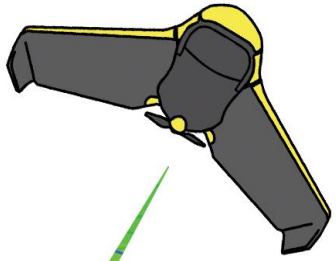
FreshLIFE

Telerilevamento a supporto della Gestione Forestale Sostenibile

LIFE14_ENV/IT/000414 - Demonstrating remote sensing integration in sustainable forest management



LIFE Environment and Resource Efficiency

LIFE14 ENV/IT/000414
Demonstrating Remote Sensing integration in sustainable forest management

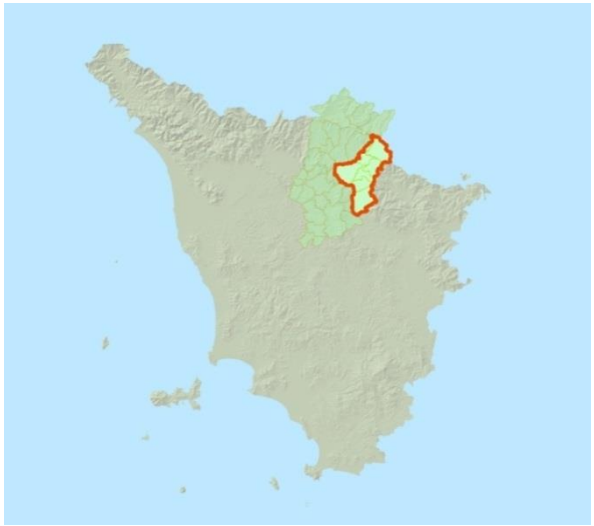
Bacci D.[1], Barzagli A.[2], Del Monte B.[1], Del Perugia B.[2], Travaglini D.[2]

[1]Municipalities Union Valdarno and Valdisieve
[2]University of Florence

April 6th, 2017

MUNICIPALITIES UNION VALDARNO AND VALDISIEVE (UCVV)

Tuscany, Italy



In the north est side of Tuscany

Rincine public forest (green) and project area (red)

The activities of UCVV

1. **Public forest properties (tuscany region)(PAFR)) management** and Muraglione property (UCVV owner) 4.500 ha according to sustainable selvicolture rules;
2. **Training and qualification of forest workers** (public and private) to improve safety standars and productivity level at the same time;
3. **Management** of the processes about **agricolture and forest activities** linked by specific regional laws (LR 39/00 e s.m.i.) (tagli boschivi, movimenti terra, ecc.) and, in associated way for the municipalities also for building activities;
4. **Active partecipation in the integrated sistem fire fight of Tuscany** region through the availability of specialized personell and destinated ; associated management of burned forest areas inventory;
5. **Hydraulic maintenance of waterways**
6. Intermunicipality civil protection office;
7. Associated management of the enviromental impact evaluation processes;
8. Agricolture activities service (ecotourism, enviromental education etc.)
9. **Field research activities in collaboration** with UNIFI, CNR and others;
10. Actions to promote renewable energy sources
11. To be underlined that the **only one Italian Model Forest is based here, in Rincine**

The activities of UCVV in the project

1. Action B1, existing data forniture
2. Action B2, new data acquisition
3. Action B5, data elaboration
4. Action D6, workshop and seminars
5. Action D7, networking

LIST OF BENEFICIARIES

1) Italian Academy of Forest Sciences (Coordinating beneficiary)
2) Municipality of Caprarola
3) Society Demetra
4) Oben spin-off of the University of Sassari
5) Molise Region
6) RomaNatura
7) Municipalities Union Valdarno and Valdisieve
8) University of Florence
9) University of Molise
10) University of Tuscia

PROJECT DURATION

Start date: September 7th, 2015
End date: September 6th, 2019

PROJECT BUDGET

Total project budget: € 2,854,979
Total eligible project budget: € 2,810,804
EU financial contribution: € 1,686,201

OBJECTIVES

Demonstrating the feasibility of integration of data collected from forest inventories with remotely sensed information for the spatial estimation of selected Forest Europe quantitative indicators of Sustainable Forest Management (SFM)

Goals of demonstration activities:

1. Testing and evaluating the technical and economic feasibility of integrating remote sensed information collected by Drones equipped with LiDAR and multispectral sensors, with plot-level data from forest inventories, in order to:

    i) map Forest Europe SFM indicators;

    ii) stratify medium to large scale forest management units by the EEA classification of European Forest Types (EFTs)

2. Developing a Forest Information System, aggregating multiple indicator maps, to support forest managers to evaluate success towards SFM at the scale of the forest management unit

PROJECT ACTIONS

Action		2015				2016				2017				2018				2019				2020			
Action numbe	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
A. Preparatory actions (if needed)																									
B. Implementation actions (obligatory)																									
B.1	Existing data acquisition and harmonization			■	■	■	■	■																	
B.2	New data acquisition					■	■	■	■	■	■	■													
B.3	Mapping SFM indicators					■	■	■	■	■	■	■	■												
B.4	Forest Information System implementation													■	■	■	■	■	■	■					
B.5	Upscaling project results															■	■	■	■	■					
C. Monitoring of the impact of the project actions (obligatory)																									
C.1	Local monitoring			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
C.2	Large scale monitoring			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
C.3	Socio Economic Impact of the project actions on the local economy and population			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
D. Public awareness and dissemination of results (obligatory)																									
D.1	Project Website				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
D.2	Layman's Report															■	■	■	■	■					
D.3	Life Notice Boards			■	■	■											■	■	■	■					
D.4	Technical Report and Training											■	■	■	■	■	■	■	■	■					
D.5	Report for policy makers													■	■	■	■								
D.6	Workshops, seminars and meetings			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
D.7	Networking				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
E. Project management and monitoring of the project progress (obligatory)																									
E.1	Project Management and monitoring of the project progress			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
E.2	After Life Plan																	■	■	■					
E.3	Indicators			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
E.4	External Audit												■	■	■	■	■	■	■	■					

STUDY AREAS

1 Rincine

Municipality of Londa (Florence, Tuscany)
Regional estate forest
Managed by Unione di Comuni Valdarno e Valdisieve

2 Caprarola

Municipality of Caprarola (Viterbo, Lazio)
Regional Nature Reserve of Lago di Vico
Site of the Natura2000 network
Managed by Municipality of Caprarola

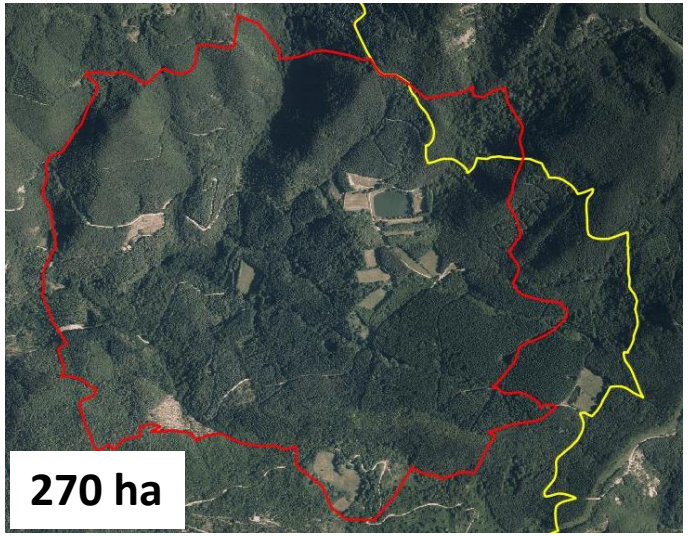
3 Decima Malafede

Municipality of Rome (Rome, Lazio)
Nature Reserve Decima Malafede
Site of the Natura2000 network
Managed by RomaNatura

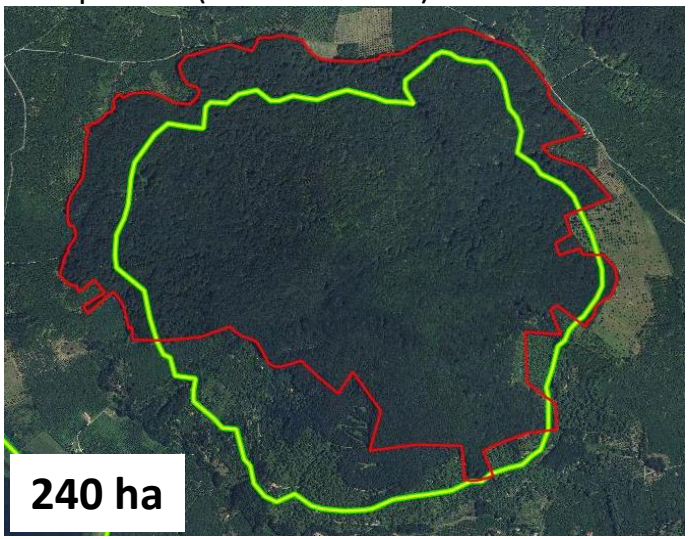
4 Bosco Pennataro

Municipality of Vastogirardi (Isernia, Molise)
Site of the Natura2000 network
Managed by National Forest Service, Office for Biodiversity Isernia

1. Rincine (500-1000 m asl)



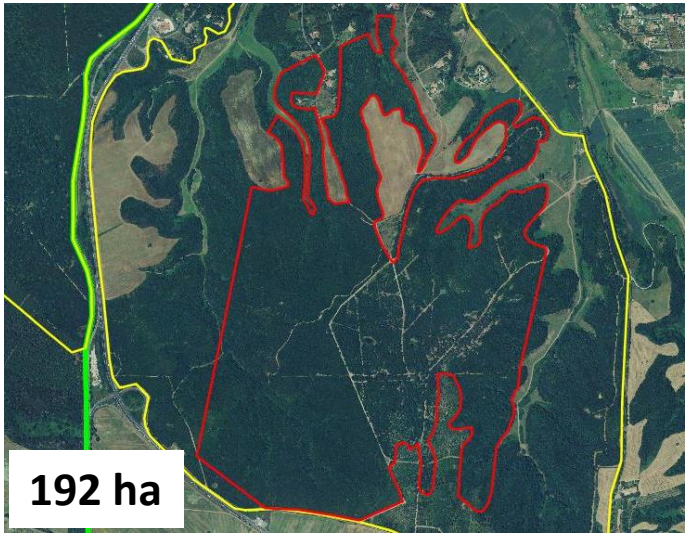
2. Caprarola (500-800 m asl)



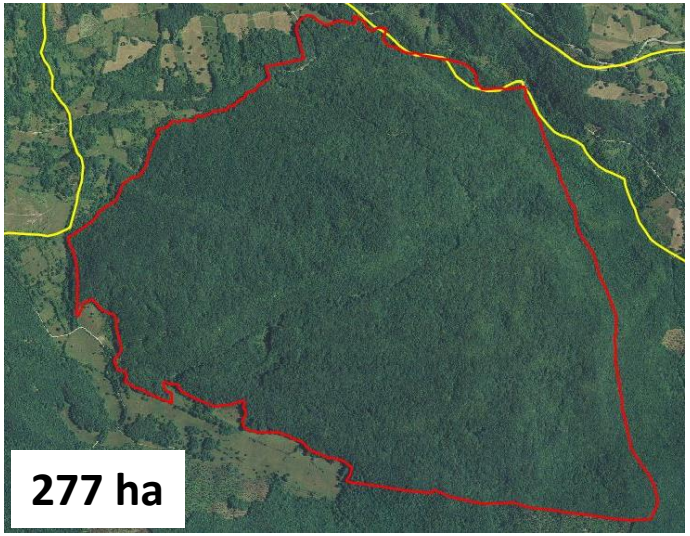
Study area

Natura2000 site

3. Decima Malafede (50-100 m asl)



4. Bosco Pennataro (1000-1200 m asl)



European Forest Type	Study area			
	Rincine	Caprarola	Decima Malafede	Bosco Pennataro
Apennine-Corsican mountainous beech forest	X	X		X
Chestnut forest	X			
Downy oak forest	X			
Italian alder forest	X			
Mediterranean evergreen oak forest			X	
Other thermophilous deciduous forests	X			
Plantations of not-site-native species and self-sown exotic forest	X			
Plantations of site-native species	X		X	
Turkey oak, Hungarian oak and Sessile oak forest	X	X	X	X
Other (e.g., shrubs, non forest)	X		X	

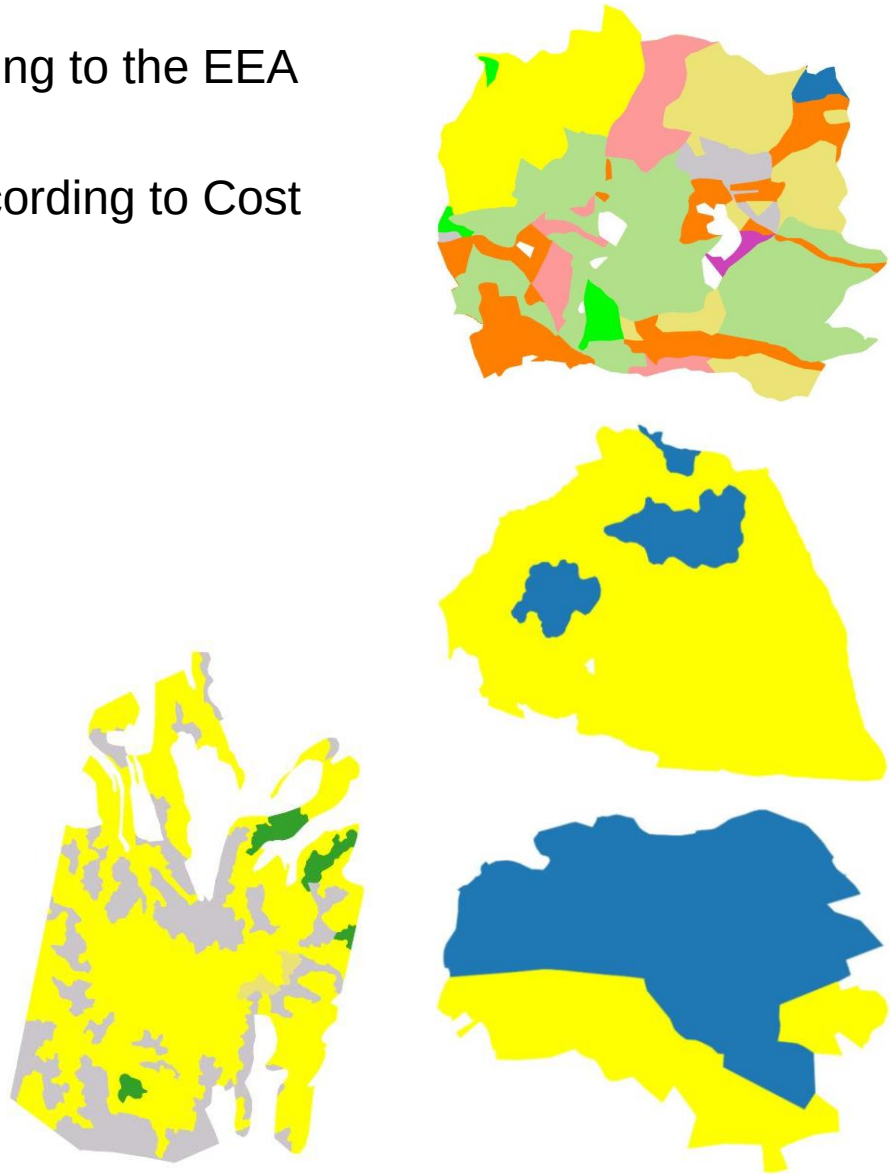
ACTION B1 - Existing data acquisition and harmonization

Existing data		Study area			
		Rincine	Caprarola	Decima Malafede	Bosco Pennataro
Forest inventory data	Num. of plots	16 (2004)	65 (2006)	N	77 (2013-2014)
Remote sensing data	Ortophotos	Y (1954-2015)	Y (1989-2008)	Y (1989-2008)	Y (2005-2012)
	Multispectral data	N	Spot (2006), RE (2011), IRS (2012)	Spot (2006), RE (2011), IRS (2012)	Spot (2006), IRS (2012)
	LiDAR data	Y (2015)	N	N	N
Forest management data	Management plan	Y (2005-2019)	Y (1989, 2007)	N	Y (2008-2017)
	Forest compartment map	Y	Y	N	Y
	Forest type map	Y	Y	N	Y
Auxiliary data	Topographic map	Y	Y	N	Y
	Soil map	Y	Y	Y	Y
	Land use map	Y	Y	Y	Y
	Roads map	Y	Y	N	Y

Forest type maps were harmonized according to the EEA forest type classification system

Forest inventory data were harmonized according to Cost ActionE43

ID Area	ID Plot	Specie	Diametro	Altezza	Numero piante	Area basimetrica	Volume
(n)	(n)	(nome)	(cm)	(m)	(n)	(m2)	(m3)
2	1	Faggio	5	13.6	1	0.002	0.01
2	1	Faggio	30	24.0	1	0.071	0.84
2	1	Cerro	10	17.6	2	0.016	0.13
2	1	Cerro	30	24.0	1	0.071	0.82
2	1	Cerro	35	24.8	3	0.279	3.36
2	1	Cerro	40	25.6	5	0.616	7.65
2	1	Cerro	45	26.3	4	0.620	7.91
2	1	Cerro	50	26.9	3	0.569	7.43
2	1	Cerro	55	27.4	4	0.927	12.33
2	1	Cerro	60	27.9	3	0.820	11.11
2	1	Acero opalo	5	13.6	3	0.006	0.04
2	1	Acero opalo	10	17.6	10	0.077	0.66
2	1	Acero opalo	15	20.0	6	0.104	0.99
2	1	Acero opalo	20	21.6	2	0.063	0.64



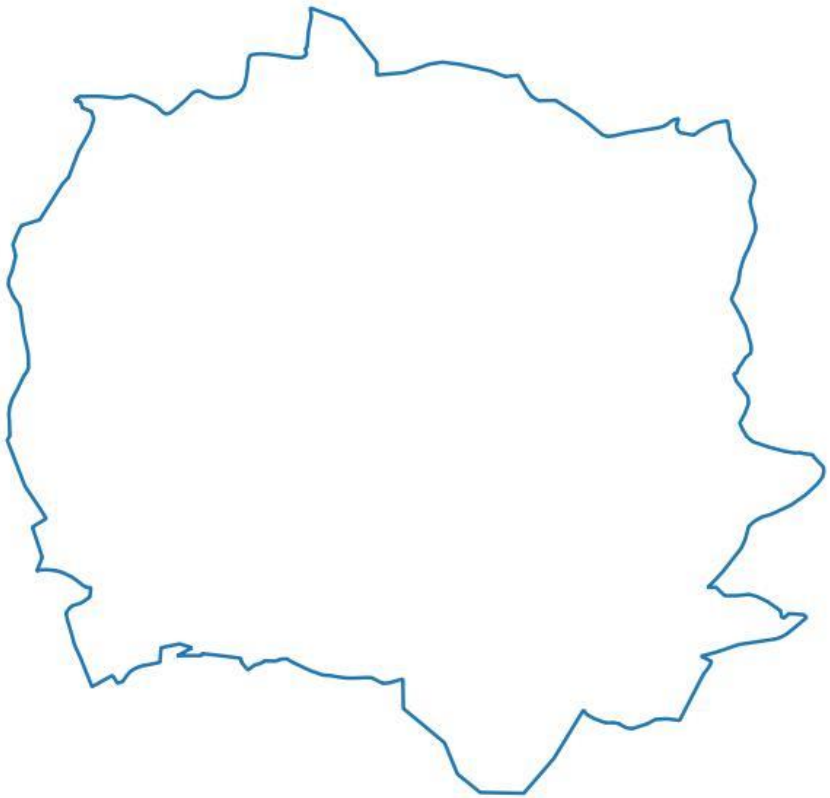
- Other
- Apennine-Corsican mountainous beech forest
- Chestnut forest
- Downy oak forest
- Italian alder forest
- Mediterranean evergreen oak forest
- Other thermophilous deciduous forests
- Plantations of not-site-native species and self-sown exotic forest
- Plantations of site-native species
- Turkey oak, Hungarian oak and Sessile oak forest

ACTION B2 - New data acquisition

- New forest inventory data
- New remote sensing data

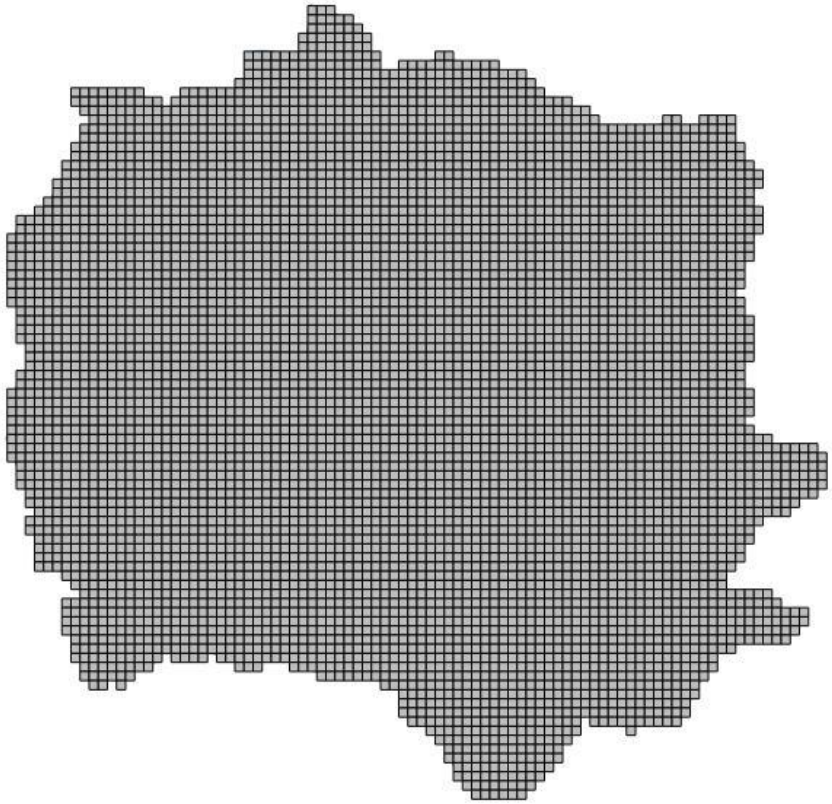
Forest inventory data

- Sampling scheme: One-per-stratum stratified sampling
- Sample size: 50 plots in each study area
- Plot size: square plot 23x23 m (529 m^2)



Study area (Rincine)

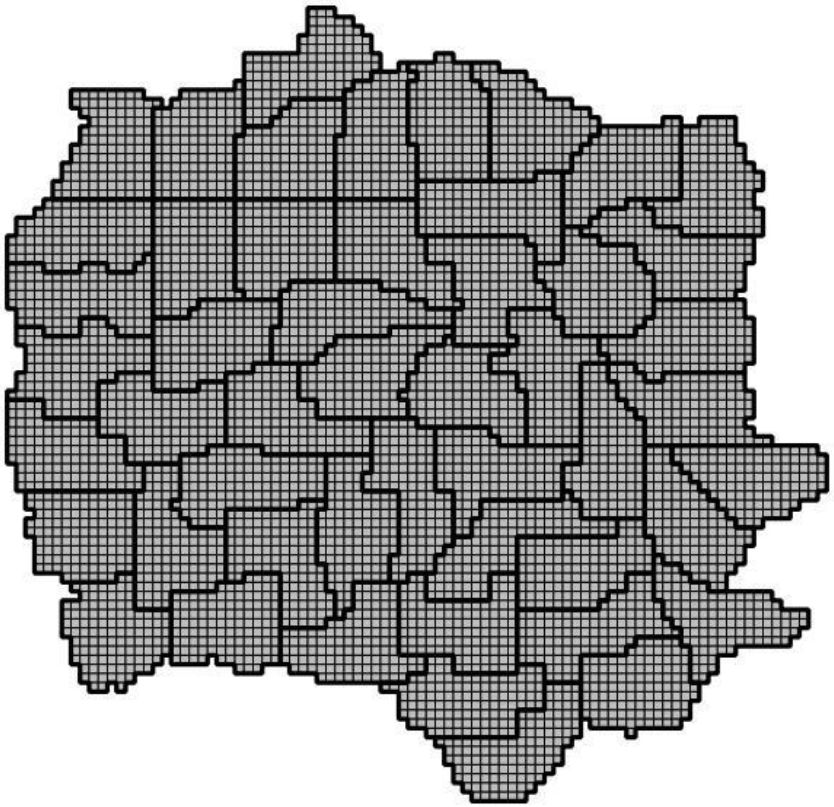
- Sampling scheme: One-per-stratum stratified sampling
- Sample size: 50 plot in each study area
- Plot size: square plot 23x23 m (529 m^2)



Study area (Rincine)

Square 23x23 m

- Sampling scheme: One-per-stratum stratified sampling
- Sample size: 50 plot in each study area
- Plot size: square plot 23x23 m (529 m^2)



- Sampling scheme: One-per-stratum stratified sampling
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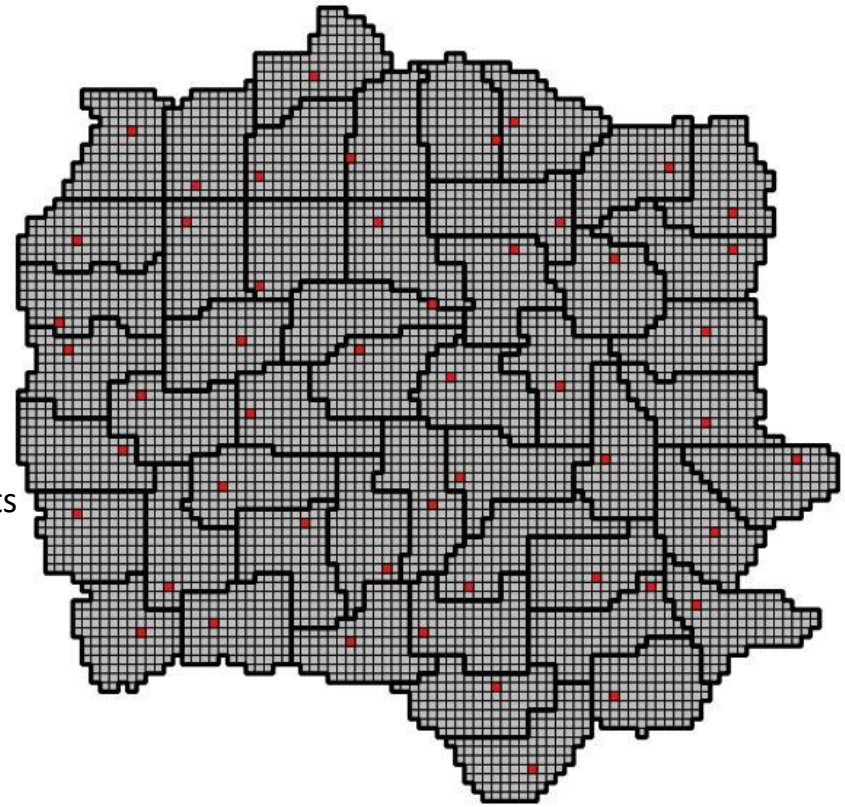


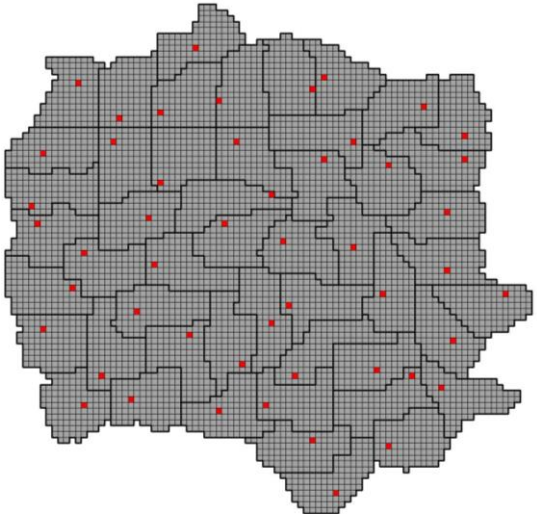
Study area (Rincine)

Square 23x23 m

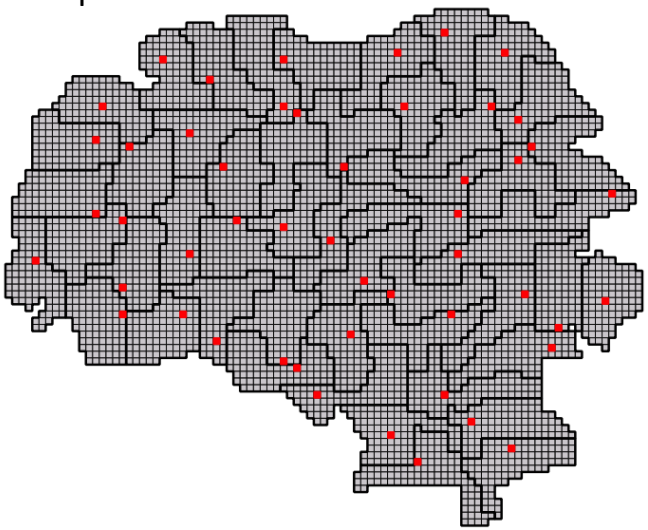
Cluster

Plot selected for field measurements

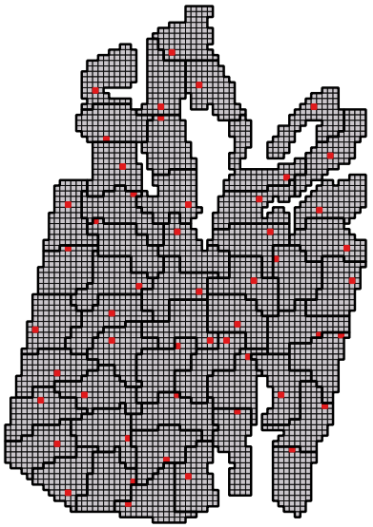
Rincine



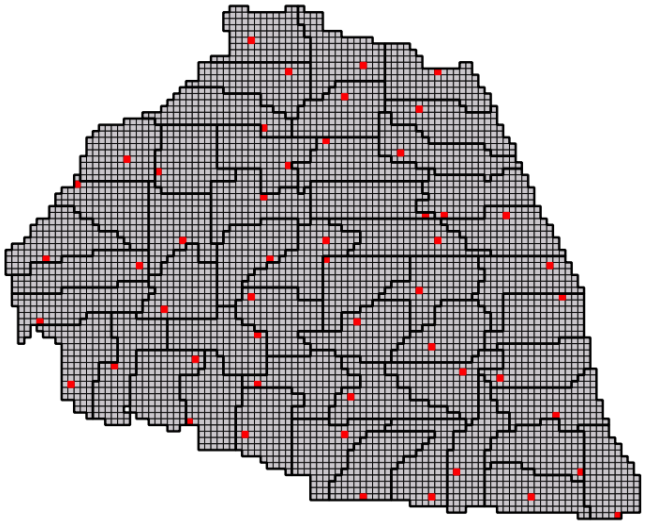
Caprarola



Decima Malafede



Bosco Pennataro



Square 23x23 m

Cluster

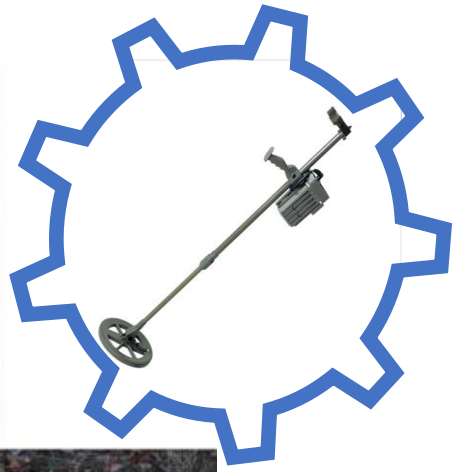
Plot selected for field measurements

A common sampling protocol was used for field works

- Positioning of permanent plots
- Measurements of living trees
- Measurements of standing deadwood
- Measurements of stumps
- Measurements of lying deadwood

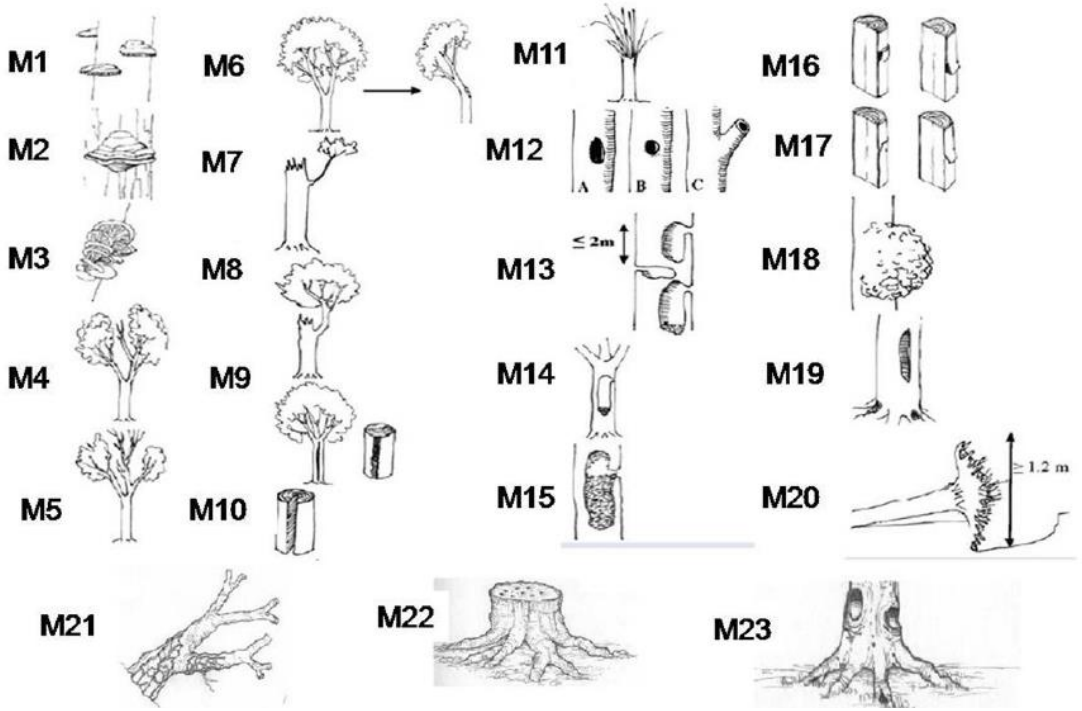
Positioning of permanent plots

- GNSS receiver (min 150 positions)
- 1 metal stake was installed in the plot centre



Measurements of living trees

- DBH > 2.5 cm
- Species
- Total height
- Height to crown base
- Crown projection (4 radii)
- Tree position (x,y)
- Crown dieback
- Microhabitat



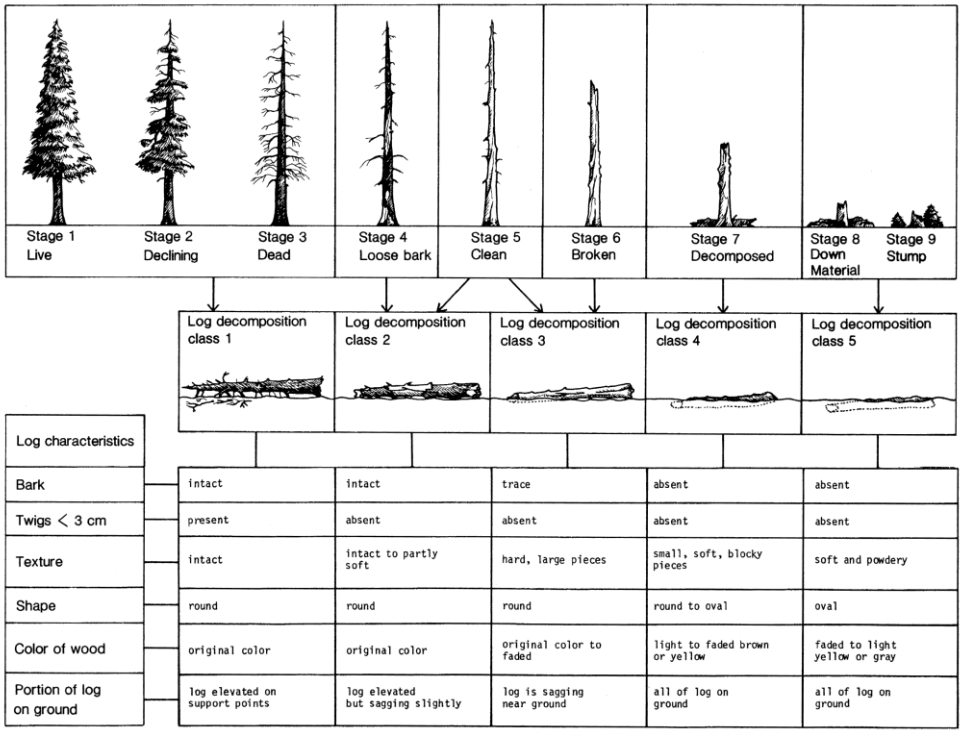
Measurements of deadwood

Standind deadwood
- DBH > 2.5
- Diameter at half height
- Total height

Stump
- Diameter > 10 cm
- Origin
- Total height

Lying deadwood
- Diameter > 10 cm, lenght > 1 m
- Diameter at half lenght
- Total lenght

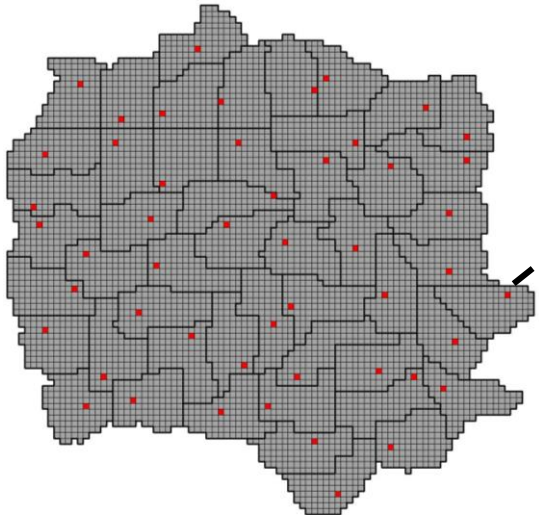
All
- Species
- Position (x,y)
- Microhabitat
- Decay

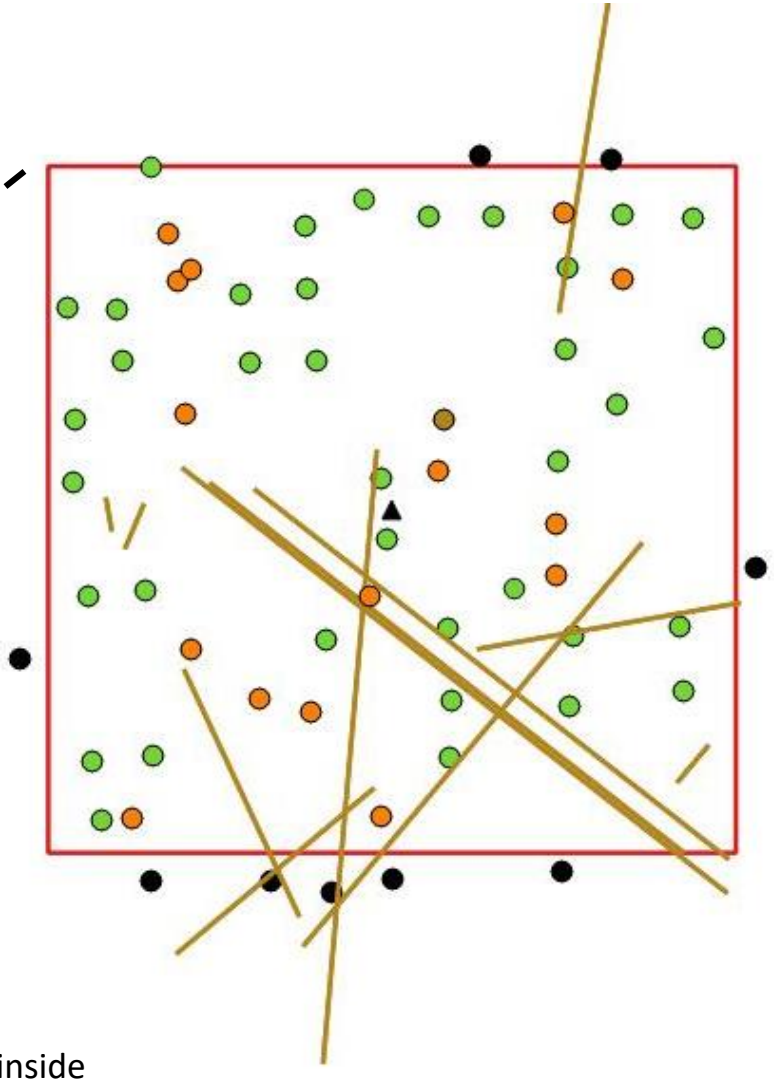


Log characteristics	Log decomposition class 1	Log decomposition class 2	Log decomposition class 3	Log decomposition class 4	Log decomposition class 5
Bark	intact	intact	trace	absent	absent
Twigs < 3 cm	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft, blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Color of wood	original color	original color	original color to faded	light to faded brown or yellow	faded to light yellow or gray
Portion of log on ground	log elevated on support points	log elevated but sagging slightly	log is sagging near ground	all of log on ground	all of log on ground

Example of spatial data base

Rincine





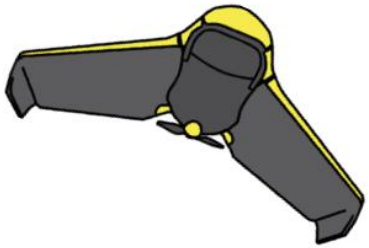
- Plot centre
- Living trees
- Standing deadwood
- Stump
- Trees outside the plot with their crown inside
- Lying deadwood

Remote sensing data

We are using two types of Drones

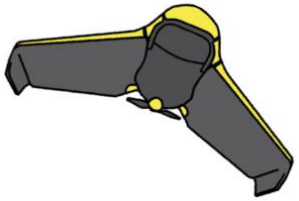
Video 01

Video 02



eBee – RGB and NIR cameras

	SONY WX	Canon S110 NIR
Flight altitude above ground level	145 m	145 m
Camera	Canon S110 RGB	Canon S110 NIR
R	660 nm	625 nm
G	520 nm	550 nm
B	450 nm	-
NIR	-	850 nm
Overlap	80%	90%
Sidelap	75%	85%
Focal length	4 mm	5 mm
ISO Sensibility	ISO-100	ISO-1600
Shutter speed	1/2000 sec	1/2000 sec
Image dimension	4608 x 3456	4000 x 3000
Field of view	200 x 150 m	168 × 126 m
Estimated ground sampling distance	0.050 m	0.042 m



eBee – Num. of flights, acquisition time and num. of images in each study area

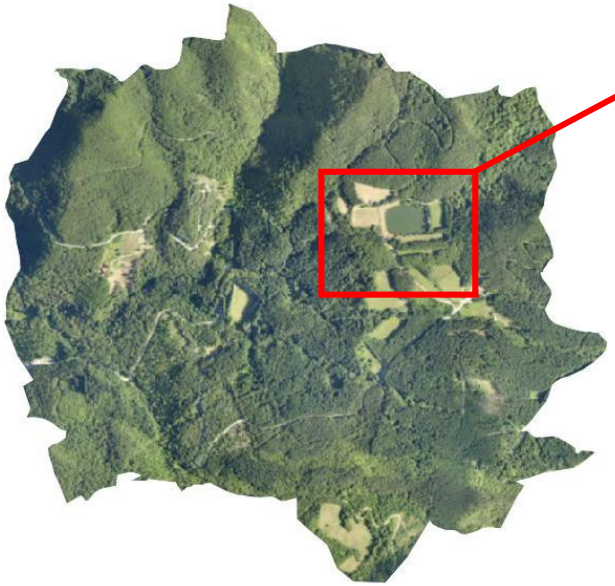
Camera	Study area	Num. of GCP	Num. of flights	Tot. acquisition time	Num. of images
RGB	Caprarola	12	4	3h20'	483
NIR	Caprarola		5	4h20'	564
RGB	Bosco Pennataro	12	4	3h50'	608
NIR	Bosco Pennataro		5	4h35'	689
RGB	Rincine	12	4	3h25'	506
NIR	Rincine		5	4h10'	682
Tot.		36	27	52h40'	3532

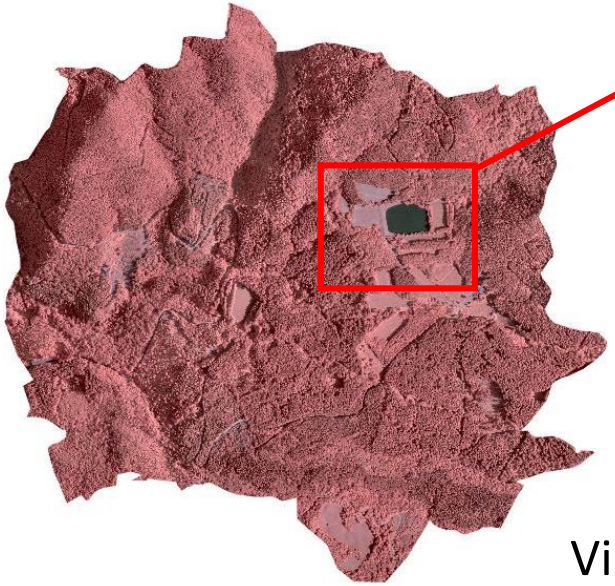
Softwares:

- eMotion2 to simulate, to plan and to monitor the flight
- Agisoft PhotoScan for image processing and to create a 3D point cloud

Products:

- 2 dense point clouds, RGB and NIR (ranging between 20-40 points/m^2)
- 2 Digital Surface Model - DSM (50 cm spatial resolution)
- 2 ortophotos, RGB and NIR (10 cm spatial resolution)





Video 03

Octocopter – LiDAR sensor

Sensor:

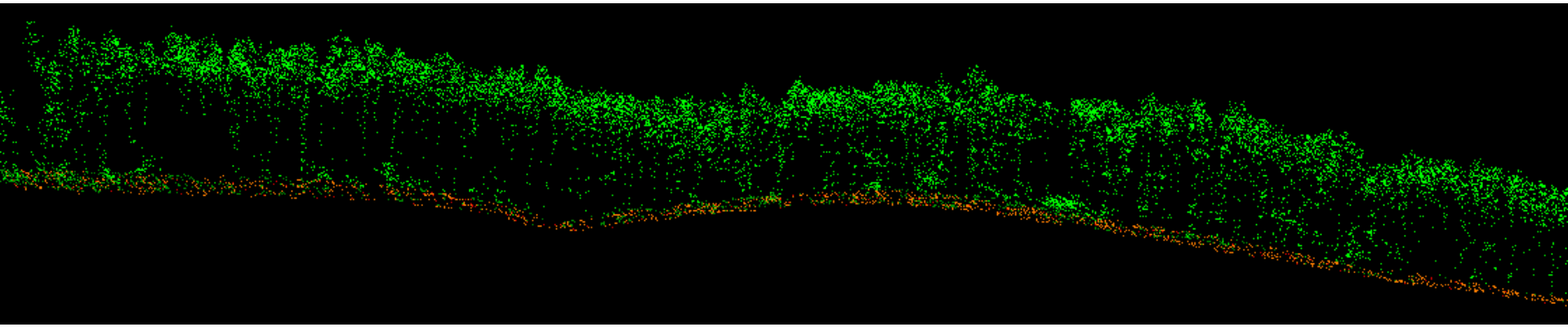
- Yellowscan (up to 50 points/m^2)

Software:

- Lastools for 3D point cloud processing and analysis

Products:

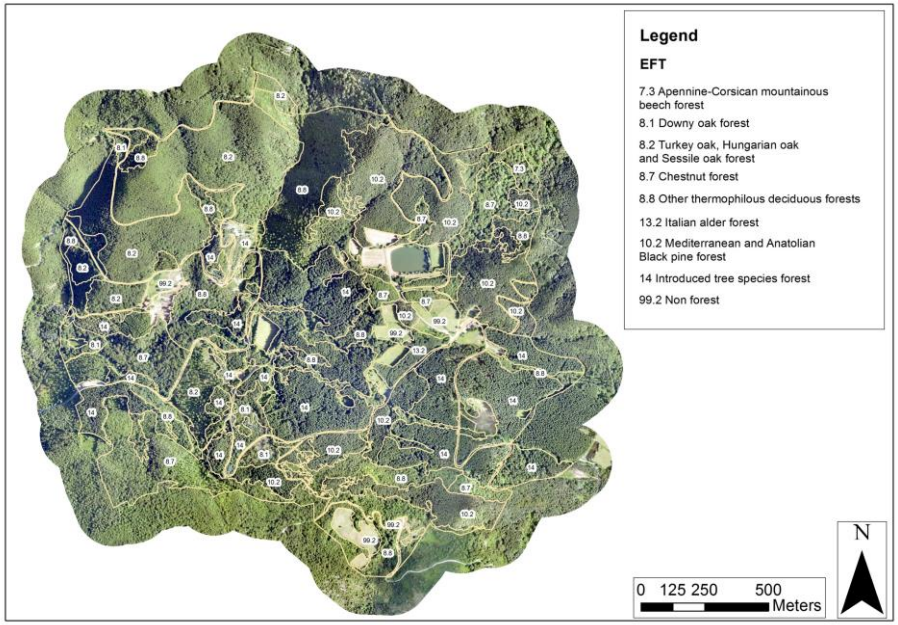
- 3D point cloud
- Digital Surface Model - DSM
- Digital Terrain Model – DTM
- Canopy Height Model – CHM = DSM-DTM

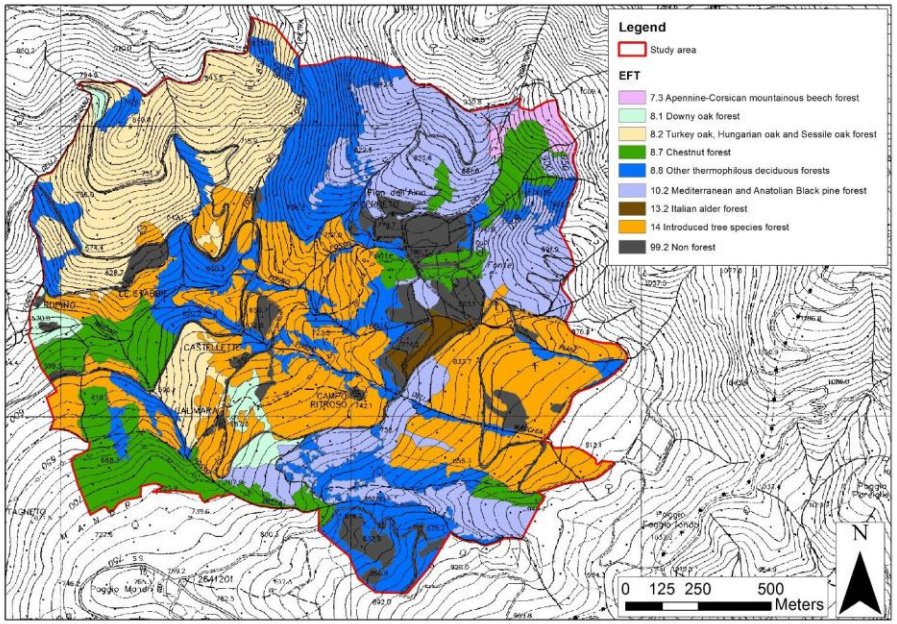


ACTION B3 – Mapping SFM indicators

- Action B3 is in progress
- At present we are working on:
  1) EFT classification
  2) Defoliation
  3) Growing stock volume

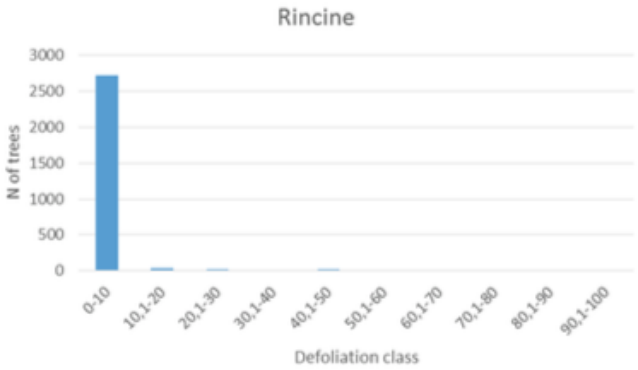
Preliminary results – European Forest Types

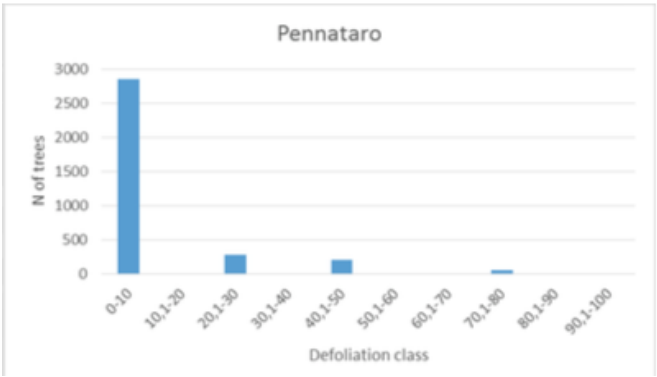




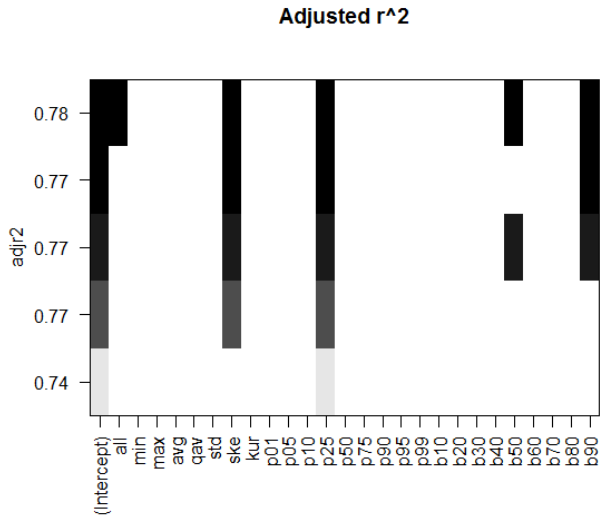
Study area	Visual classification			Semiautomatic classification				
	Time (h)	Accuracy (%)		Time (h)			Accuracy (%)	
		OA	KIA	Segmentation	Classification	Total	OA	KIA
Rincine	10	0.94	0.92	-	-	-	-	-
Caprarola	8	0.90	0.82	0.45	3	3.45	0.80	0.62
Bosco Pennataro	8	0.74	0.37	-	-	-	-	-

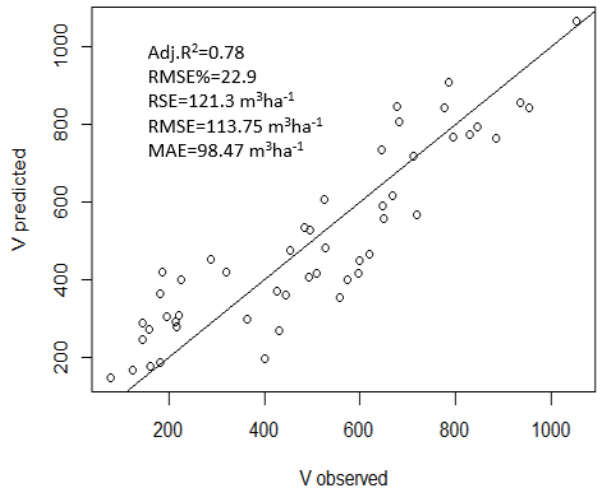
Preliminary results – Defoliation

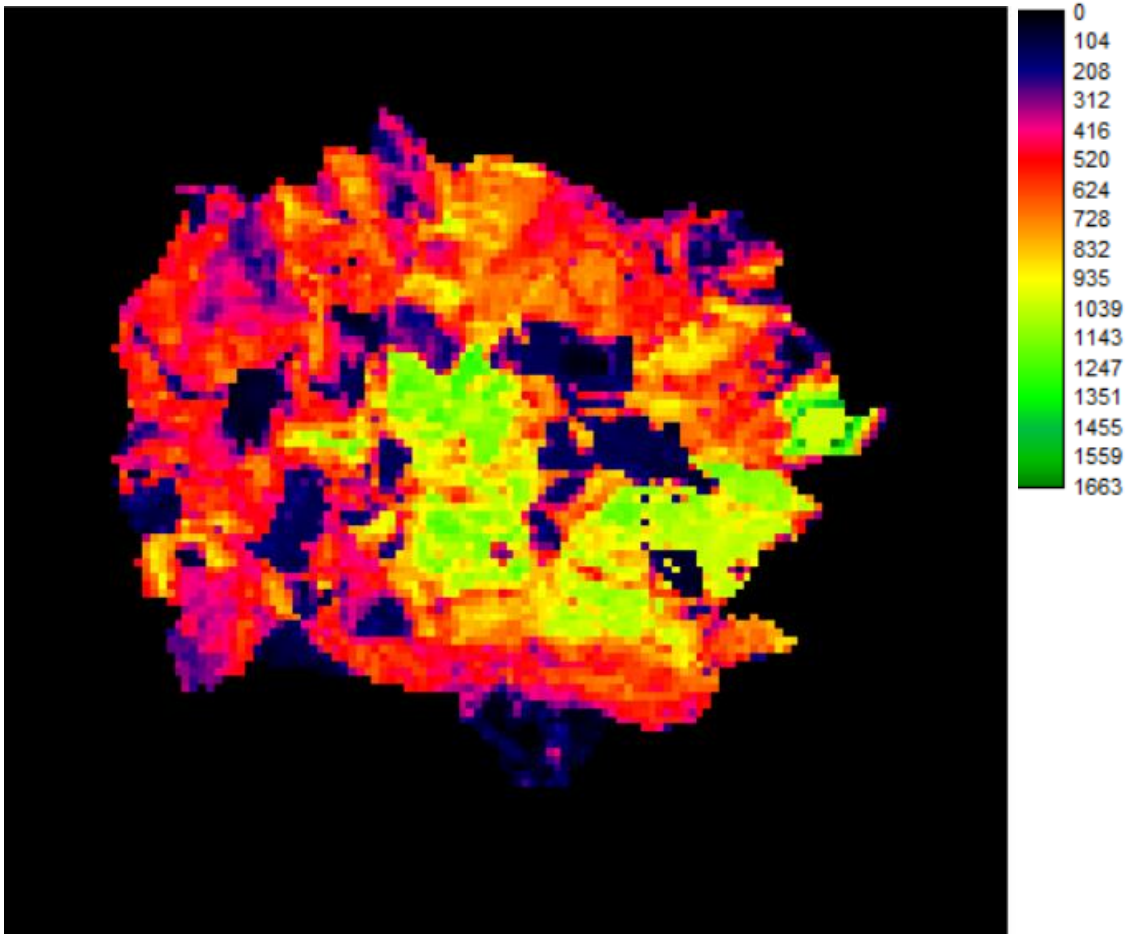




Preliminary results – Growing stock volume (m^3/ha)







Thank you for your attention!!