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Mappatura degli European Forest Types da drone e applicazioni per la stima di indicatori di biodiversità forestale

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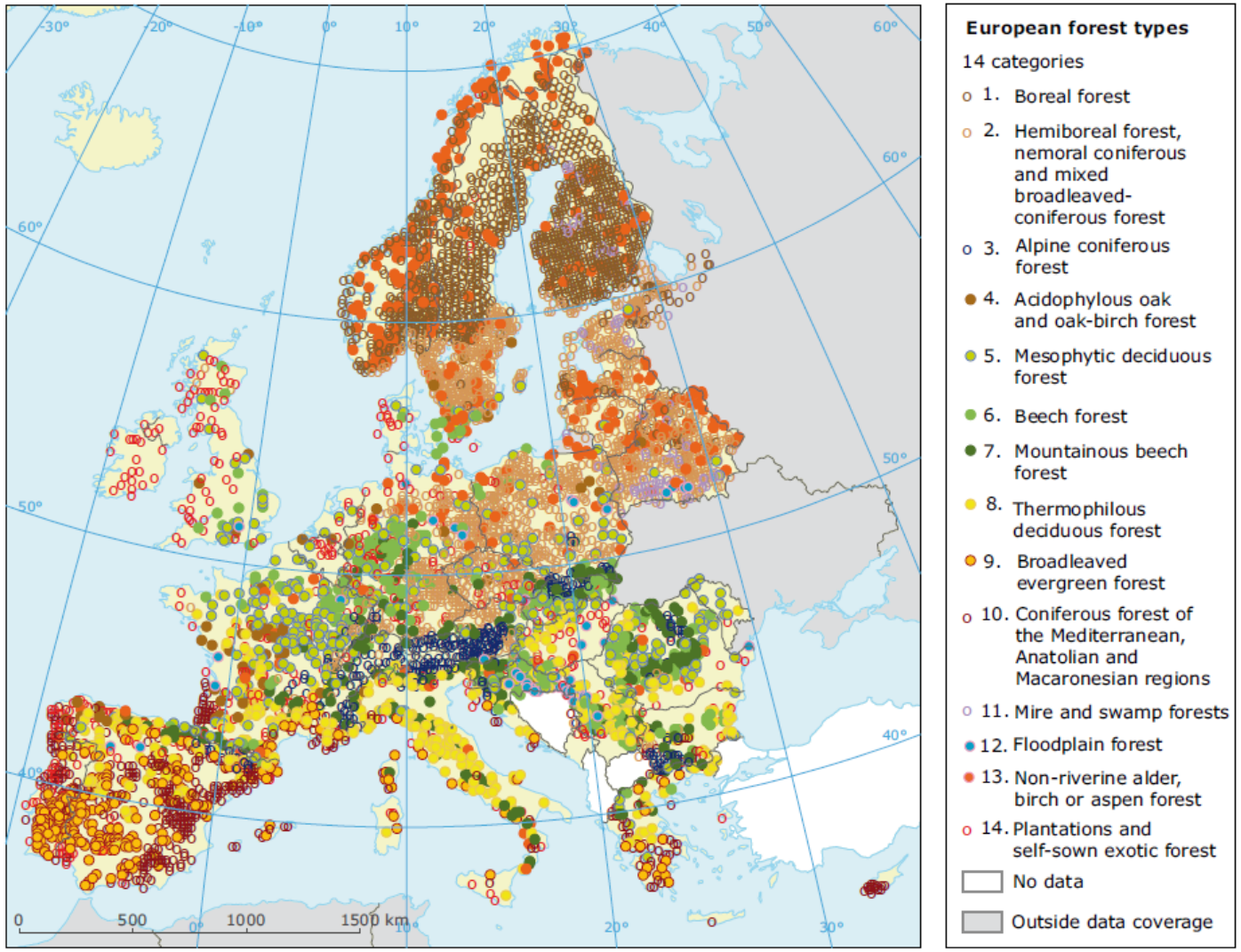
Background

The European Forest Types (EFTs) are a flexible approach to:
- stratify forest area by ecologically distinct forest communities

- Monitor SFM indicators especially biodiversity-related ones (species richness and diversity, stand structure)



Source: EEA, 2008

Aims of the study

- To test and evaluate methods coupling remotely sensed information collected from RPAS with plot-level data
- To derive maps of European Forest Types (EFTs) for the project pilot study areas
  Minimum mapping unit: 0.5 ha (sensu FAO def)
- To compare two different mapping approaches (visual interpretation vs semi automatic classification)

Target EFTs to be mapped

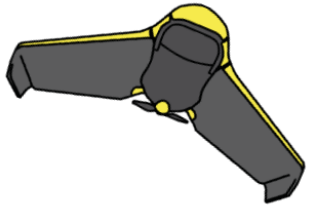
- 7.3 Apennine-Corsican mountainous beech forest
- 8.1 Downy oak forest
- 8.2 Turkey oak, Hungarian oak and Sessile oak forest
- 8.7 Chestnut forest
- 8.8 Other thermophilous deciduous forests
- 10.2 Mediterranean and Anatolian Black pine forest
- 13.2 Italian alder forest
- 14 Introduced tree species forest

Source: Barbati et al. 2014, FORECO

Study areas

- Rincine (1)
  - Comune di Londa (FI)
  - Unione dei comuni Valdarno e Val di Sieve
- Caprarola (2)
  - Comune di Caprarola (VT)
  - Unione dei comuni Valdarno e Val di Sieve
- Bosco Pennataro (3)
  - Comune di Vastogirardi (IS)
  - CFS-UTD Isernia

Materials: Ebee orthomosaic



Ebee (Sensefly)

Very high resolution true color orthomosaics (ground resolution 10 cm^2 pixel), processed from image data collected in the visible spectrum by a camera equipped on eBee

Methods: EFT classification

Visual classification

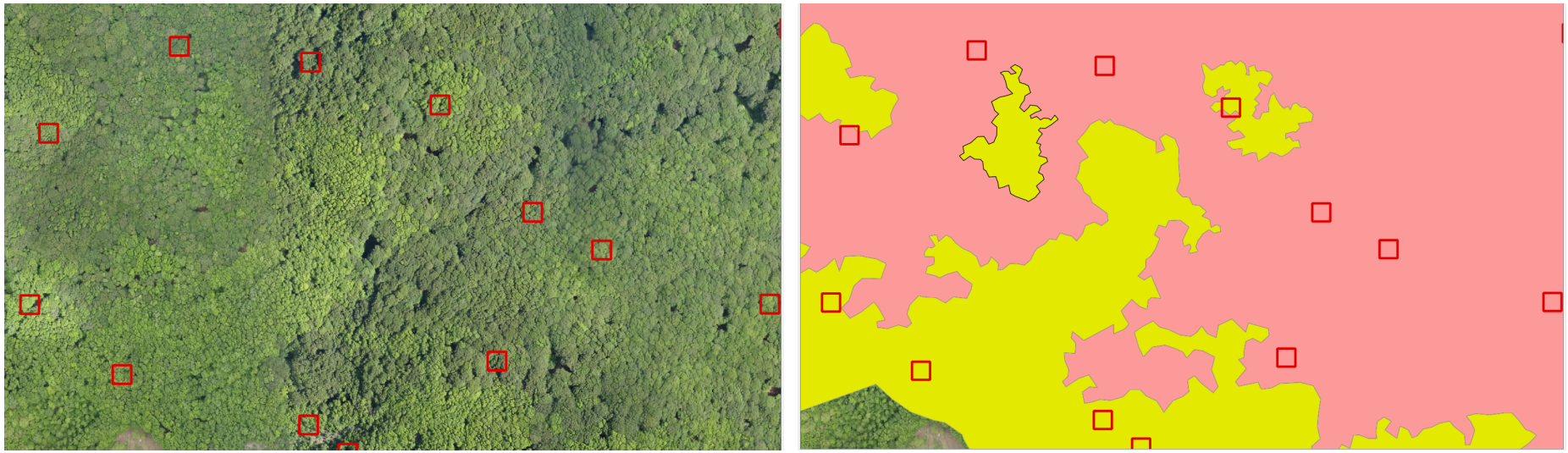
- Differences in tone in the **green band** → distinguishing tree dominant species
- Combination of tone, size, shape and texture criteria support identification to genus or species (e.g. their branching habit & spectral response)

VS

Semi-automatic classification

- Multi-resolution segmentation algorithm (eCognition)
- Optimal segmentation parameters (Scale factor, geometric and spectral homogeneity, compactness) specifically set for each test area
- The classification of the objects performed through the Standard Nearest Neighbour algorithm
- STD.N.N trained based on polygons (training sites) derived by visual interpretation, equally distributed among the classes to be classified

Methods: maps validation

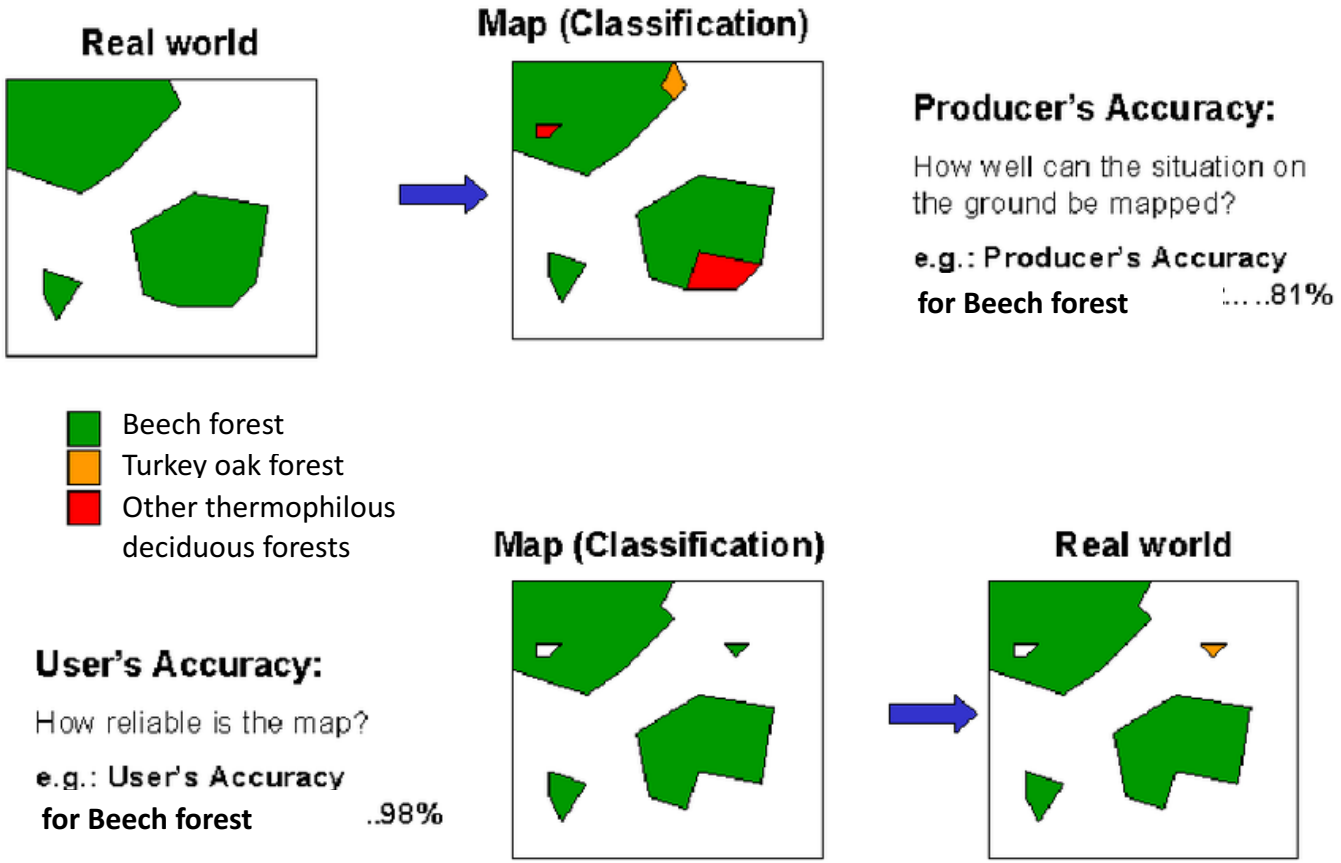


Dominant tree species at plot level (50 plots for each study area) identified using relative basal area proportion

Methods: maps validation

- Producer's accuracy corresponds to error of omission (**exclusion**): e.g. beech forest sites omitted from that forest type

- User's accuracy corresponds to error of commission (**inclusion**): Turkey oak sites included erroneously in beech forest type

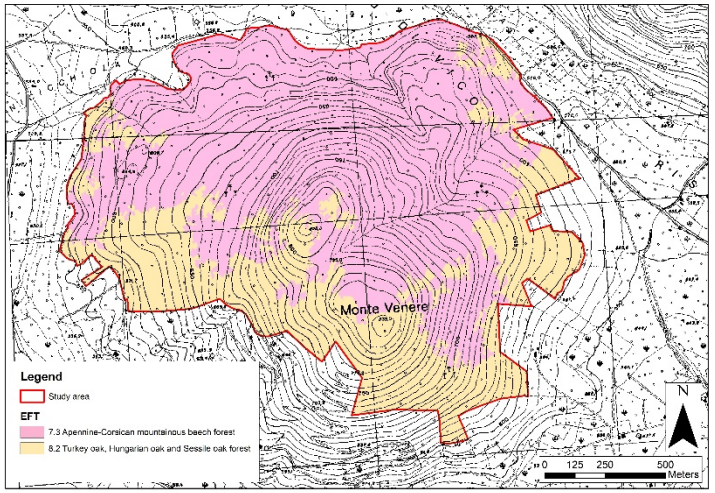


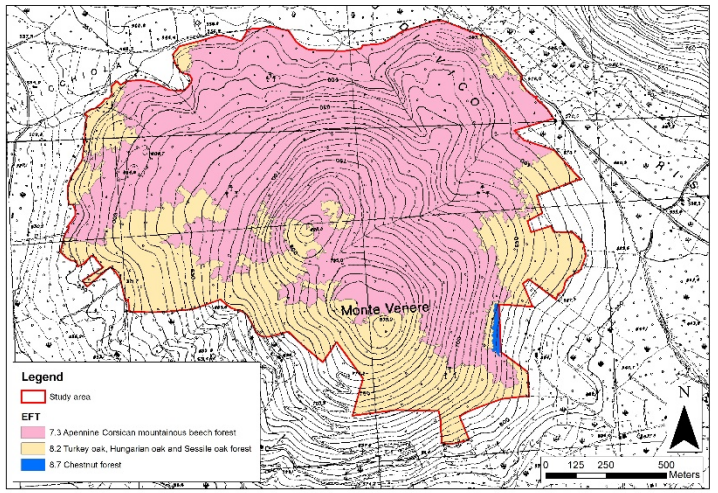
Source: Banko, 1998

Results: Caprarola

Classification			
Semi-automatic classification		Visual image interpretation	
OA	KIA	OA	KIA
0,86	0,69	0,92	0,82

Forest type	PA	UA	PA	UA
7.3 Apennine Corsican mountainous beech forest;	0,88	0,91	0,94	0,94
8.2 Turkey oak, Hungarian oak and Sessile oak forest;	0,82	0,78	0,88	0,88

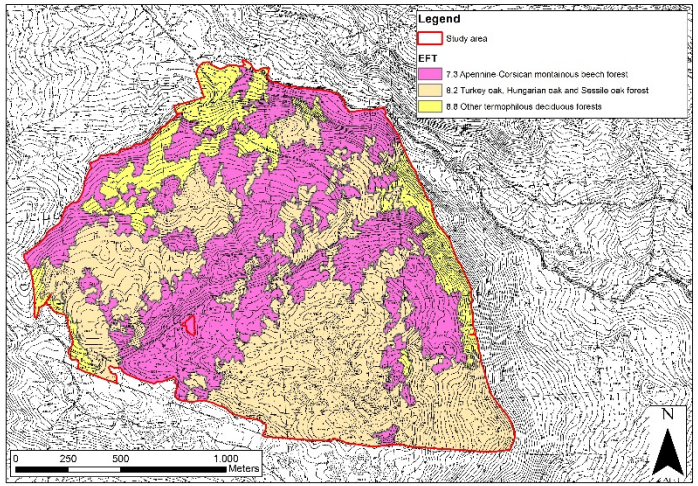


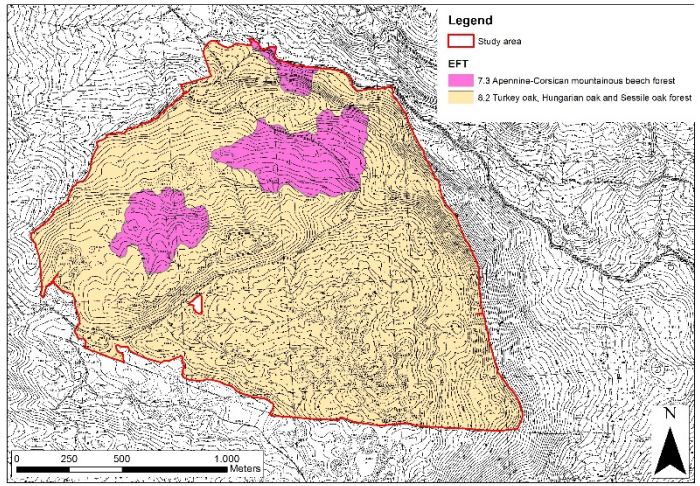


Results: Bosco Pennataro

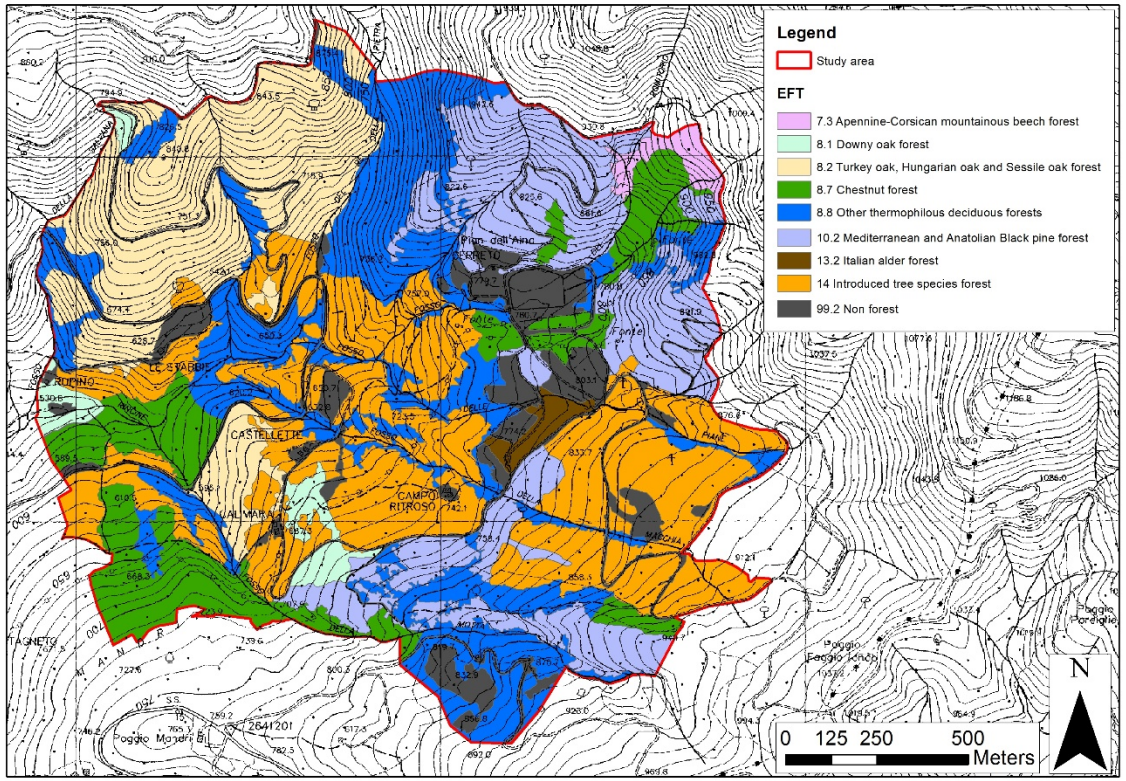
	Classification			
	Semi-automatic classification		Visual image interpretation	
	OA	KIA	OA	KIA
	0,48	0,21	0,74	0,37

Forest type	PA	UA	PA	UA
7.3 Apennine Corsican mountainous beech forest;	0,70	0,32	0,71	0,36
8.2 Turkey oak, Hungarian oak and Sessile oak forest;	0,46	0,72	0,74	1,00
8.8 Other termophilous deciduous forest	0,33	0,40	-	0,00



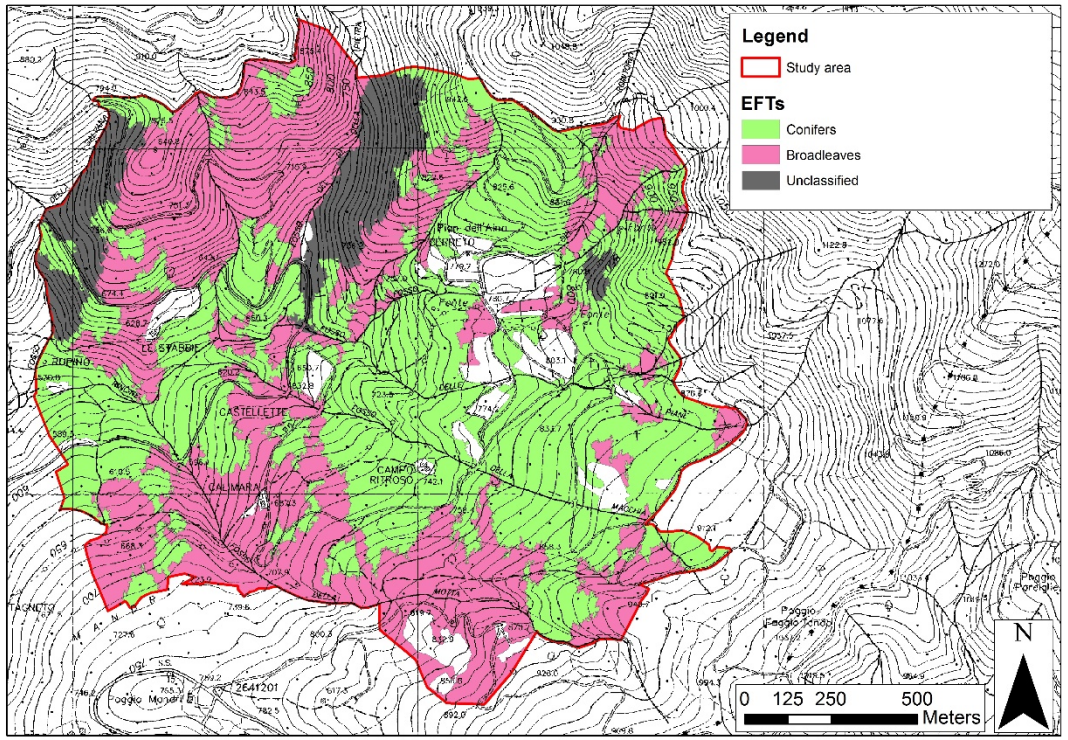


Results: Rincine



	OA	KIA
	0.94	0.92
Per class accuracy by EFTs	**PA**	**UA**
7.3 Appenine Beech	1	1
8.2 Turkey oak	1	1
8.7 Chestnut	1	1
8.8 Other thermophilous deciduous	0.6	1
10.2 Mediterranean Black pine	1	0.85
14 Introduced tree species	0.95	0.95

Results: Rincine



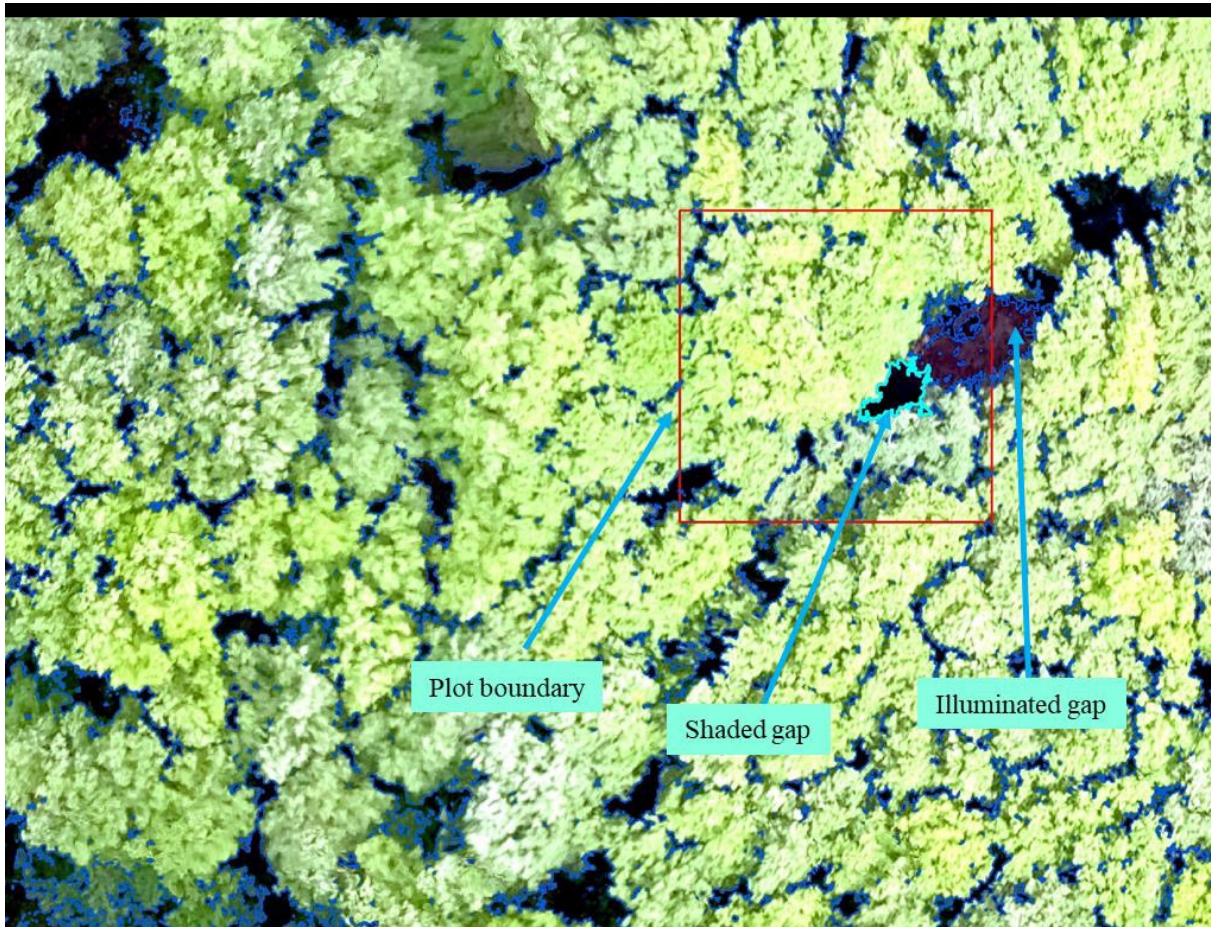
- Worst quality of the orthomosaic (e.g. relief shadows, cloud cover)
- Only aggregated classes (i.e. conifers/broadleaves were classified

Classification	
Semi-automatic classification	
OA	KIA
0,67	0,33

Forest type	PA	UA
Conifers	0,79	0,70
Broadleaves	0,50	0,63

Future perspective: Biodiversity indicators

Very high resolution true color orthomosaic of Caprarola used to perform a "contrast split segmentation" to map **canopy gaps**

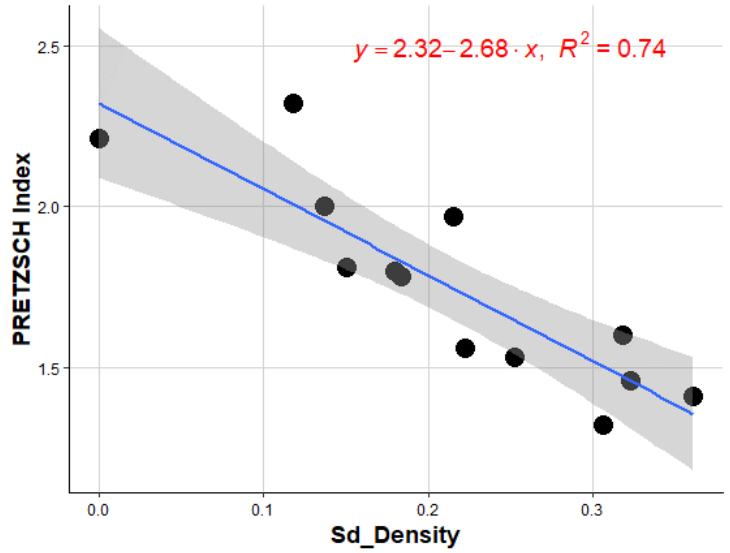


Future perspective: Biodiversity indicators

Variables with normal distribution		
Variables	ANOVA	TUKEY
I_PRETZSCH	***	(1 vs 2)***; (1 vs 3)***
HAB	*	(1 vs 2)**
%_HAB	**	(1 vs 2)*
Non normal distributed variables		
Variables	KRUSKAL-WALLIS	MANN-WHITNEY
N_SPECIES	***	(1 vs 2)***; (1 vs 3)***
I_MARGALEF	***	(1 vs 2)***; (1 vs 3)***
I_SHANNON	***	(1 vs 2)***; (1 vs 3)***

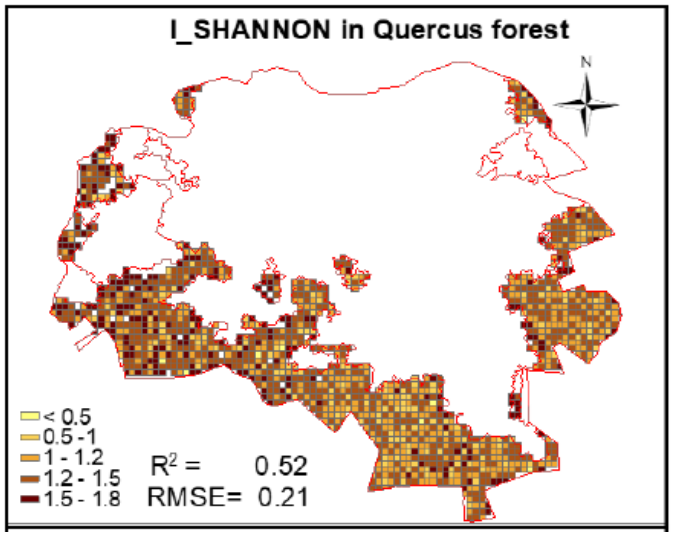
*p<0,05; ** p<0,01; *** p<0,001; 1 = beech forest; 2 = oak forest; 3 = mixed forest

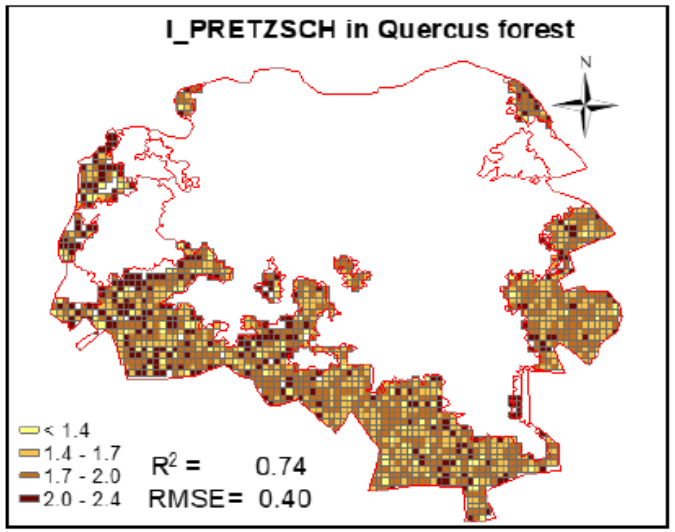
- Biodiversity-related variables found to be significanlty different amongst forest types in Caprarola test site (Beech≠oak, Beech ≠mixed oak & beech)

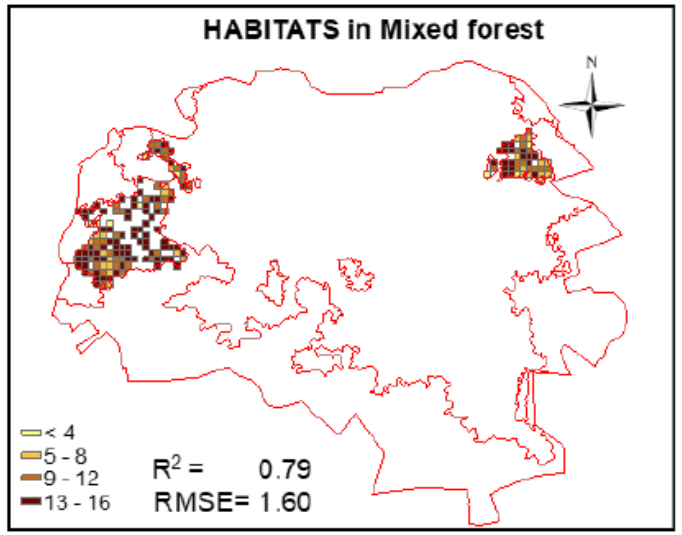


- Correlation and linear regression techniques → to explore relationships between gaps patch metrics & biodiversity variables

Future perspective: Biodiversity indicators







- High values (>50%) of variation of some biodiversity indicators in Quercus and Mixed forests are accounted for by simple linear regression models based on patch metrics

Concluding remarks

- High per-class thematic accuracy for forest type mapping (PA and OA>80%) can be achieved by visual interpretation on a very fine spatial scale (minimum mapping unit=0.5 ha), even within forest areas with heterogeneous fine-scaled spatial pattern of tree dominant species like Rincine
- Segmentation (faster, replicable) is highly dependent on the image quality of the orthomosaic & on target classes to be mapped
- Estimation of forest features using canopy gaps as a proxy led to disparate results. Some promising results were obtained for Shannon index, Number of habitat trees and Pretzch index
- Using EFTs as strata for modeling forest features using canopy gaps increased result accuracy
- UAV true color remote sensing presents a high potential for forest inventory, forest monitoring, and biodiversity assessment

Thanks for your kind attention

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