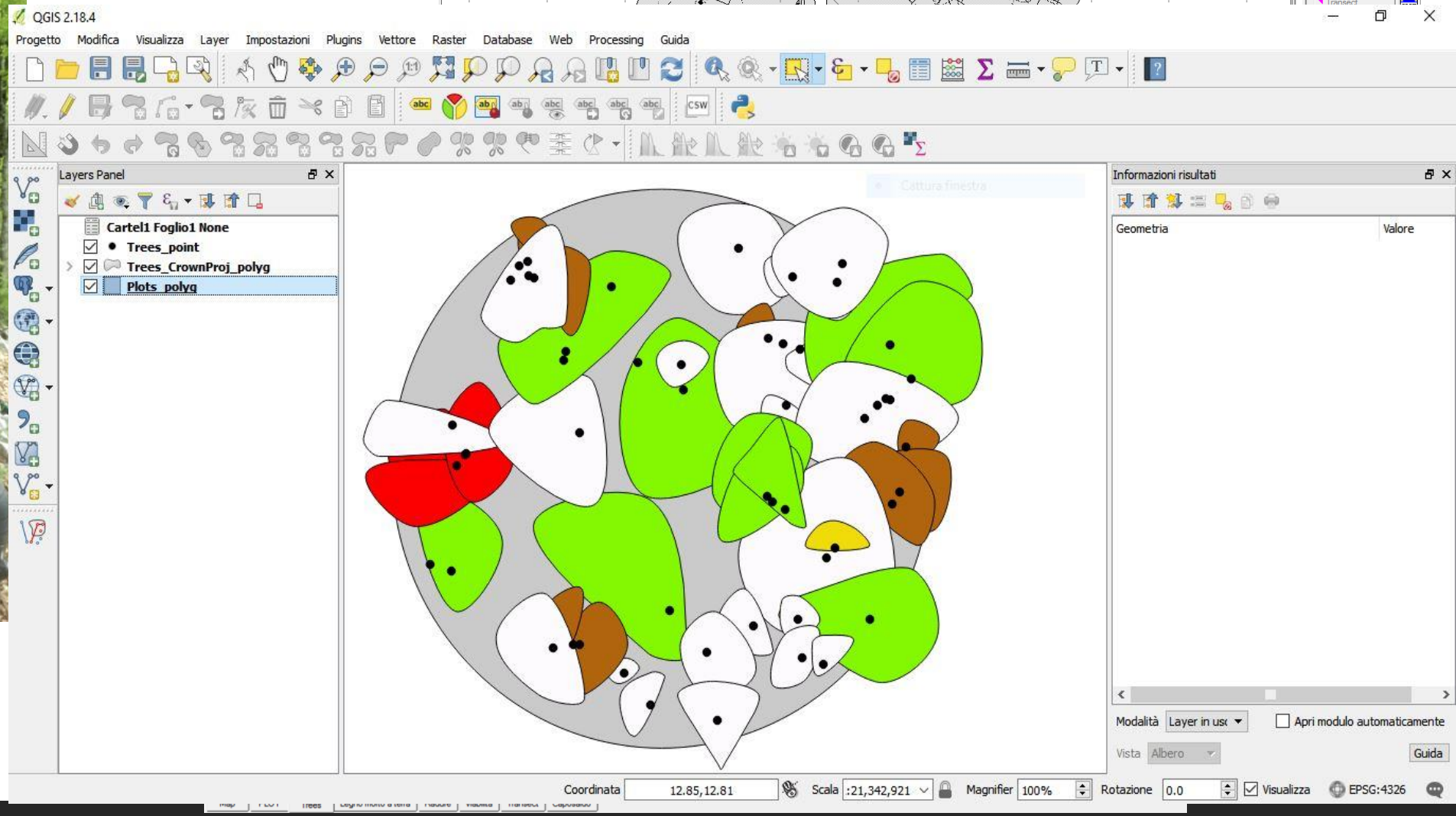

FieldMap → field GIS

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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

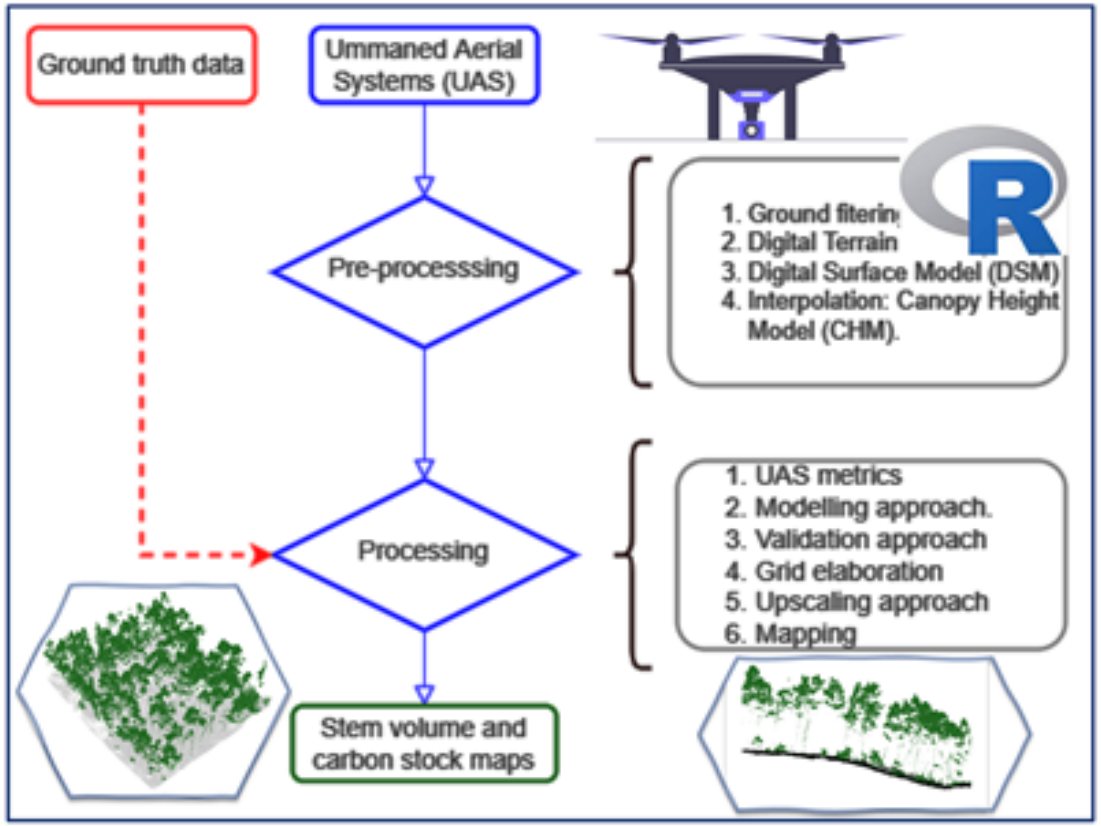

Figura 2: Approccio metodologico per l'analisi dei dati LiDAR (Light Detection and Ranging). La tecnologia LiDAR usata per la raccolta di dati attraverso un drone è comunemente definita UAS (Ummaned Aerial Systems)

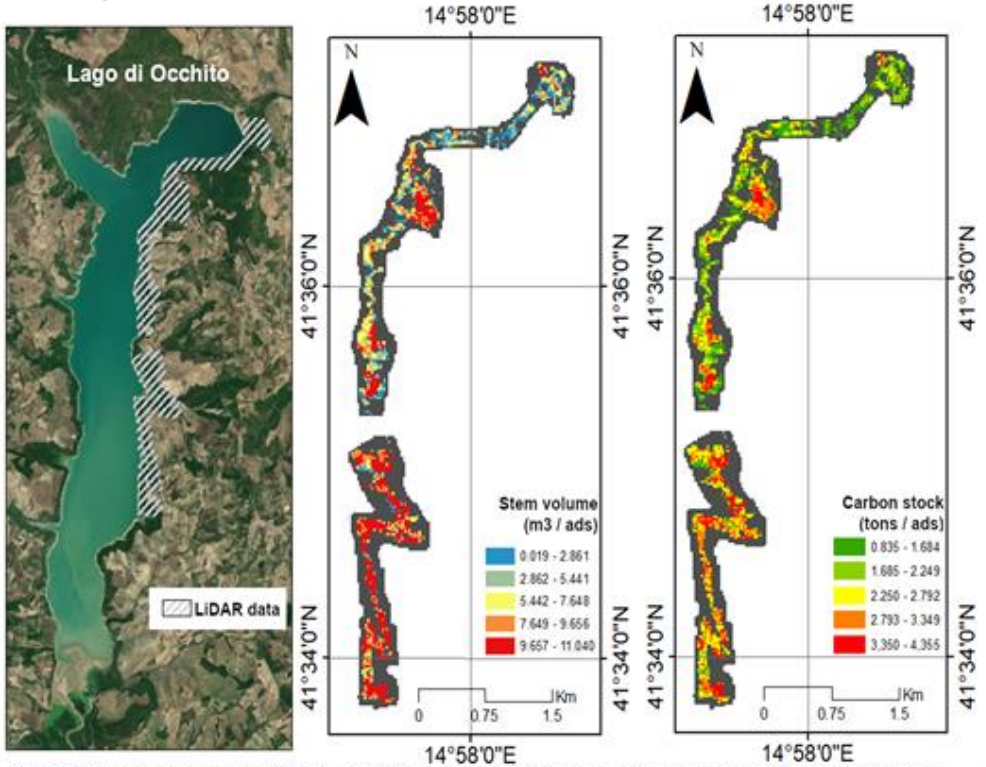

Figura 3: Da sinistra a destra, la mappa della foresta coperta dai dati LiDAR (Light Detetion and Ranging) e la mappa della stima della biomassa (Stem volume m3/ads) e dello stock di carbonio (carbon stock tons/ads) di tale foresta. Le aree di saggio 'ads' erano di 529m2.

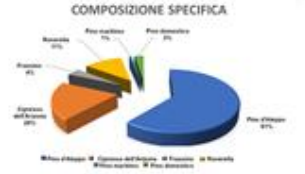

Figura 4: Composizione specifica del popolamento.

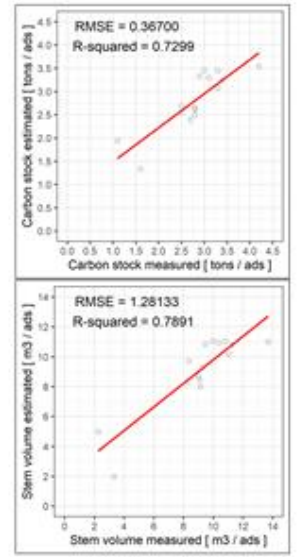

Figura 5: Confronto tra variabile osservata e predetta.

Forest management plan

Innovative tools for monitoring SFM

Airborne Laser Scanning to detect Tree-related Microhabitats

remote sensing

MDPI

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]

FRESh Life

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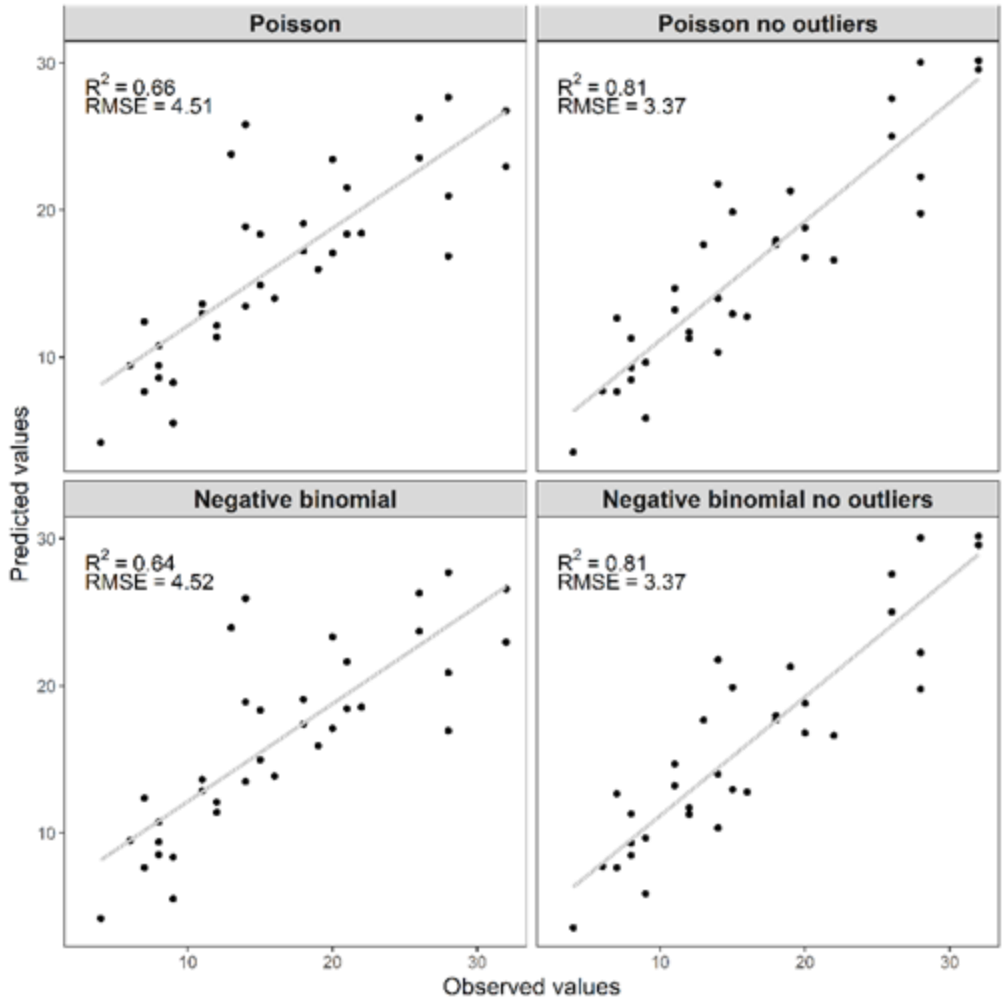
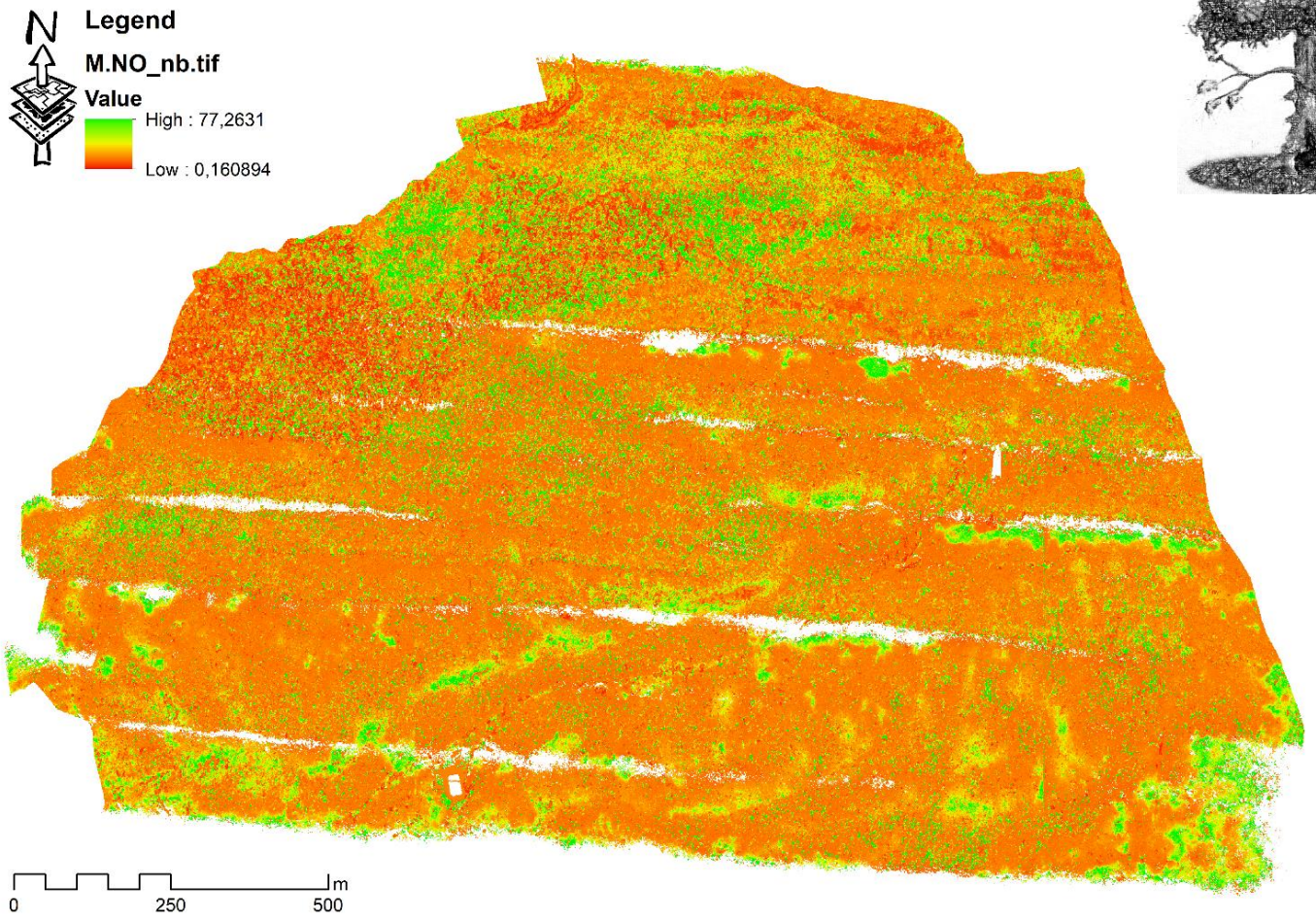
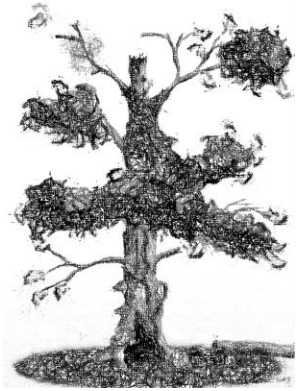


Trees which present one or more TreMs (i.e., Habitat Tree)





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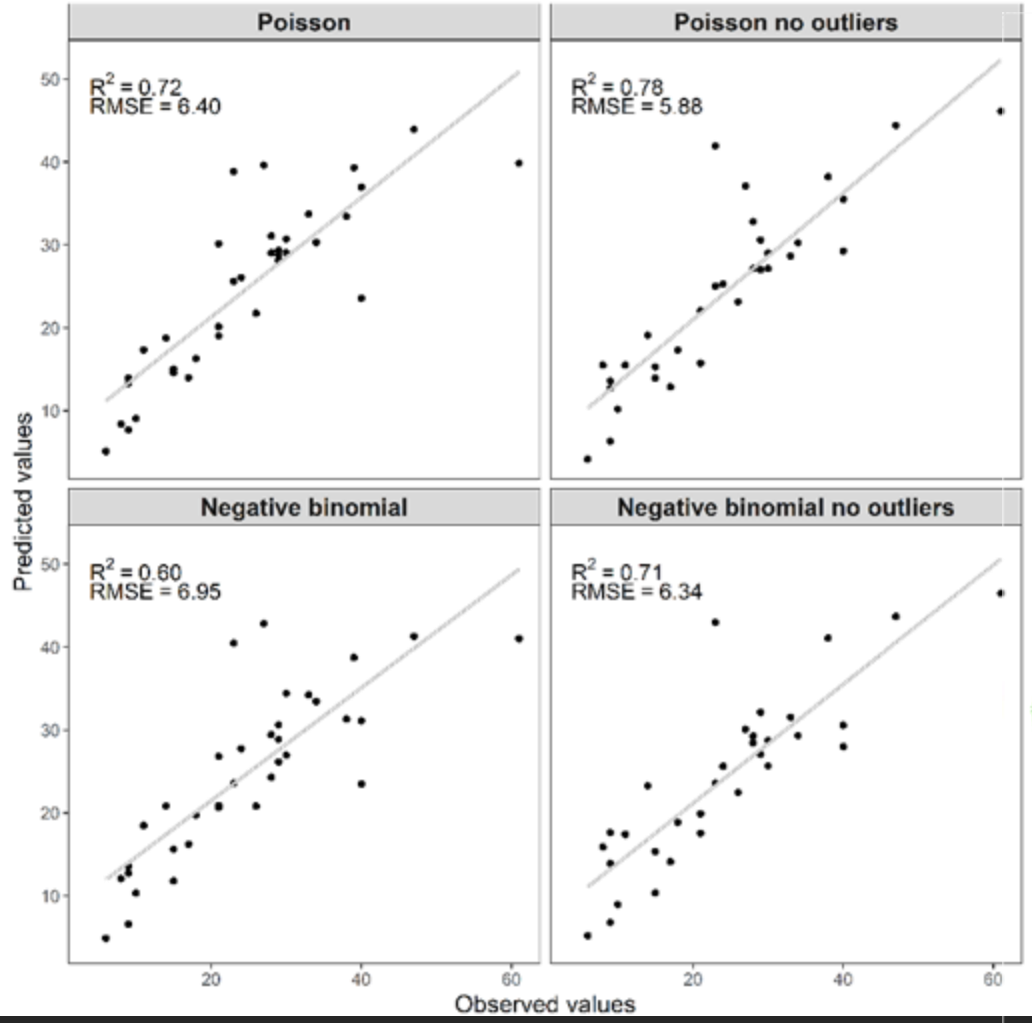
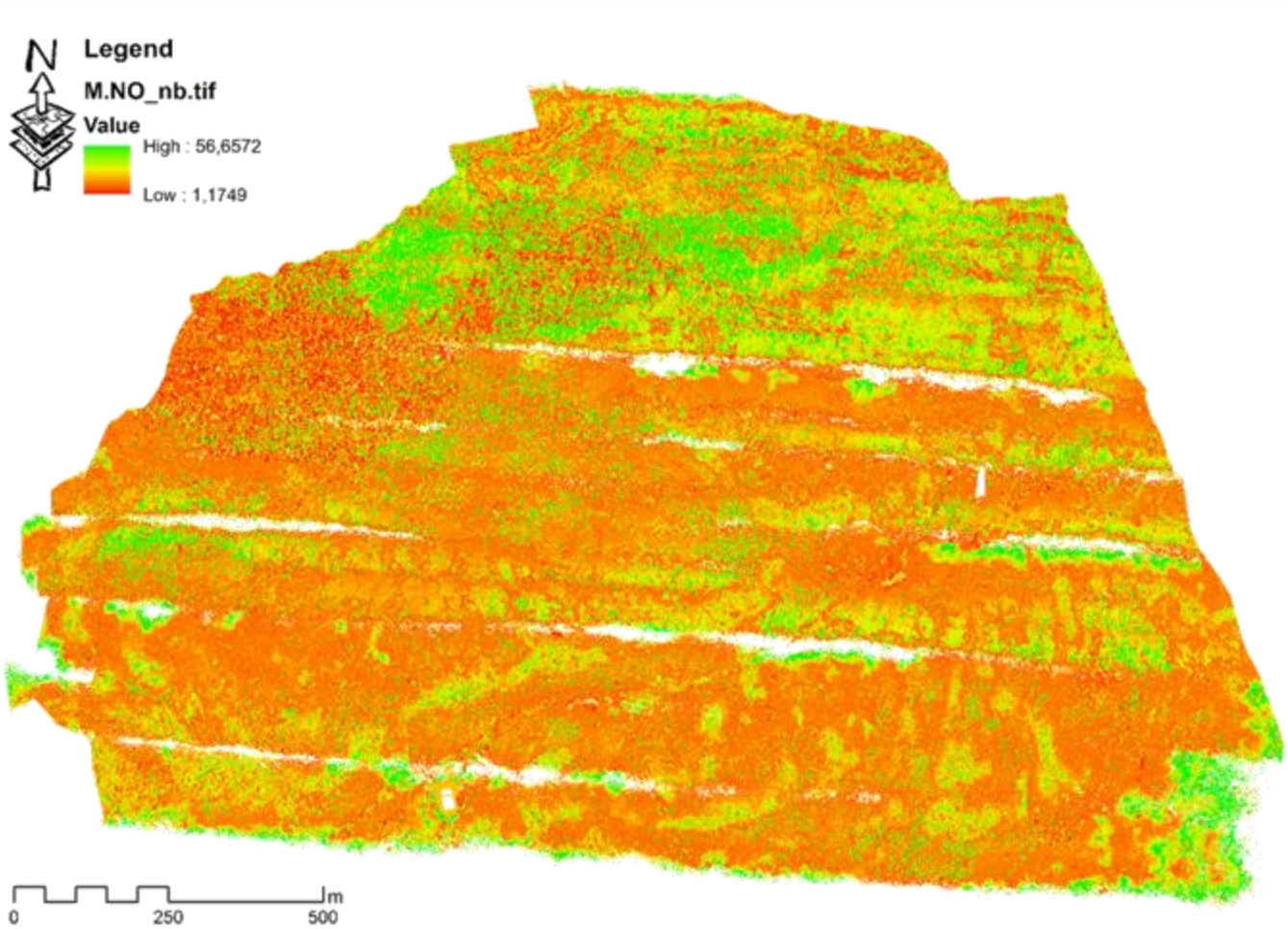


ABUNDANCE OF TREMS



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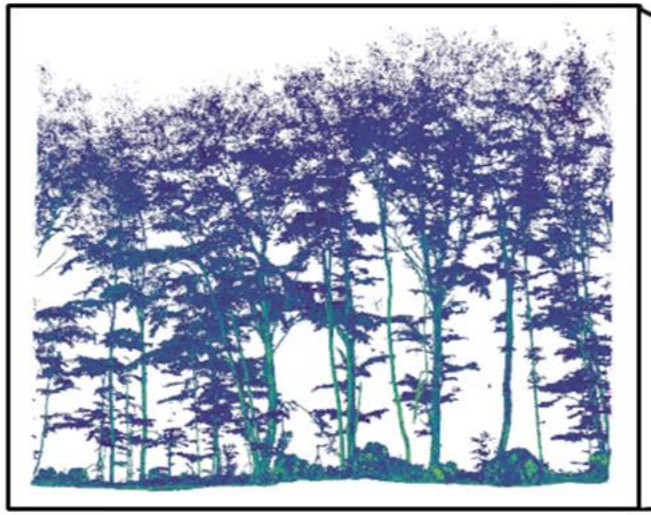

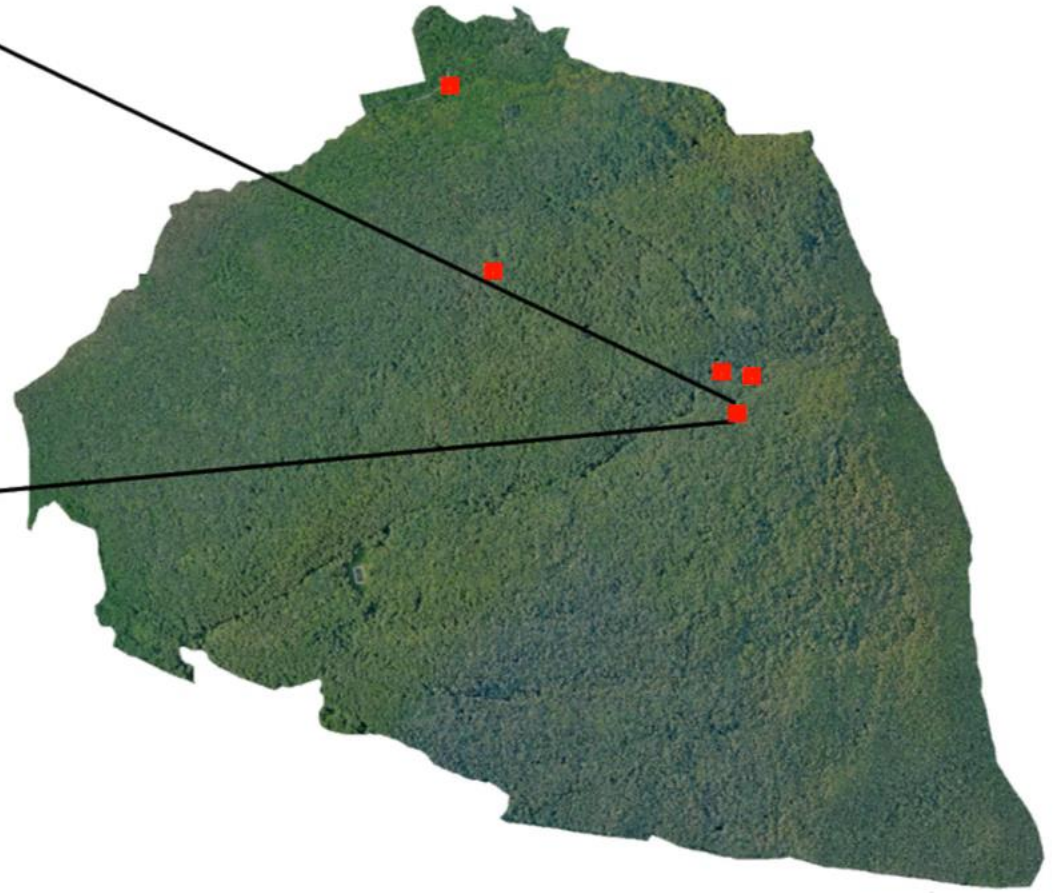

N

Legend

ADS

Km
0
0.5
1

Bosco Pennataro

Deadwood and TreMs

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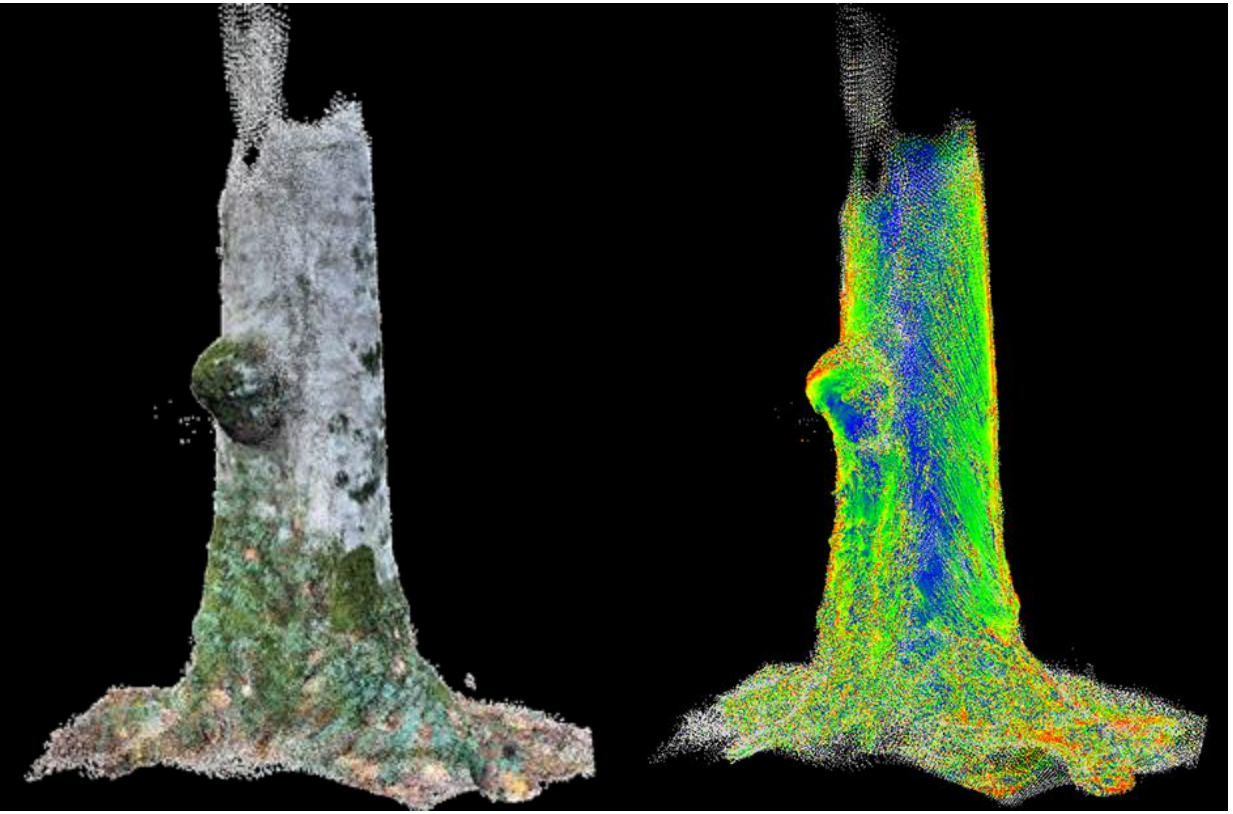
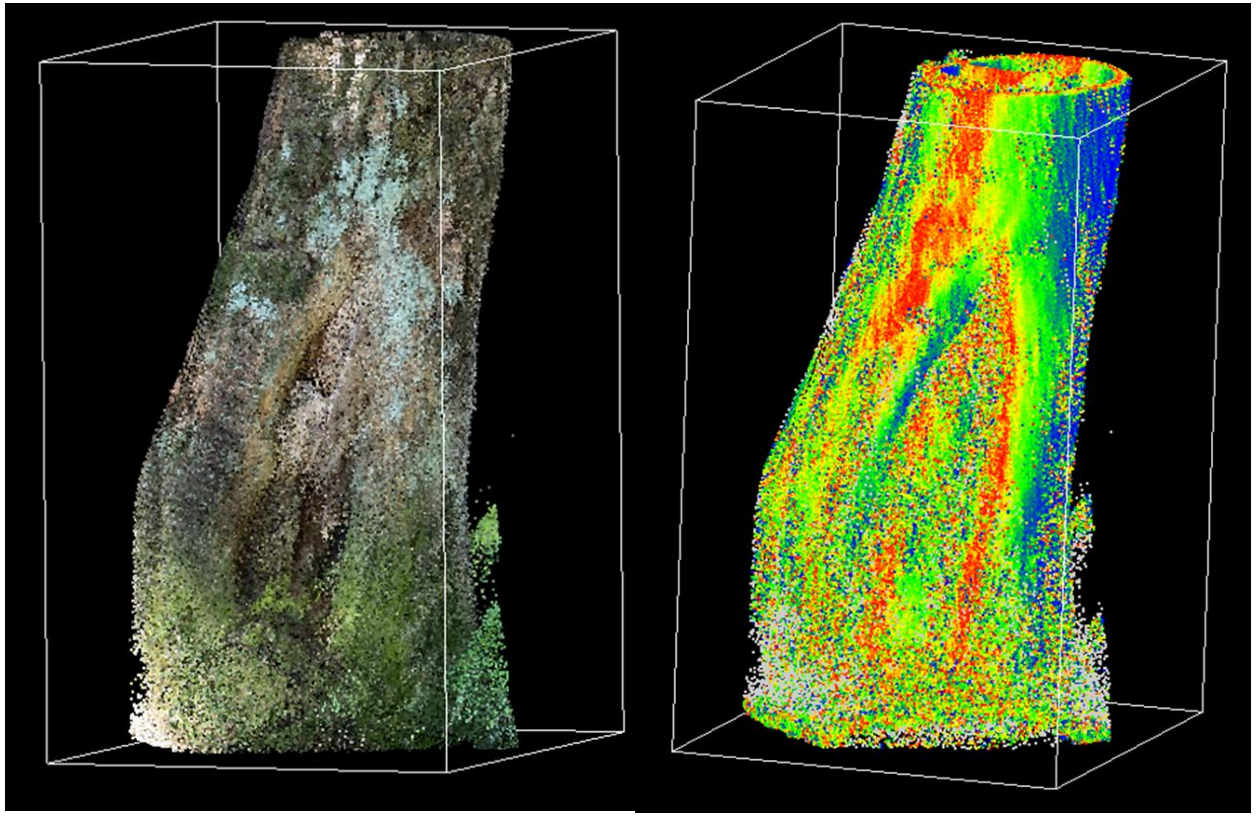
GR31



CV24



TreMs

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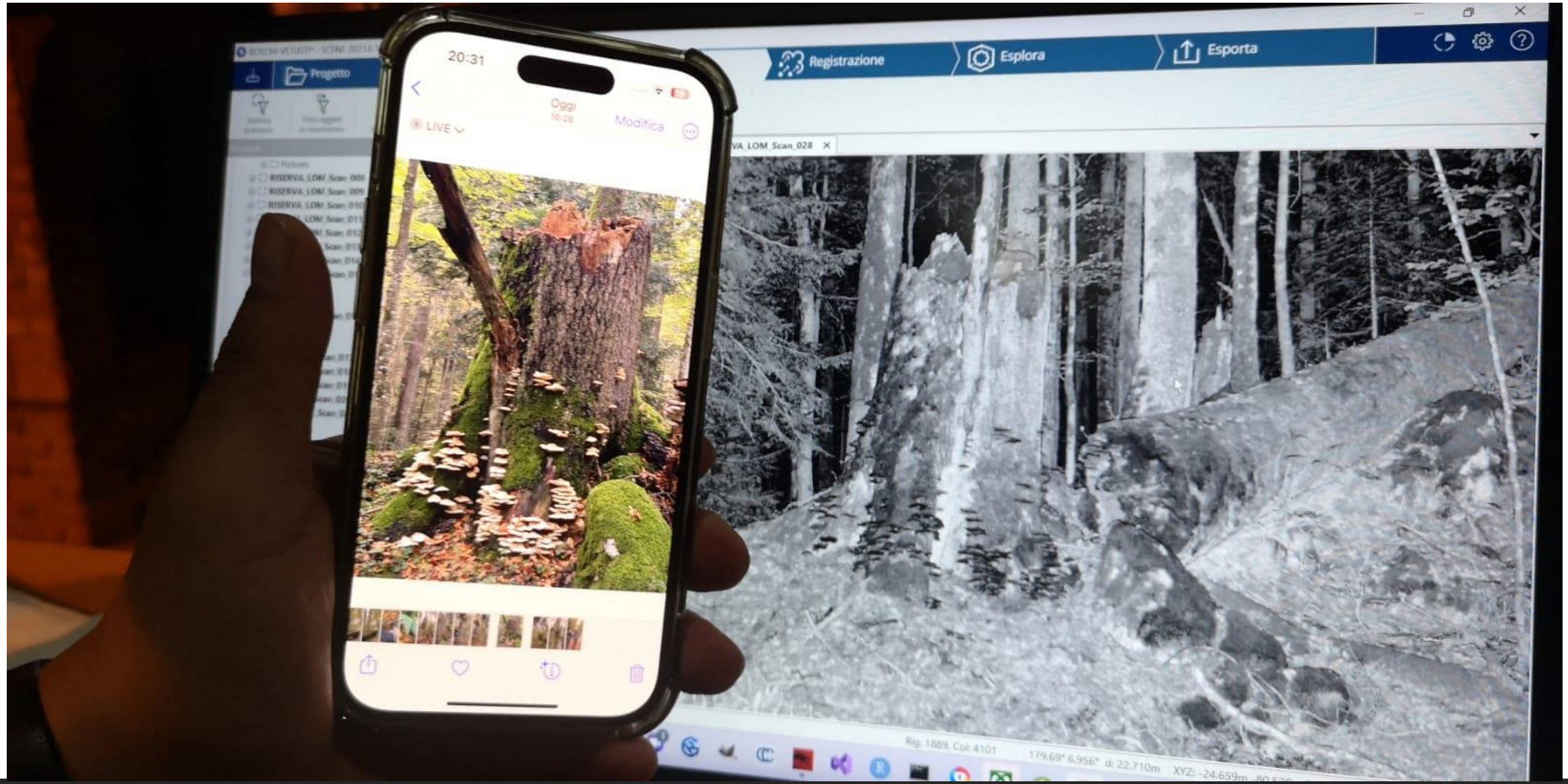

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Innovative tools for monitoring SFM

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

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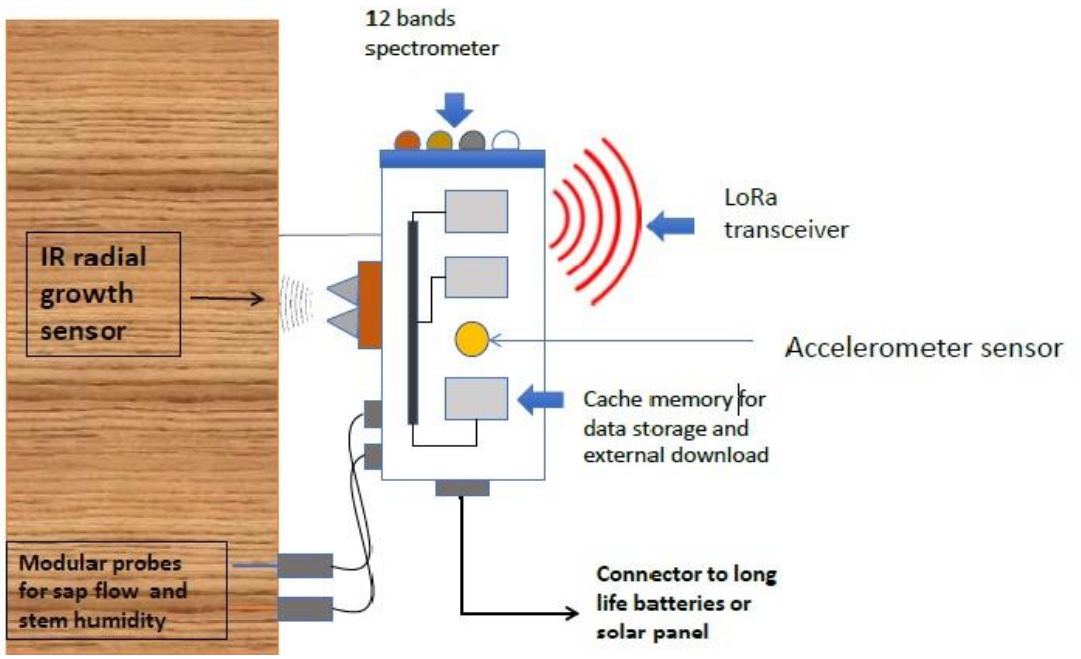

1 hour sampling rate
Transpiration (sap-flow)
Stem humidity (SWC)
Multispectral signature of light transmitted through the canopy
Tree radial growth
Accelerations along a 3D coordinate system used to detect tree movements
Air temperature and relative humidity

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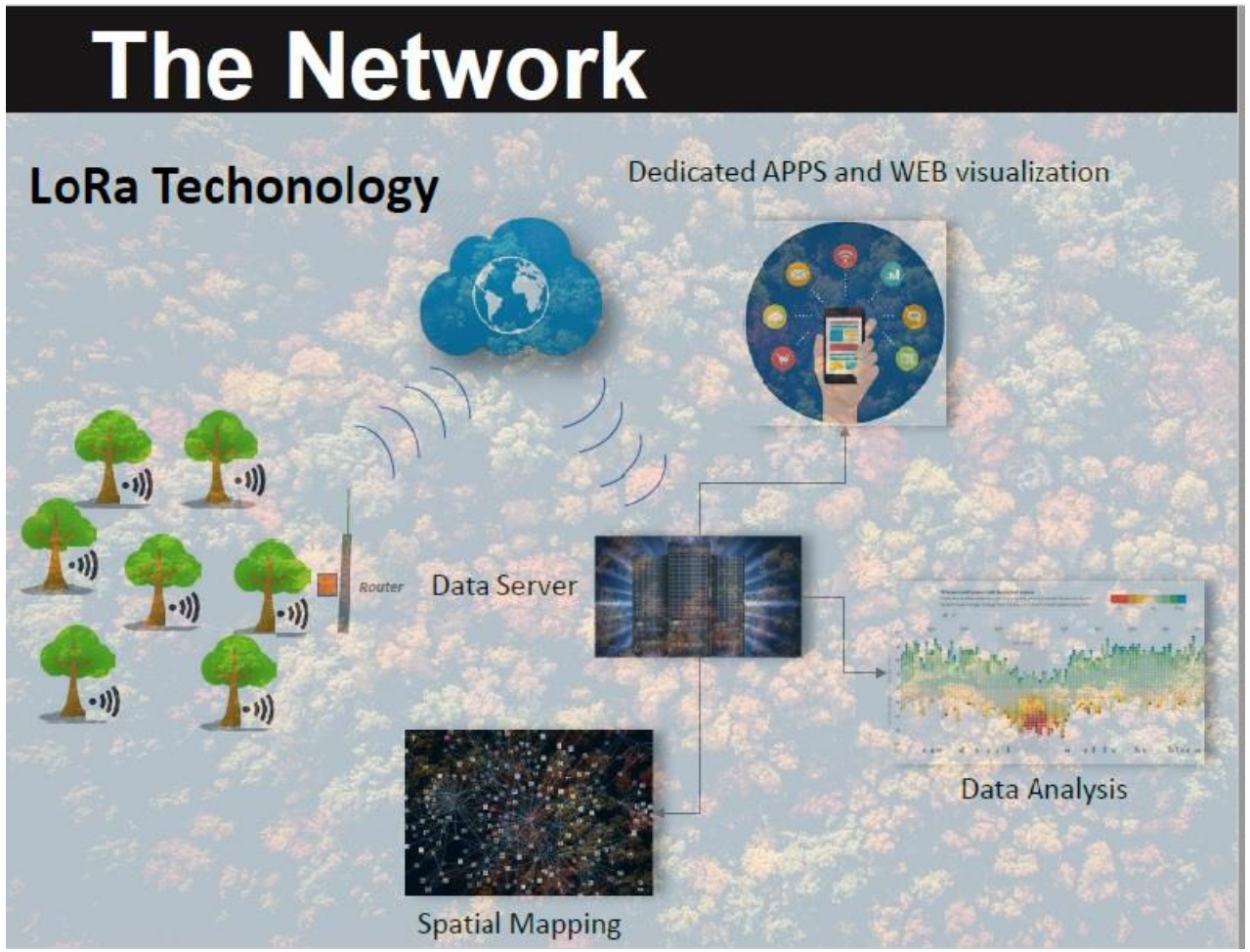

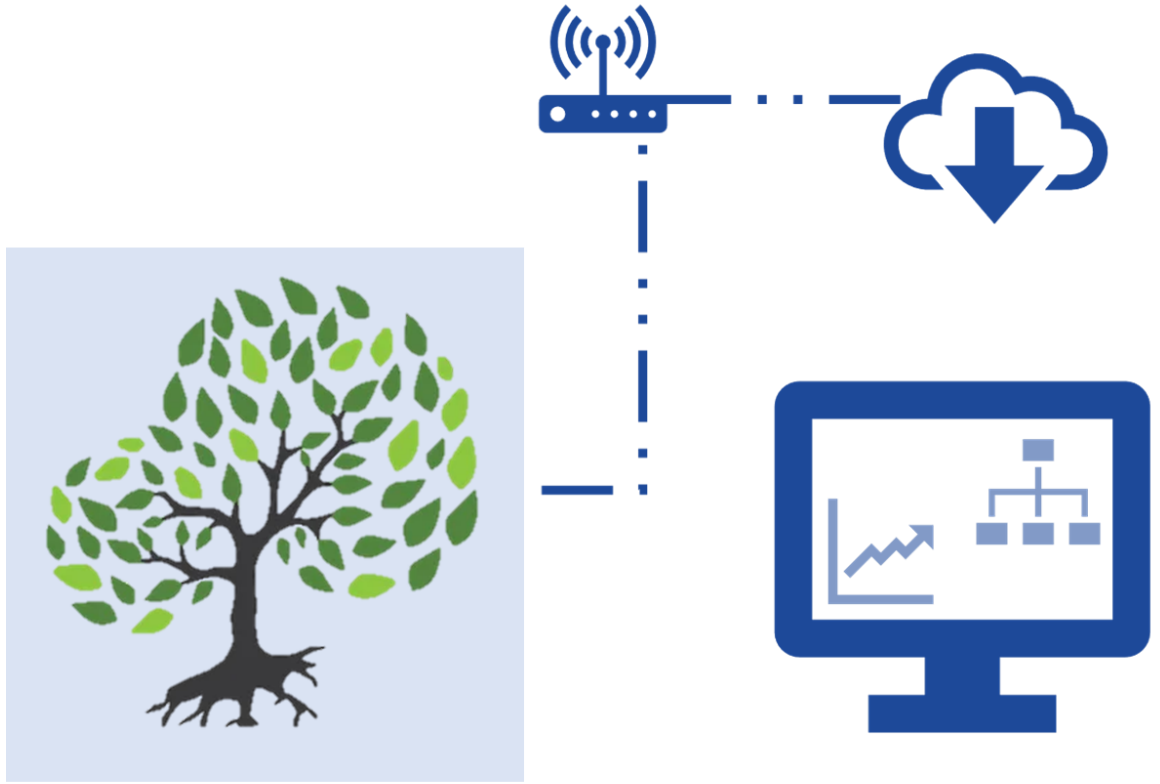

TT-Cloud is in turn connected to the internet via the GPRS network and sends data to a computer server

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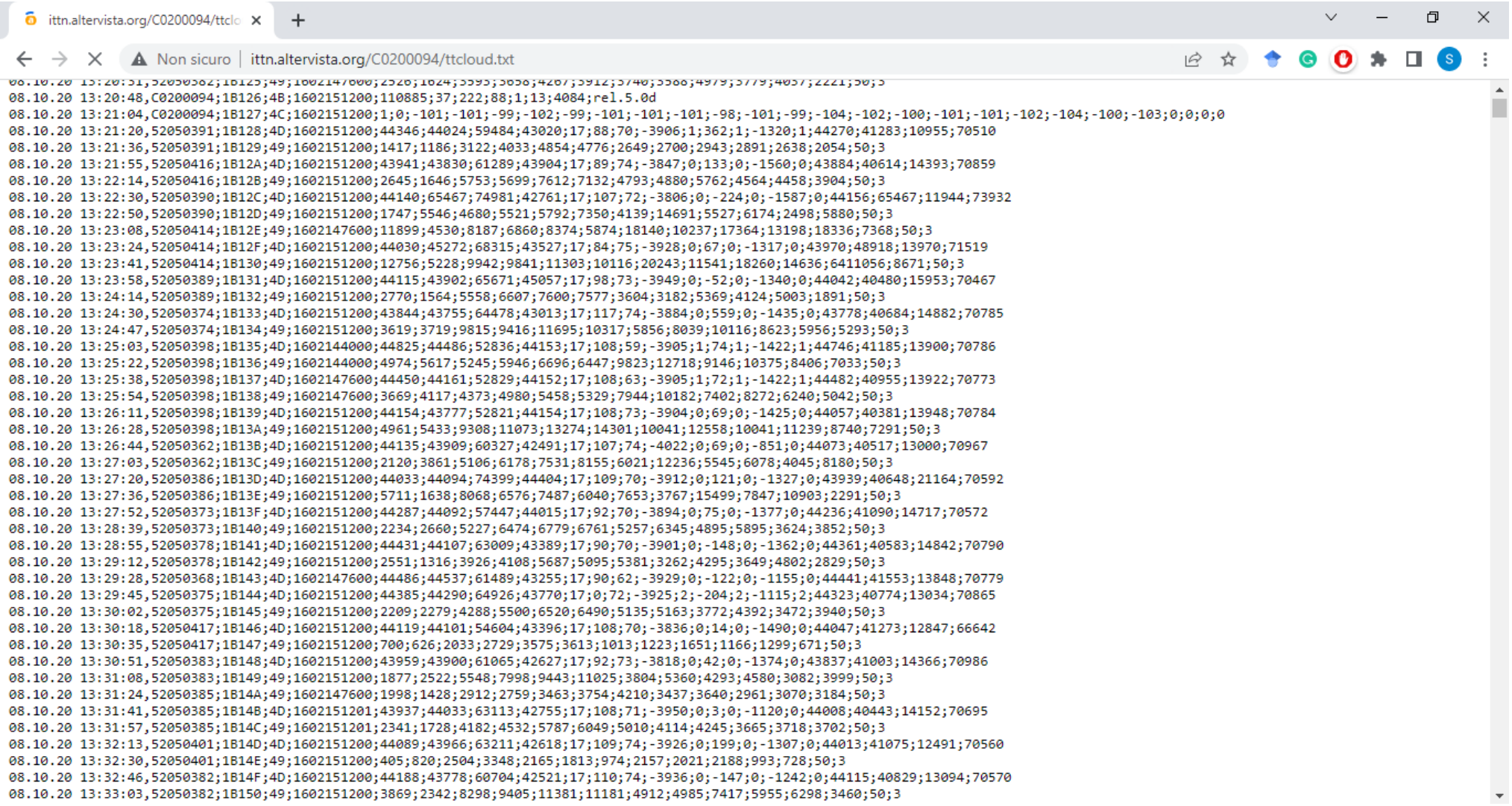

Data server

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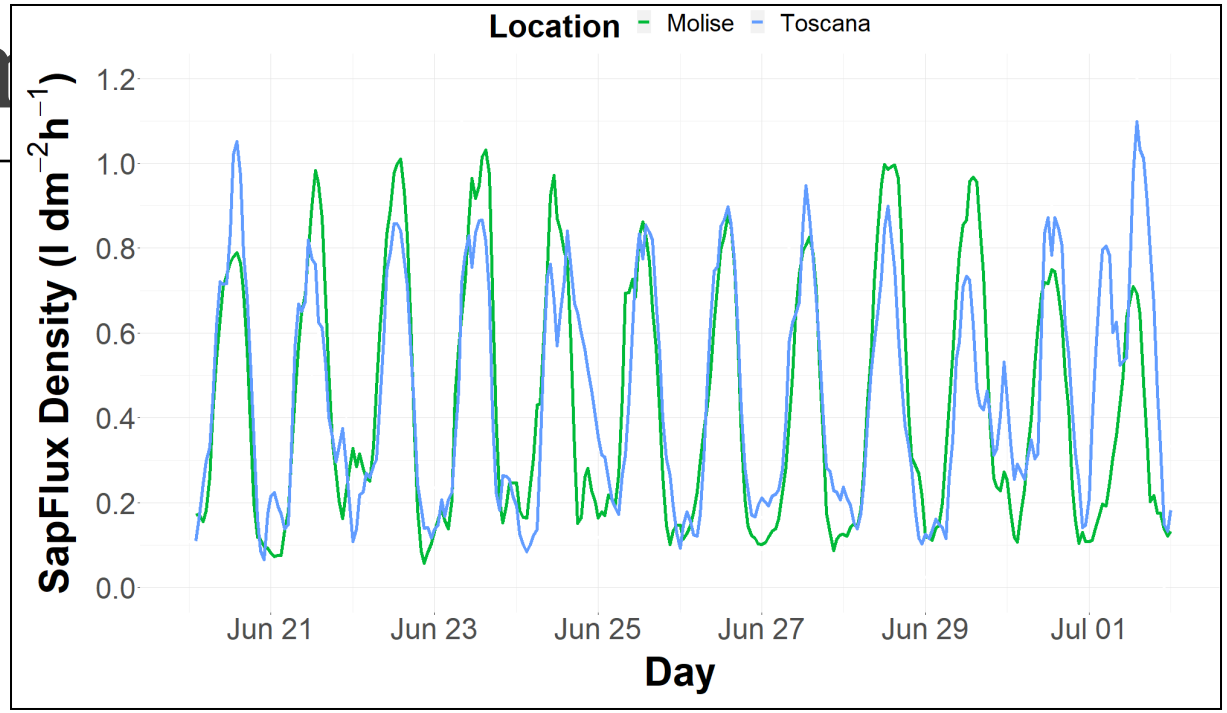
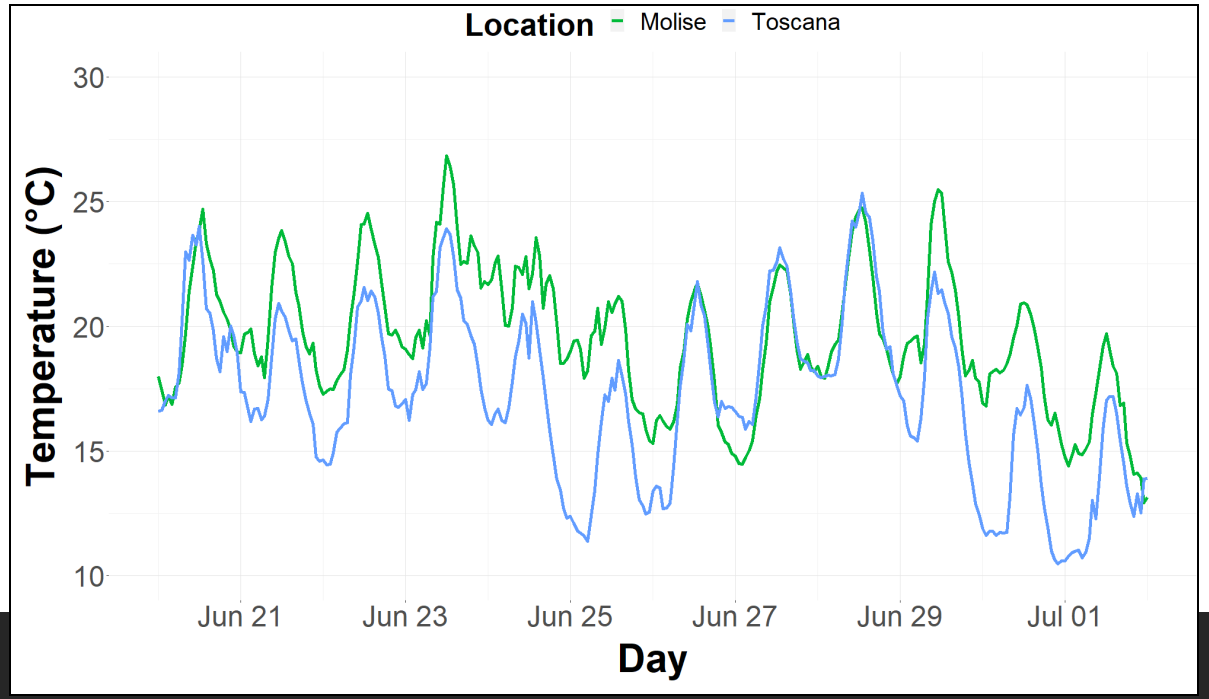
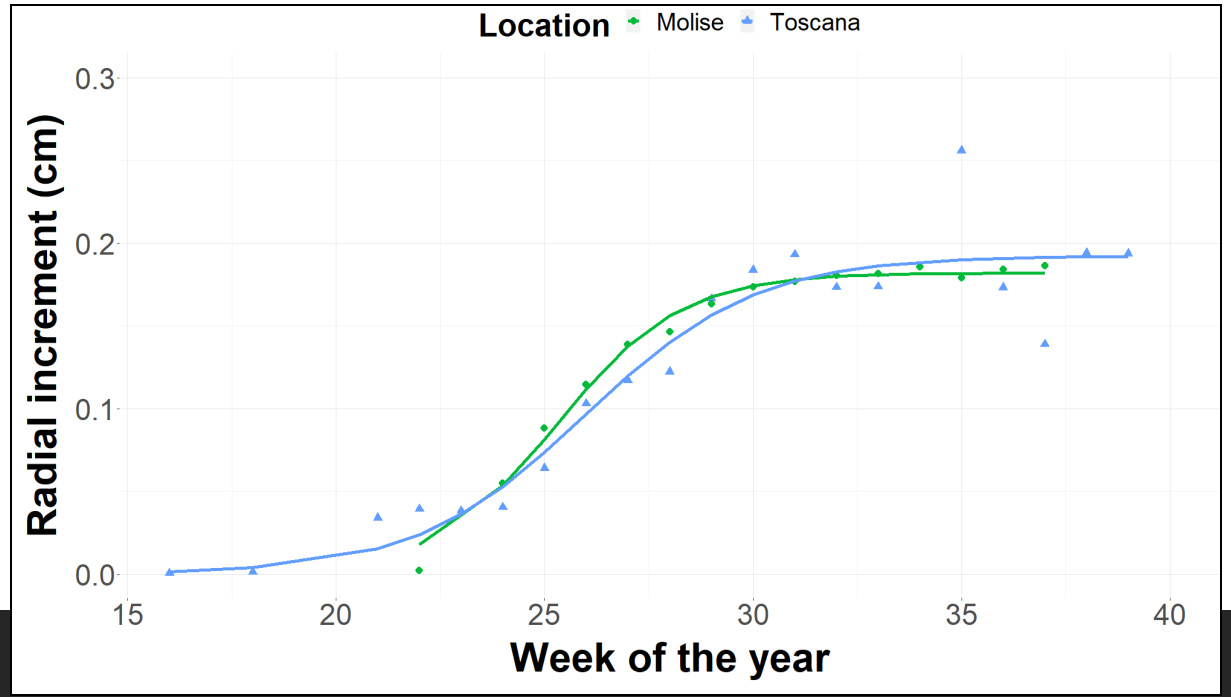
Comparison between two sites in Italy

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







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Damaged sensors

Replaced senors/TTs

Water

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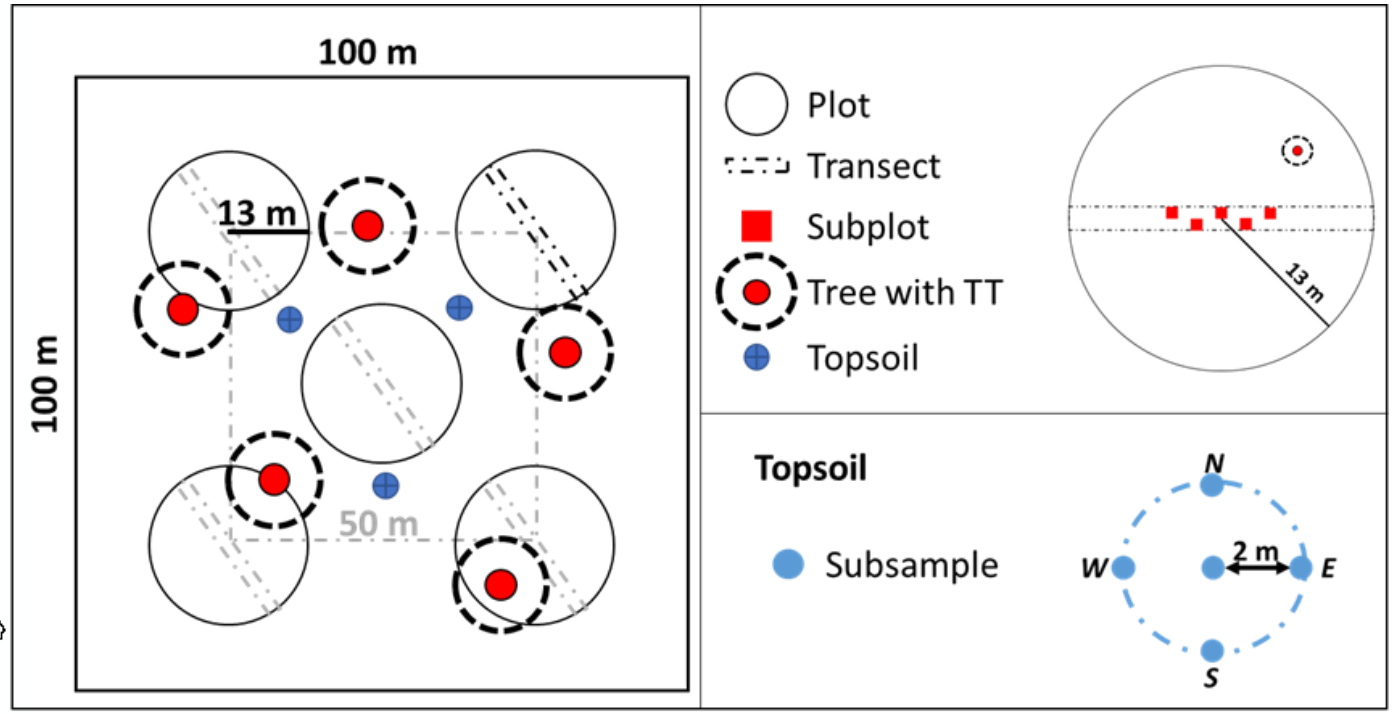
La nuova rete italiana dei TreeTalker



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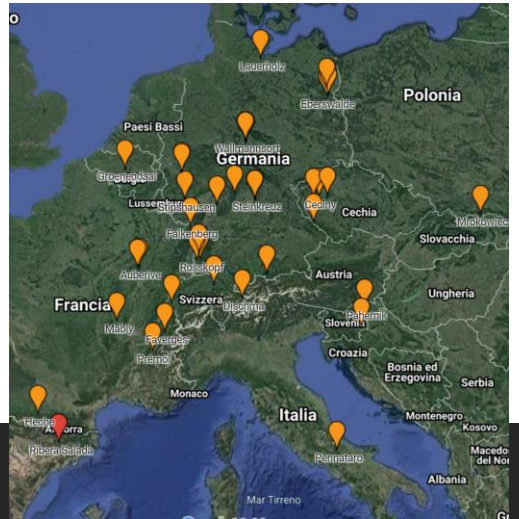
Field activities

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



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Thank you!

Università degli Studi del Molise

Dipartimento Agricoltura, Ambiente e Alimenti