Day 2 of the ABRESO Meeting: Fall 2022

Consiglio Nazionale delle Ricerche

Dipartimento Scienze del Sistema Terra e Tecnologie per l'Ambiente

ABRESO
Italian activities report 2022

Land use change: abandonment of traditional agricultural practices in Italian alpine mountain

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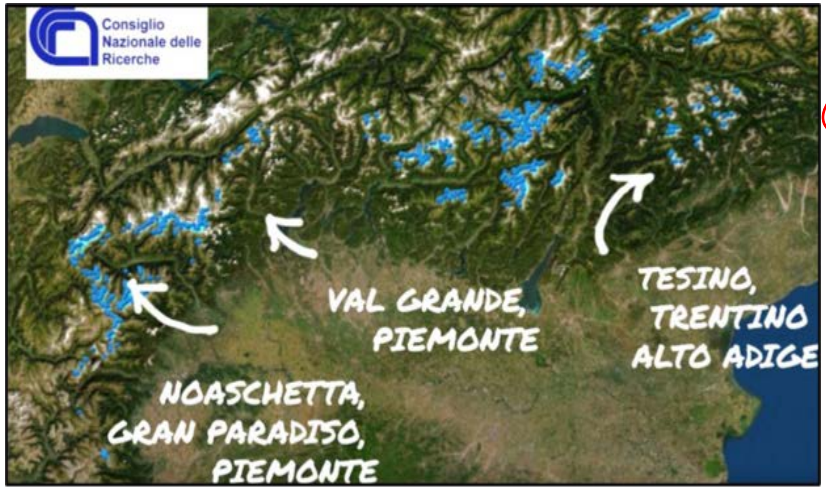
ABRESO Italian Activities report 2022

Three case studies along the Alpine arc: two National Parks (Gran Paradiso and Val Grande, Piemonte) and a silvo-pastoral system (Trentino Alto Adige)



Abandonment/Rebound at case studies (1300-1700 m a.s.l.):

- **Noaschetta**
  Pasture *vs* Tree recolonization
- **Val Grande**
  Terraces/Pasture *vs* Tree recolonization
- **Tesino (Telvagola and Brocon)**
  Pasture *vs* Tree recolonization and *vice versa*

Activities are Interplay between three pillars :

1) ***"Ground" activities***
2) ***Remote sensing***
3) ***Social science***

Soil Biogeochemistry
Geomorphology
Plant Physiology
Phenology
CO_2 flux

Natural Science & Social Science

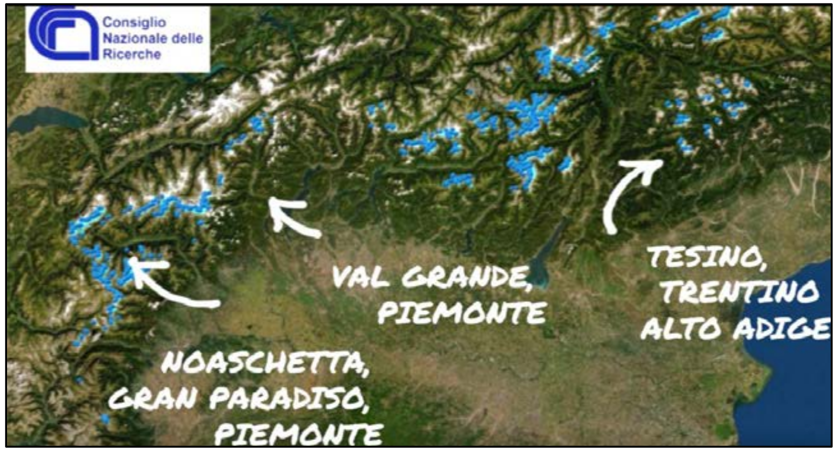
Satellite
Ortophotos
Land cover
Snow cover

Economics of complex systems
Policy evaluation
Economic territory planning

Research actitives presented by:

Andrea Scartazza (CNR Researcher: *Ground based activities)*
Maria Patrizia Adamo (CNR Researcher: *Remote Sensing*)
Chiara Richiardi (PhD, Belmont Forum Grant)
Lisa Sella (CNR Researcher: *Social Science*)

Natural Science: ground based researches at Italian case studies

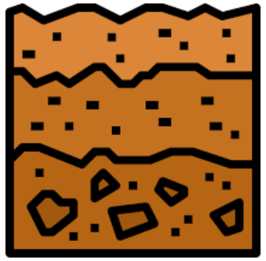


ABANDONMENT EFFECTS IN THE SELECTED CASE STUDIES ON SOIL-PLANT INTERACTIONS

- **Noaschetta**
  Pasture *vs* tree recolonization
- **Val Grande**
  Terraces/pasture *vs* tree recolonization
- **Tesino (Telvagola and Brocon)**
  Pasture *vs* tree recolonization and *viceversa*

Soil-Plant interactions

- **Plant biodiversity**
- **Carbon (C) and nitrogen (N) concentration**
- **Leaf functional traits:**
  - leaf mass per area (LMA)
  - Leaf pigments (chlorophylls, flavonols, anthocyanins)
  - C and N isotope composition ($\delta^{13}C_{leaf}$, $\delta^{15}N_{leaf}$)



- **Particle size distribution and aggregate stability**
- **pH, electrical conductivity (EC)**
- **Soil organic carbon (SOC) and total soil nitrogen (N)**
- **C and N isotope composition of SOM ($\delta^{13}C$; $\delta^{15}N$)**
- **Enzymatic activities**

Carbon fluxes

Ecosystem services

Plant Biodiversity

Malga Telvagola (Pieve Tesino)

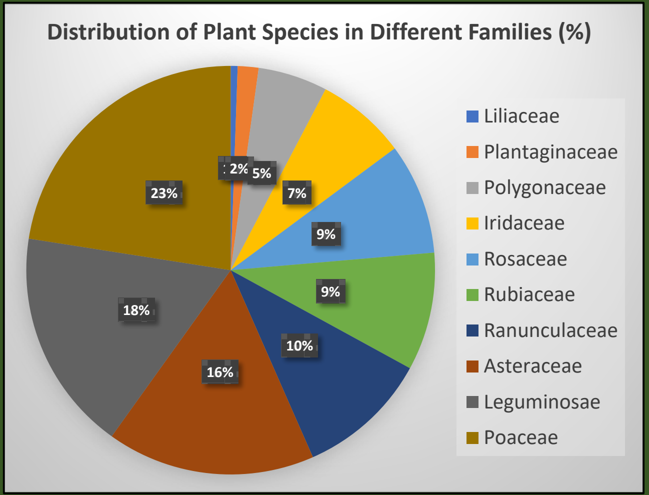
1) Old forest of *Picea abies*

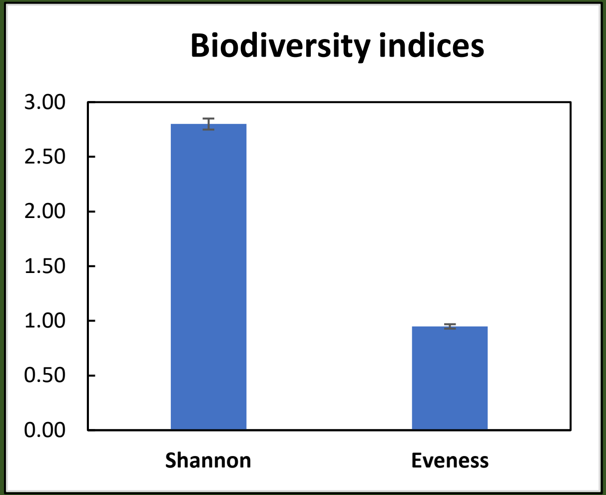
understory vegetation (*Oxalis acetosella*, *Petasites albus*, ferns and mosses)

2) Monospecific advancing front of young *P. abies* (Transition site)

3) Pasture

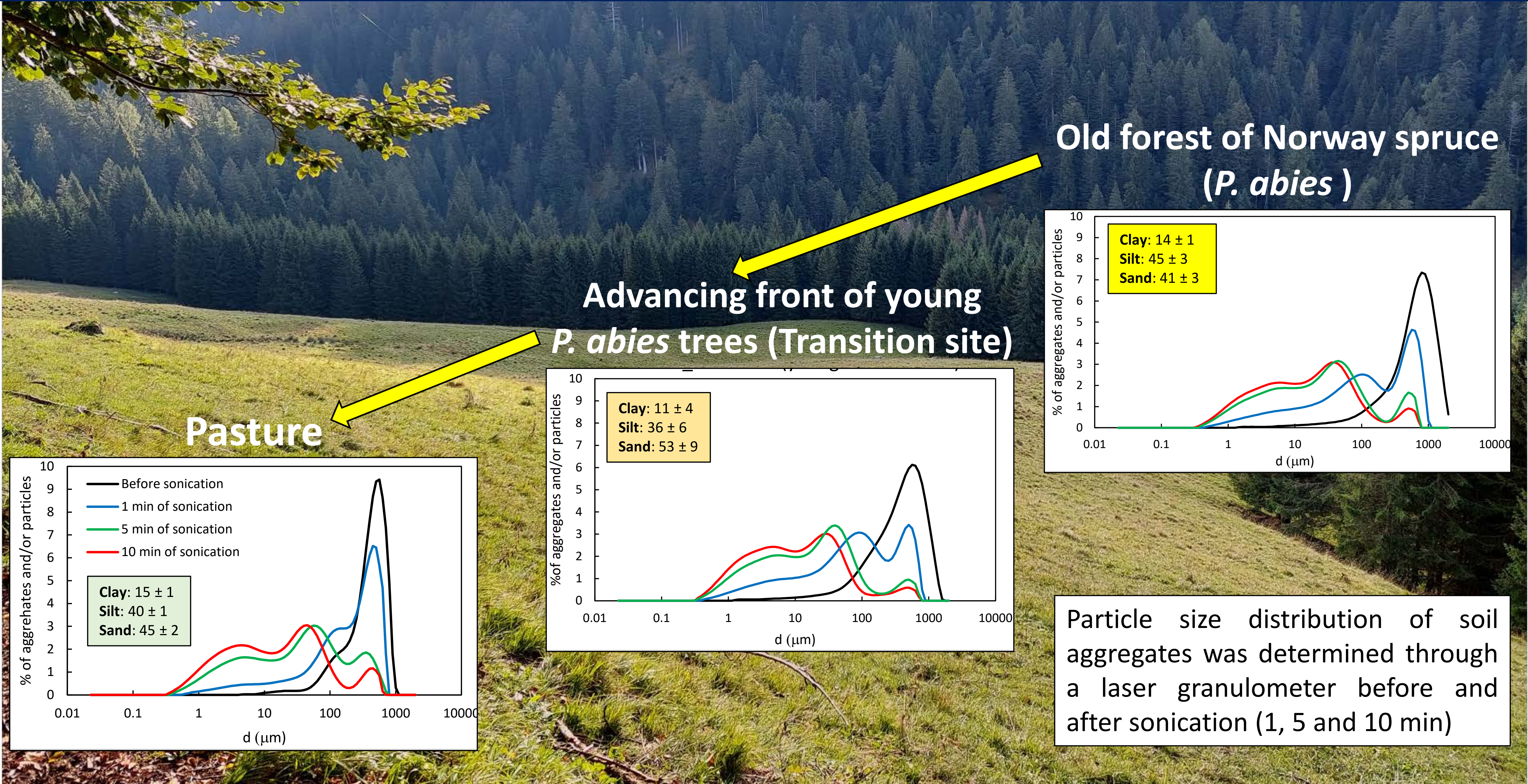
Plant Species
Achillea millefolium
Taraxacum officinalis
Deschampsia cespitosa
Phleum rhaeticus
Anthoxanthum odoratum
Festuca rubra
Avenula pubescens
Poa pratensis
Avenula versicolor
Dactylys glomerata
Crocus albiflorus
Lathyrus pratensis
Trifolium pratensis
Trifoluum repens
Vicia sepium
Colchicum autunnale
Veronica arvensis
Rumex acetosa
Ranunculus acris
Trollius europeaus
Alchemilla vulgaris
Cruciata laevips





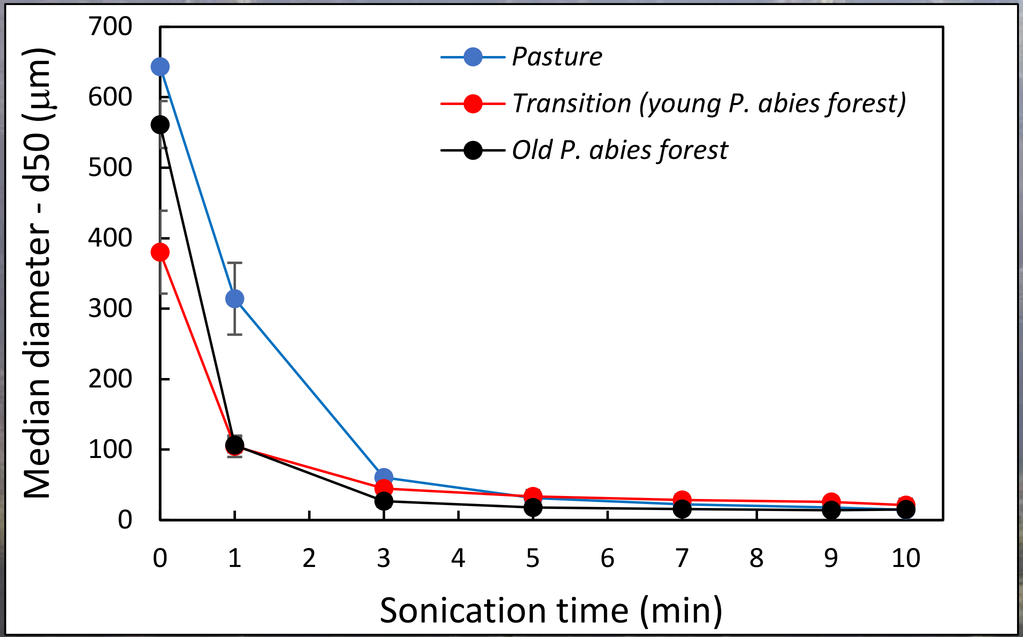
- Pasture showed a high species richness (more than 20 species of 10 different families)
- The transition from pasture to forest was associated with a drastic reduction of plant biodiversity

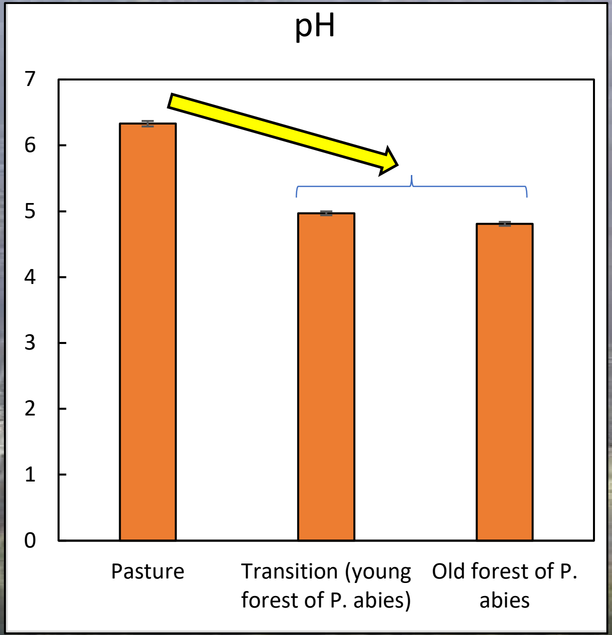
Soil Physical, Chemical and Biological Properties

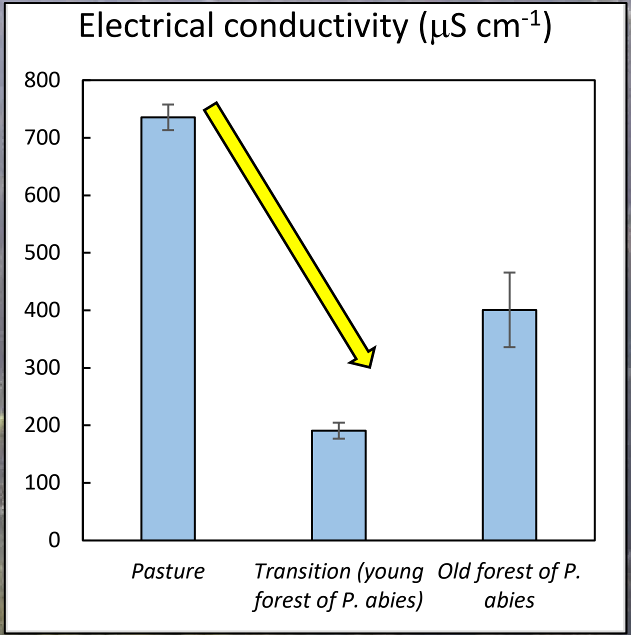


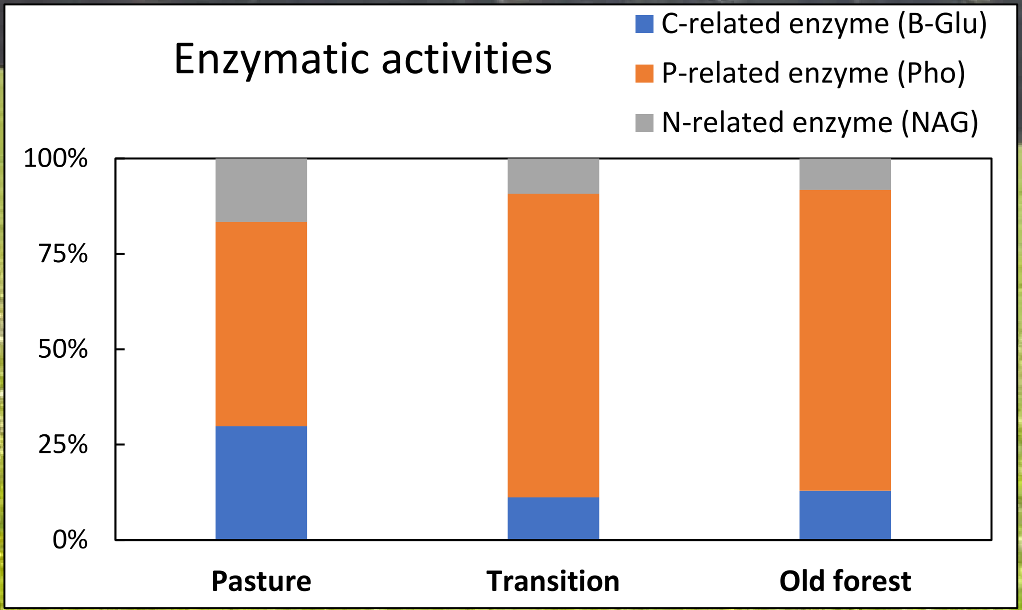
Particle size distribution of soil aggregates was determined through a laser granulometer before and after sonication (1, 5 and 10 min)

Soil Physical, Chemical and Biological Properties



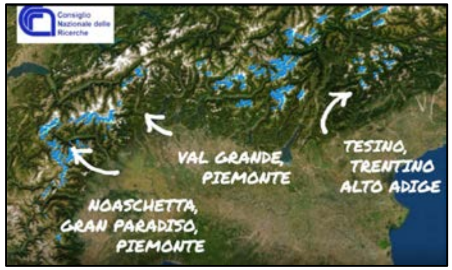


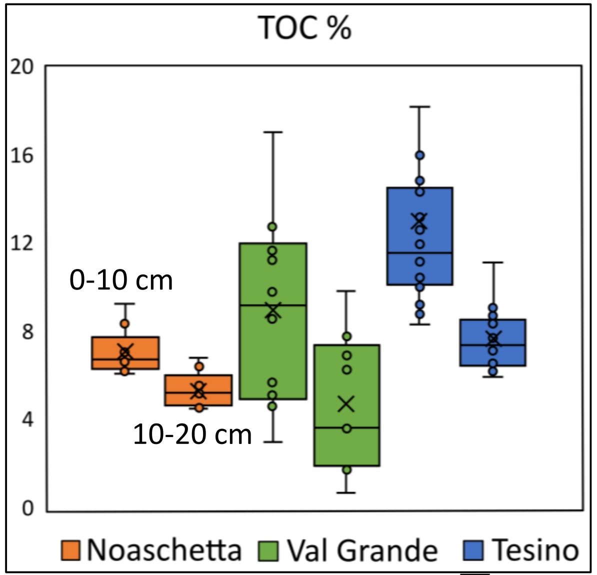


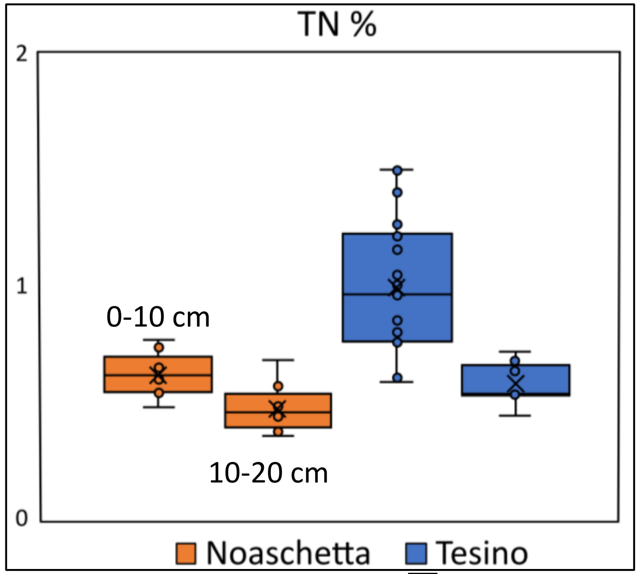


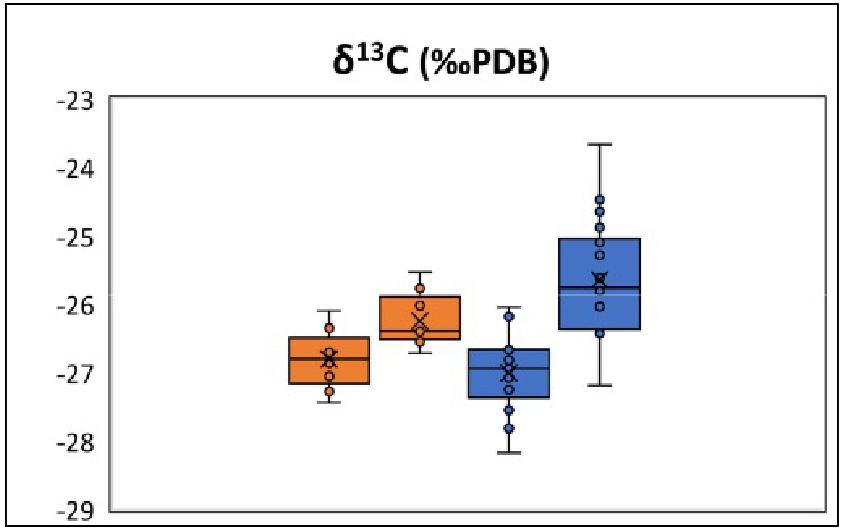
- The **median diameter (d50) of the particle-size distribution** was assumed as an estimate of soil aggregate stability
- **Forest soil showed lower d50 before sonication** and **faster d50 decrease during the first minutes of sonication than pasture soil**
- Pasture soil showed **higher pH and EC** and **different enzymatic activities** compared to *P. abies* forest soil

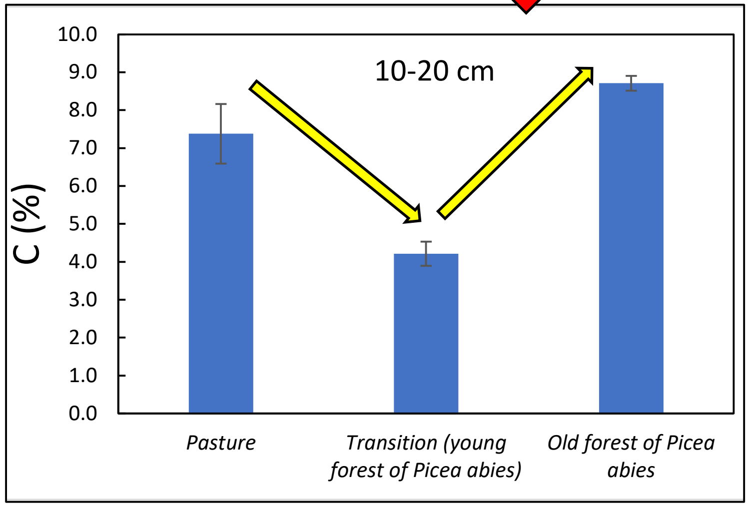
Soil Carbon, Nitrogen & Stable isotopes

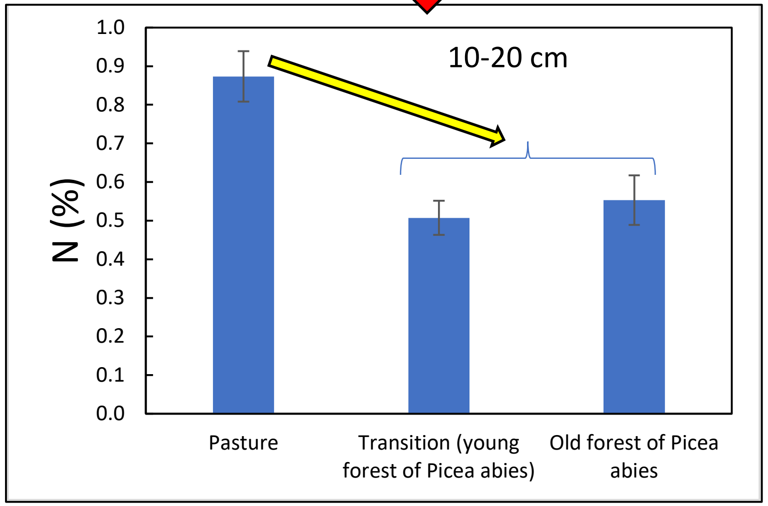


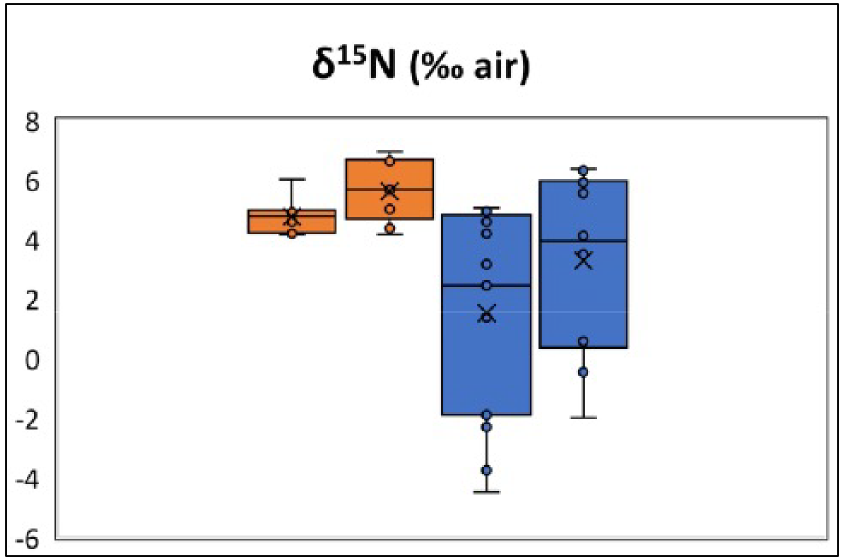




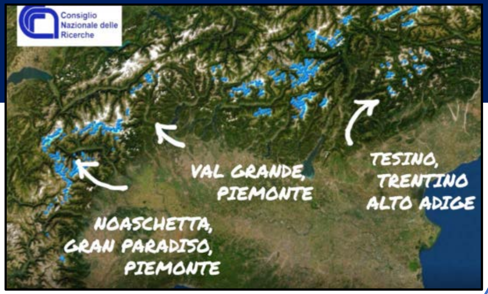


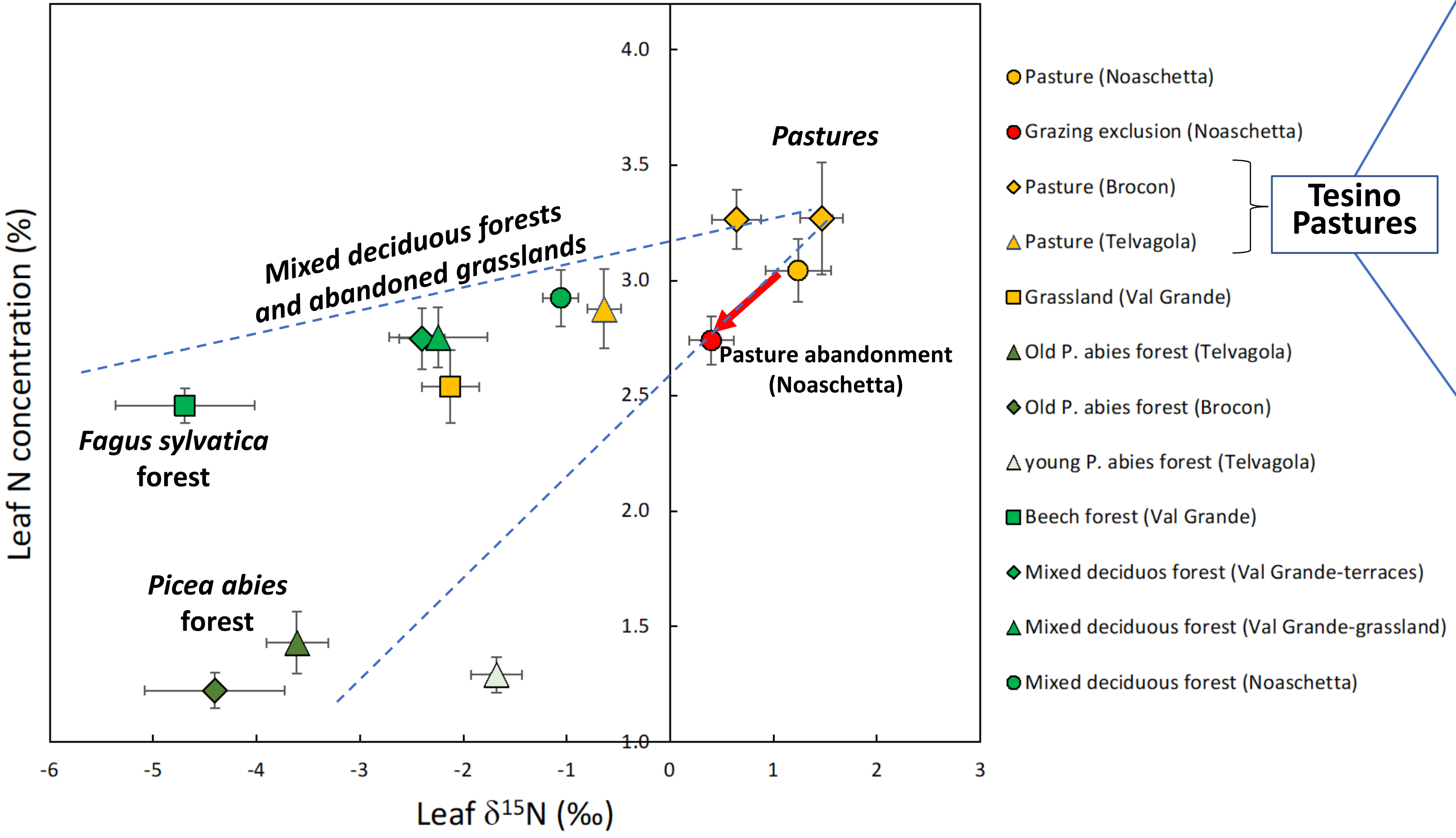


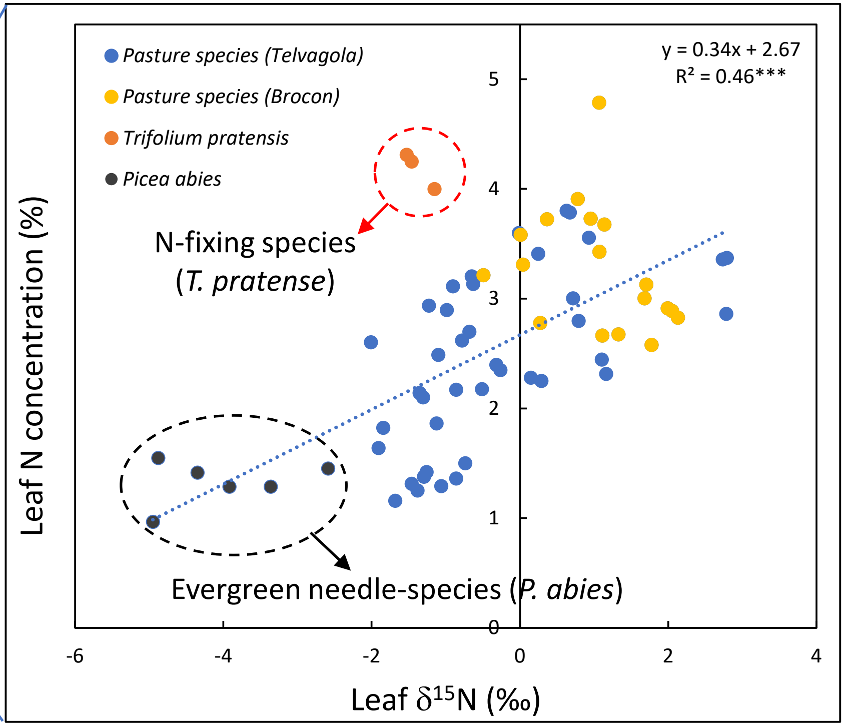




Leaf functional traits: Nitrogen concentration (%N) and N isotope composition ($\delta^{15}N$)





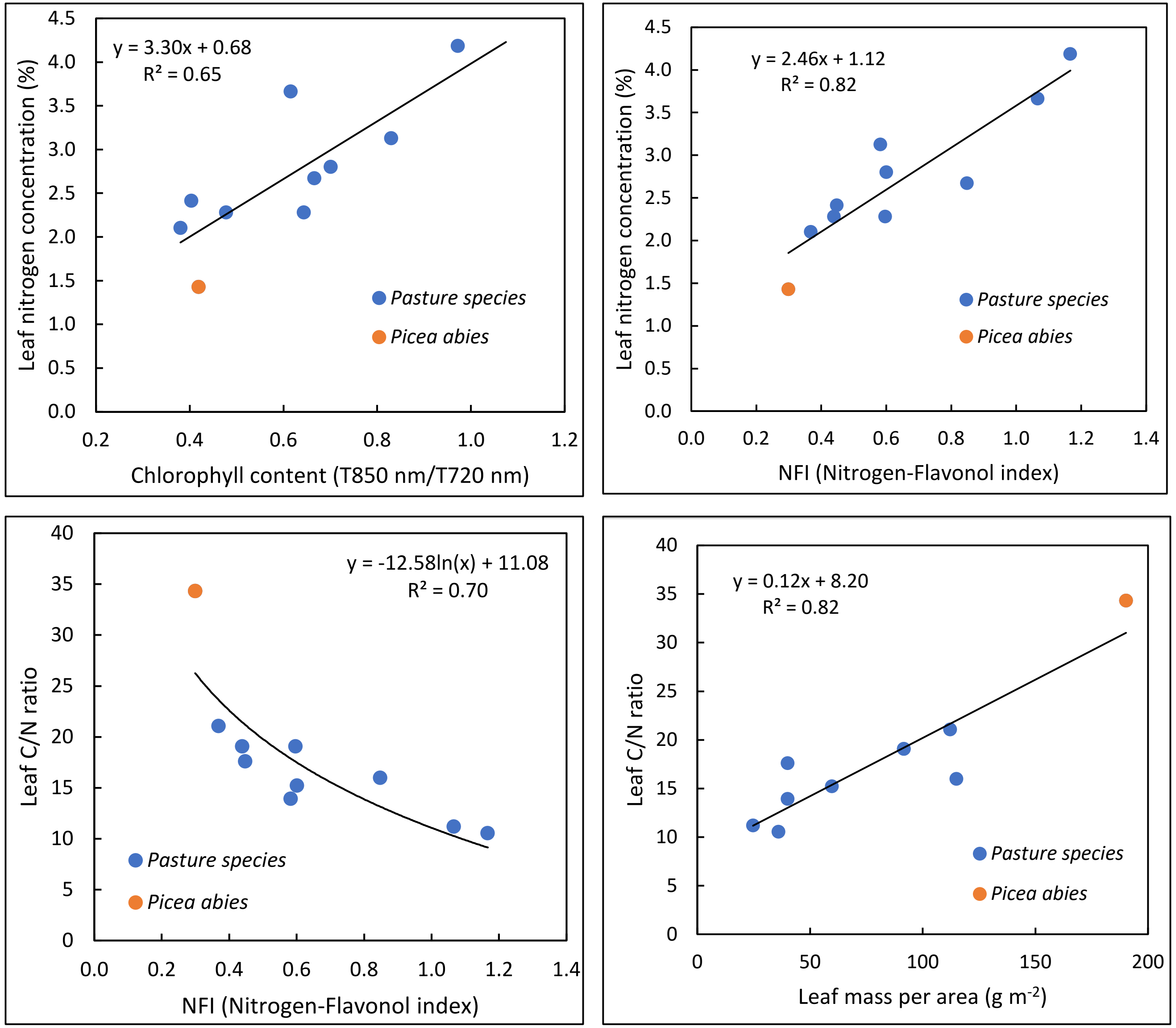


Pasture promotes:

- wide inter-specific plasticity in N resource utilization
- diversification of ecological niches

High functional biodiversity

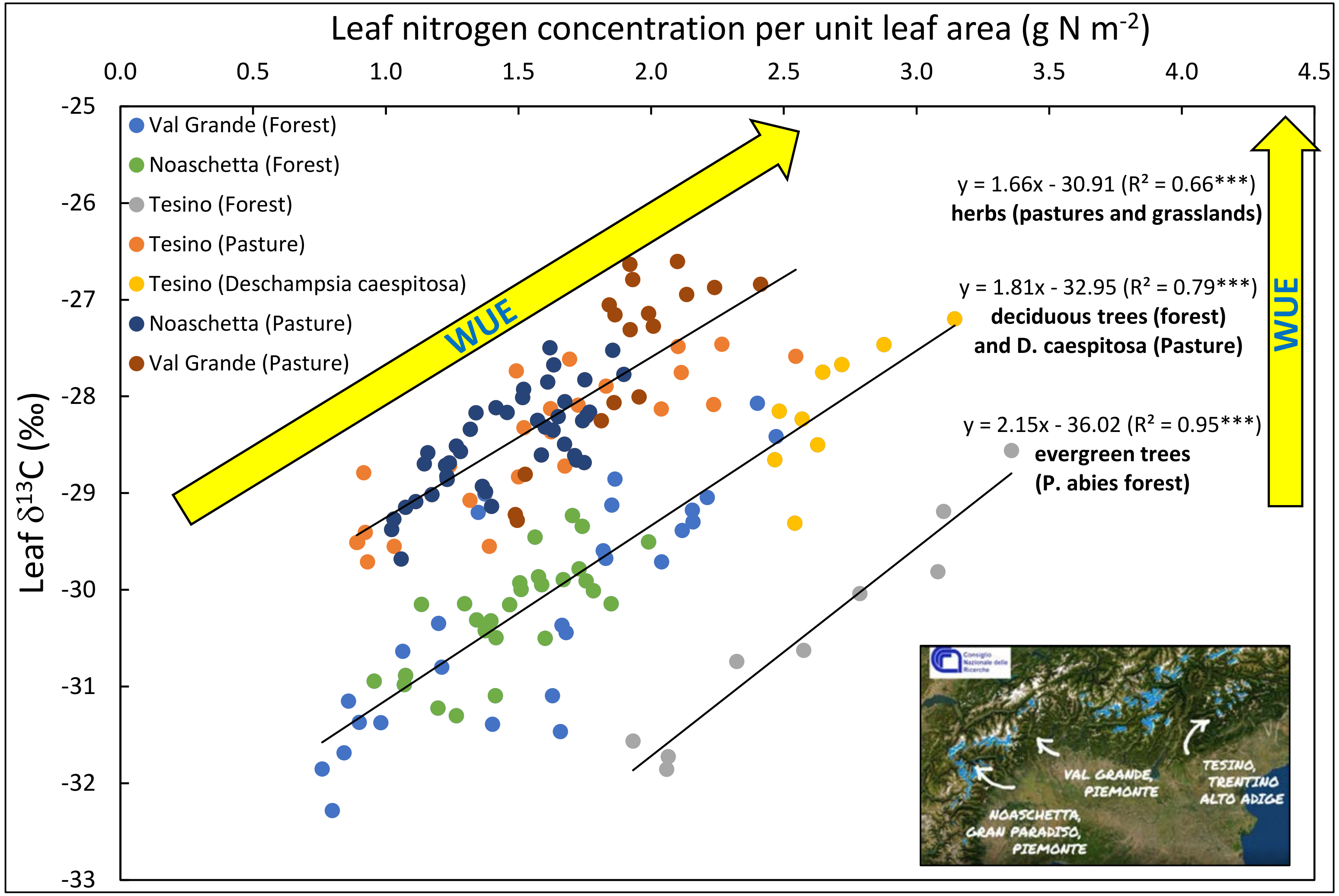
Leaf functional traits: N concentration, pigments and leaf mass per area



- Chlorophyll and flavonols are good indicators of N status in plants: under N deficiency, plants produce more flavonoids or carbon-based compounds
- Leaves of *P. abies* (Norway spruce) showed lower N concentration associated with:
  - lower values of chlorophyll content and nitrogen-flavonol index (NFI)
  - higher C/N ratio and leaf mass per area (LMA)
- These results suggest a different adapting ecological strategy and leaf economic spectrum:
  - **Forest conservative-species** (slow-growing i.e., long-lived and N-poor leaves)
  - **Pasture acquisitive-species** (fast-growing i.e., short-lived and N-rich leaves)

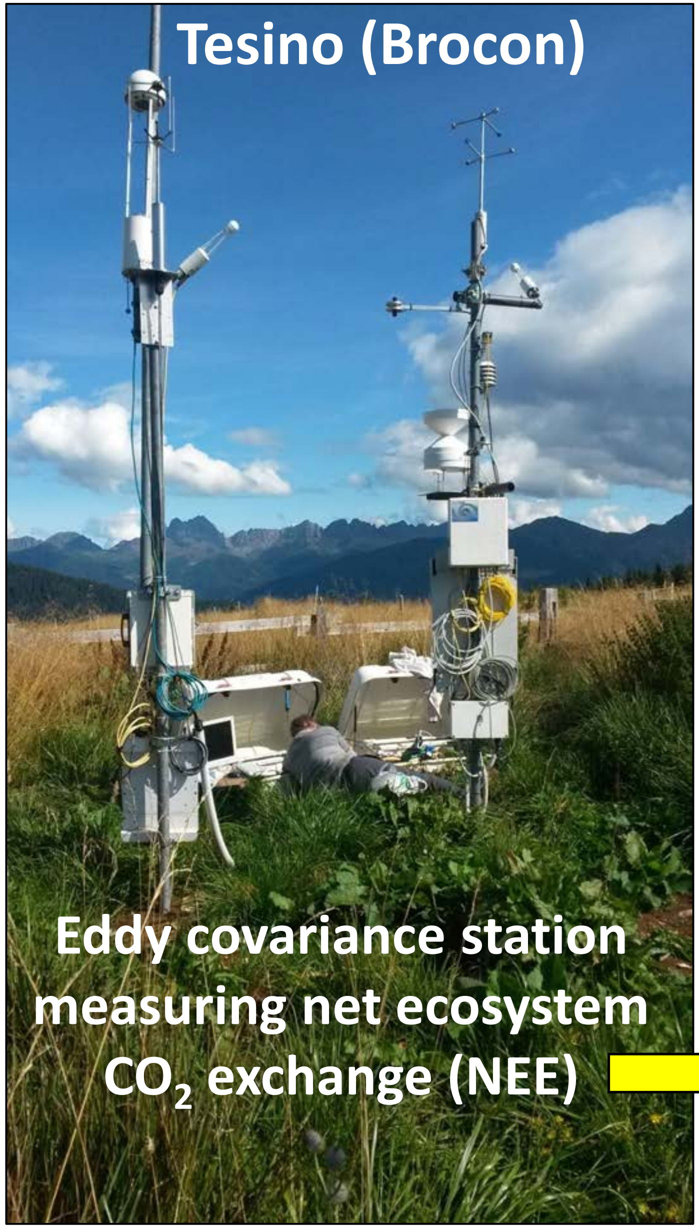
Leaf functional traits: Carbon isotope composition ($\delta^{13}C$)

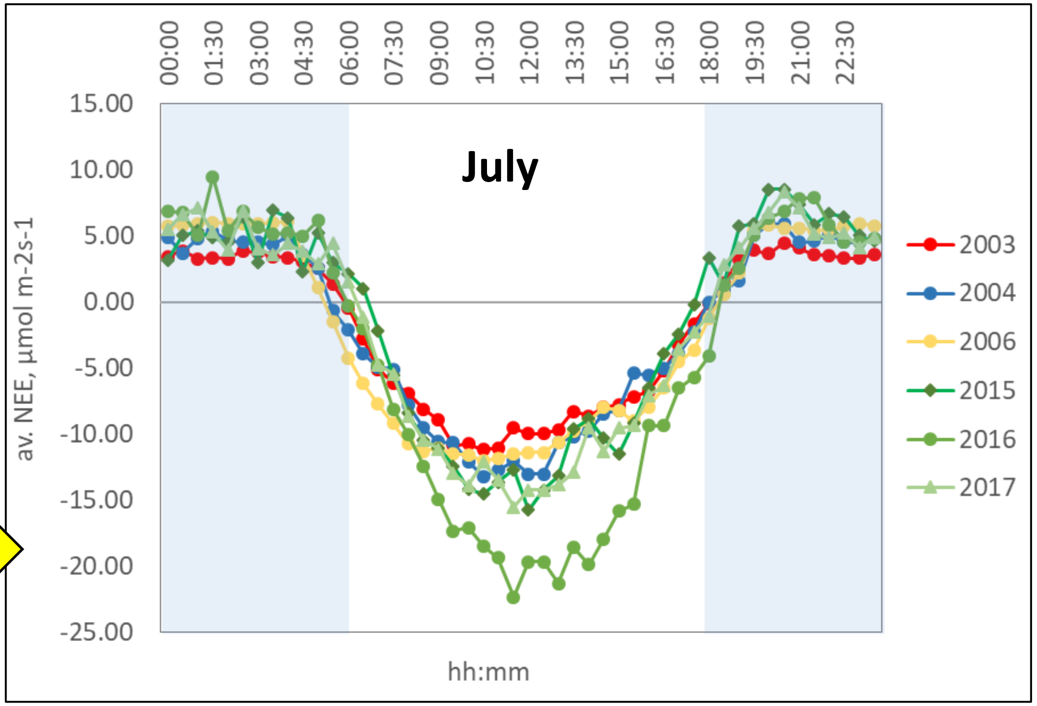
Leaf C isotope composition ($\delta^{13}C$) is considered a valuable proxy for time-integrated instantaneous water use-efficiency (WUE, i.e. the ratio between CO_2 uptake and trasnpiration water loss): an **increase of leaf $\delta^{13}C$** (less negative values) indicates an **increase of WUE**



- Different relationships between $\delta^{13}C$ and N concentration per unit leaf area for **herbs**, **deciduous trees** and **evergreen-needle trees** were observed
- Plants with **long-lived leaves** (such as the evergreen-needle *P. abies*) **invest more N in cell-walls and less in the photosynthetic apparatus** respect to **deciduous trees** and, especially, **herbaceous grassland species**
- **This was reflected in a change of $\delta^{13}C$ and, hence, WUE among different functional groups and ecosystem types**

CARBON FLUXES



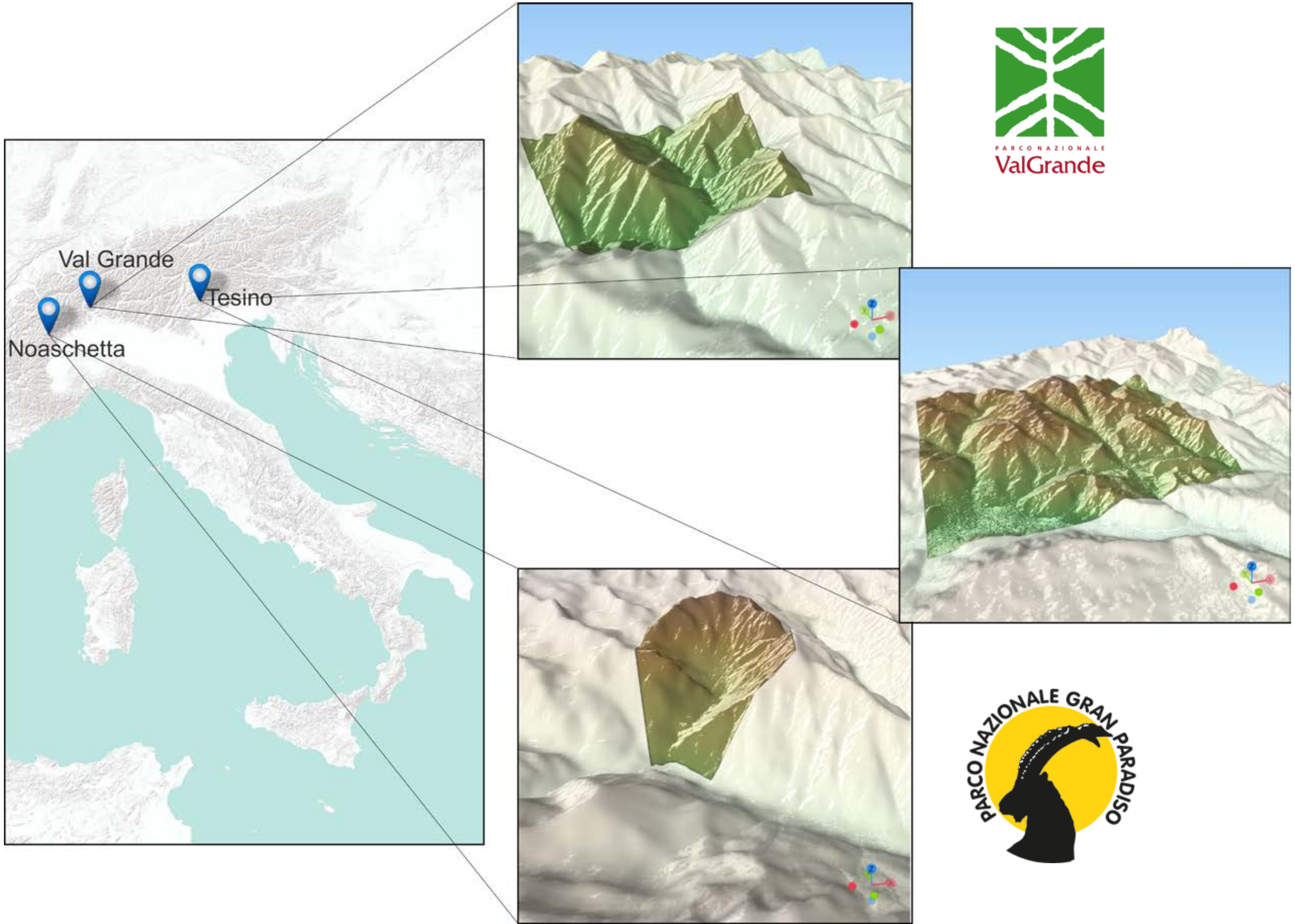


We investigate the effect of

- Snow cover duration and length of the vegetative season;
- Pasture pressure and land use-change (from pasture to forest and *vice versa*);
- Climate change;

on <u>C FLUXES, PRODUCTIVITY and CARBON SINK CAPACITY</u>

Natural Science:
Remote sensing researches at Italian case studies

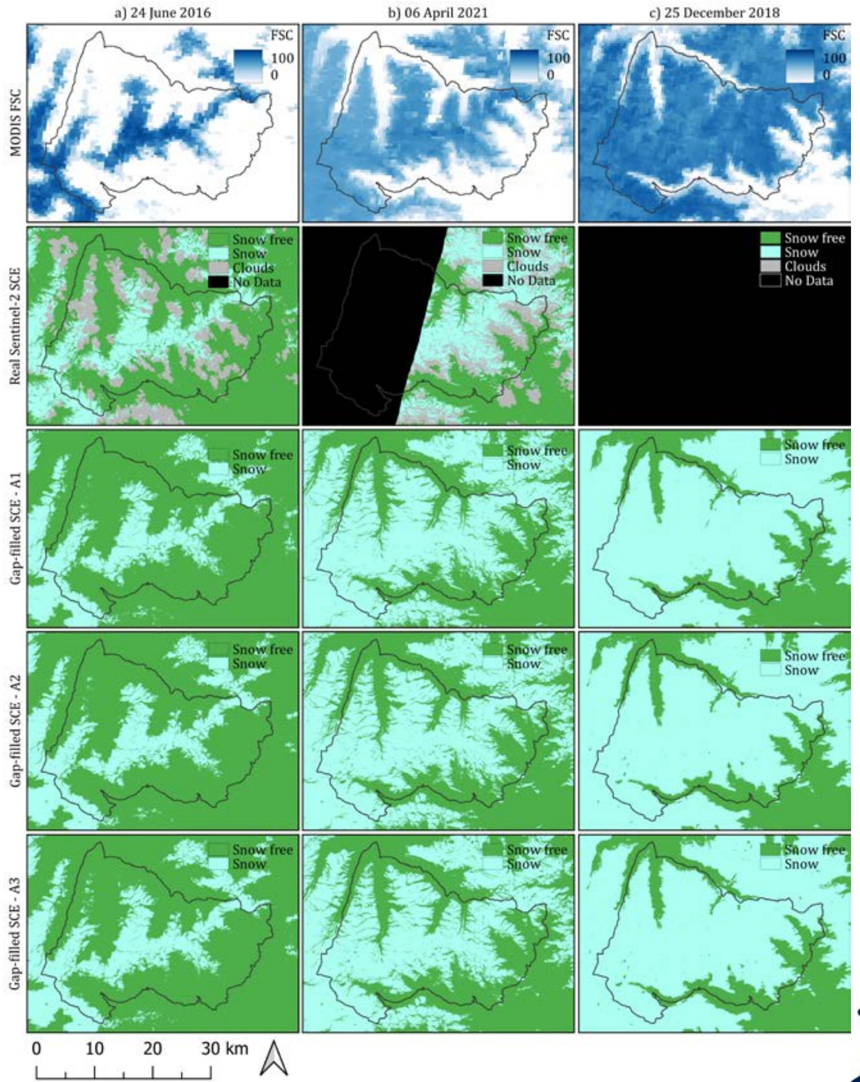


Pieve Tesino Municipality

SNOW COVER - Methodology

Gap-filling algorithm based on data fusion
of Sentinel-2 + MODIS imagery with Random Forest

Data	Approach 1	Approach 2	Approach 3	RF Variables
MOD10A1 dataset	FSC	FSC	NDSI	
S2 dataset	SCE	NDSI	NDSI	
Random forest 1	Regression	Regression	Regression	Elevation Slope Aspect Day of Year Latitude Longitude Year
Random forest 2	Classification	Regression	Regression	Elevation Slope Aspect Day of Year Year Latitude Longitude Gap-filled MODIS



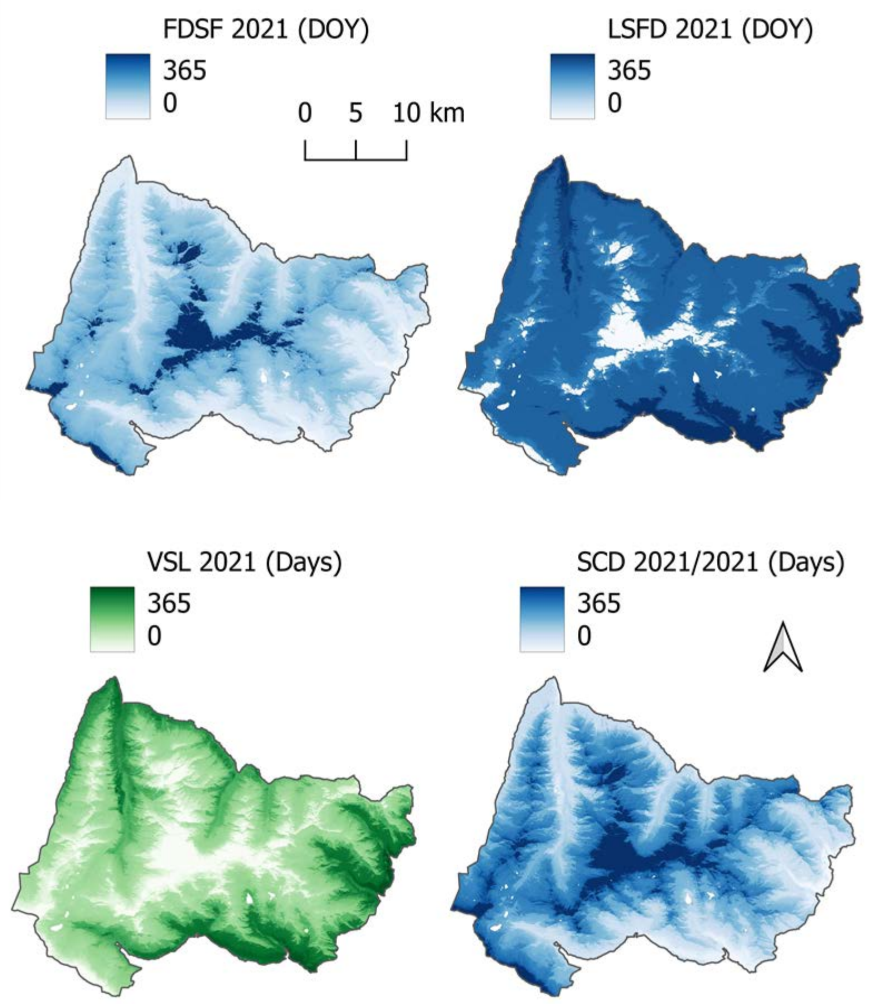
remote sensing MDPI

Comparison of three different random forest approaches to retrieve daily high-resolution snow cover maps from MODIS and Sentinel-2 in a mountain area, the Gran Paradiso National Park (NW Alps)

Chiara Richiardi[a,b*], Consolata Siniscalco[b] and Maria Adamo[a]

UNDER REVIEW

SNOW COVER - Duration



PNGP (Noaschetta)

Snow Cover can affect:
- **grazing season (start, duration)**
- **phenology and quality of grazing**
- **water availability**

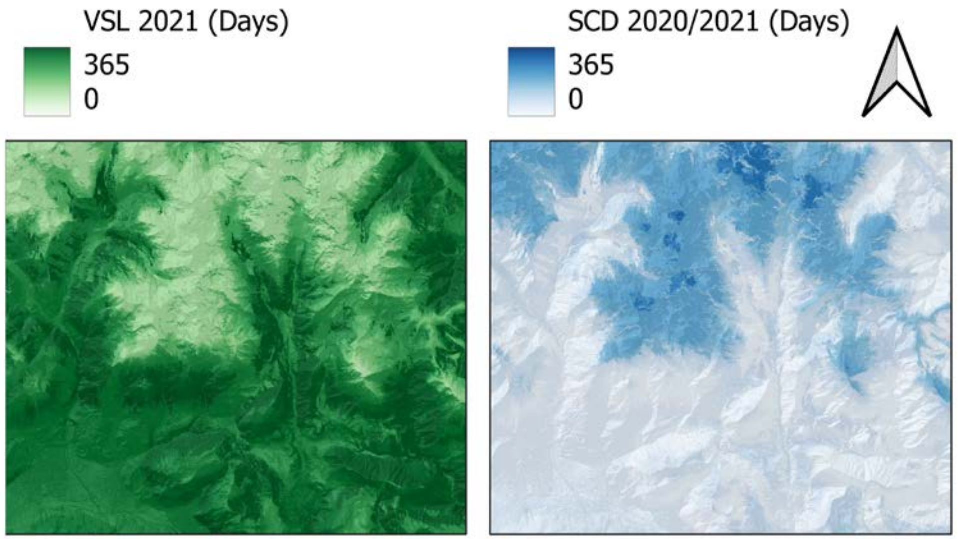
	RMSE (days)	MAE (days)	MBE (days)
LSFD	17.2	7.9	2.5
FSFD	8.7	5.5	2.0
SCD	18.9	11.0	0.5

Validation VS weather stations

- **FSFD -** First Snow-Free Day
- **LSFD -** Last Snow-Free Day
- **VSL -** Vegetative Season Length
- **SCD - S**now Cover Duration

Tesino

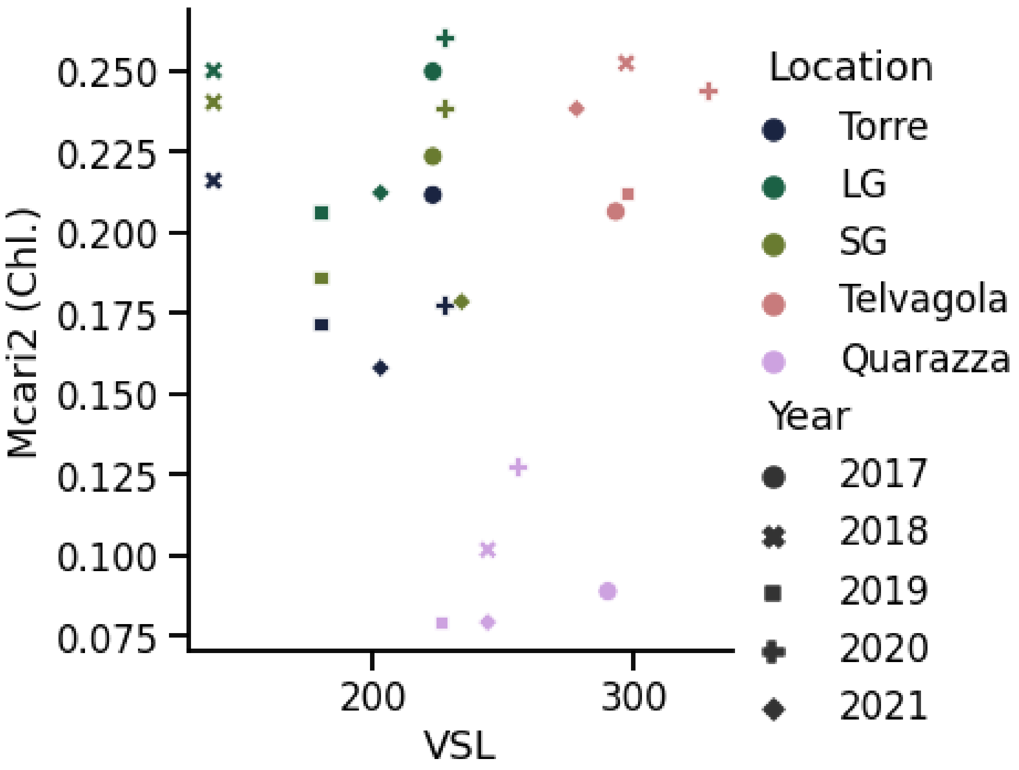
SNOW COVER - Duration

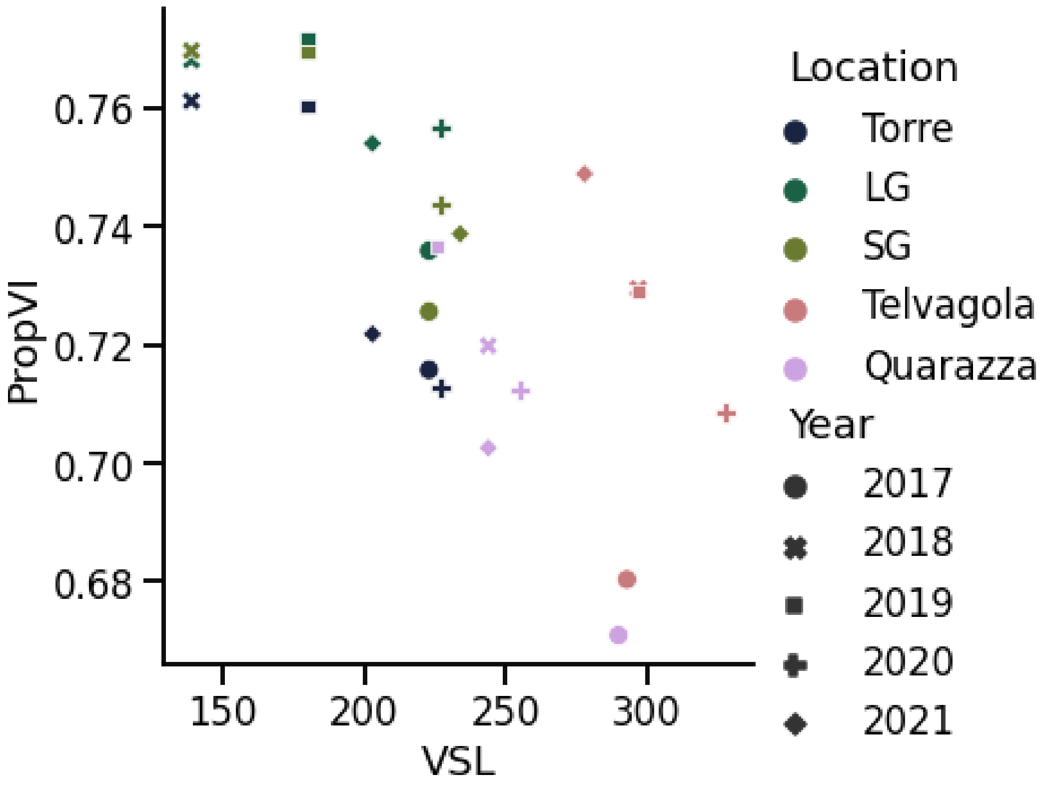


Validation in progress

- **First Snow-Free Day** (FSFD)
- **Last Snow-Free Day** (LSFD)
- **Vegetative Season Length** (VSL)
- **Snow Cover Duration** (SCD)

SNOW COVER and GRAZING SEASON





Each location has distinct levels of vegetation index that are not impacted by VSL

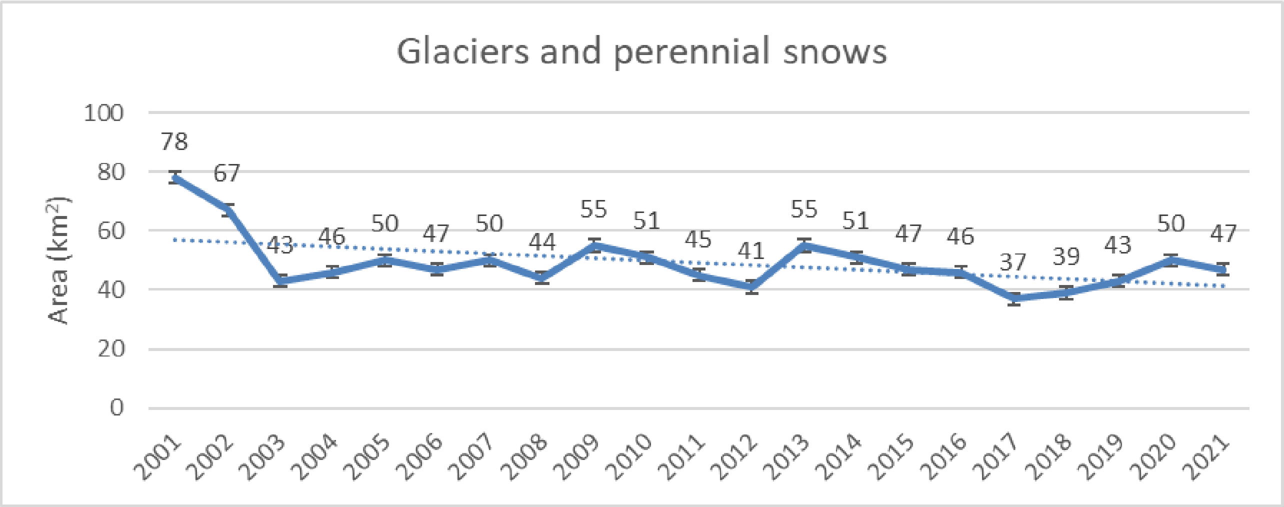
VSL impacts the average across-season proportion of chlorophyll over the other pigments (PropVI)

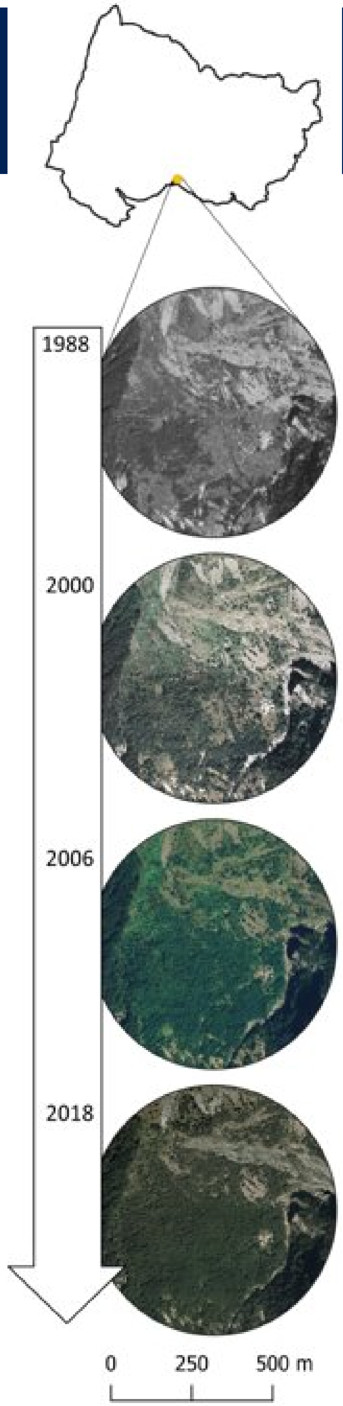
Noaschetta

SNOW COVER - Trends

Snowline Elevation

Integration of Landsat data to extend time series from 2000 to today, at 30 m spatial resolution





LAND COVER CHANGES

Do stakeholders acknowledge the real changes in land cover?

1. WHY

- ➢ Observed Land cover maps and related temporal changes from the 1990s vs Web-based survey of perceived

2. WHAT

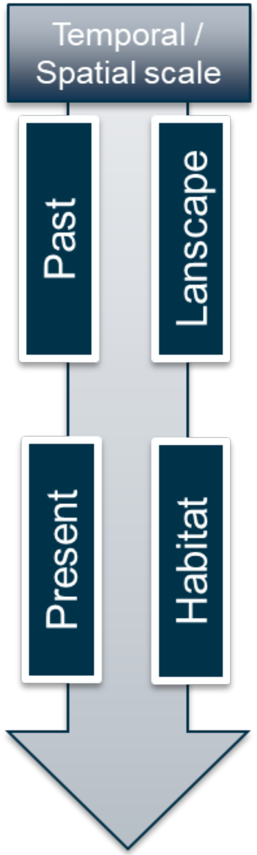
- ➢ Time series of LULC maps from about 1990 on (30 years)
- ➢ Changes detection

3. HOW

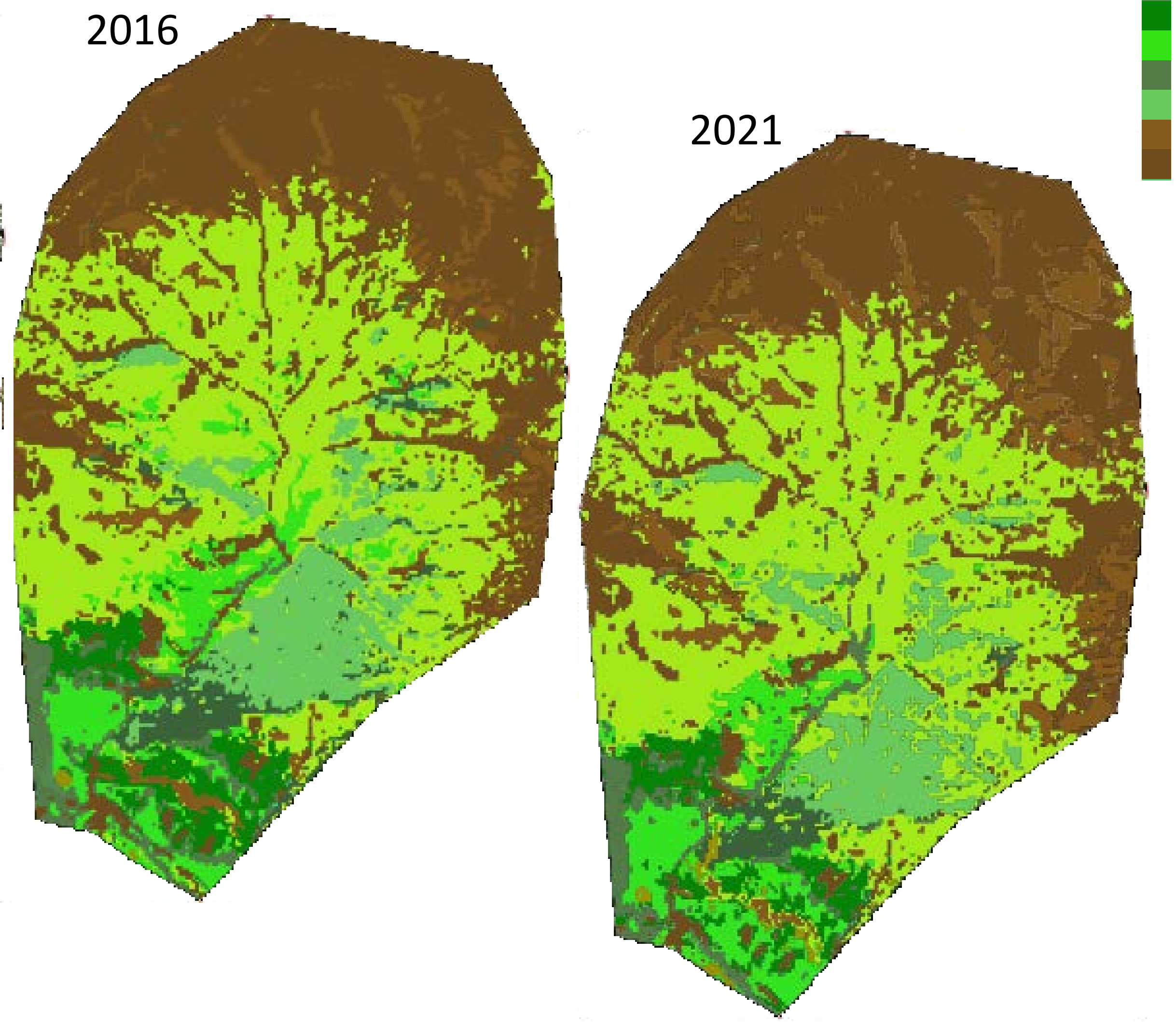
- ➢ AI-based approaches
- ➢ Multi-source approach (Sentinel1, Sentinel2, Landsat + others)

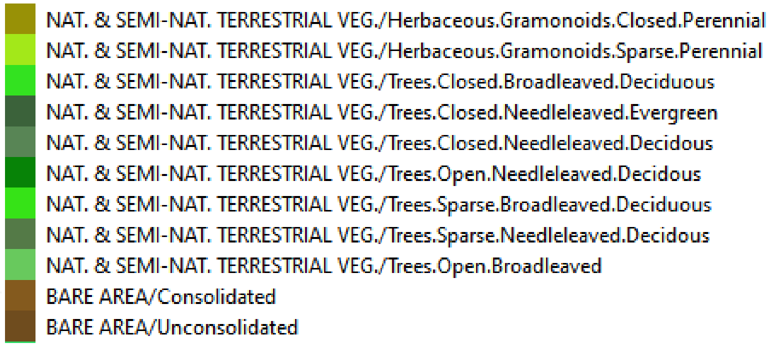
4. CHALLENGES

- ➢ How to perform training/validation in the past?
- ➢ Etherogeneous landscape and complex topography



LAND COVER CHANGES



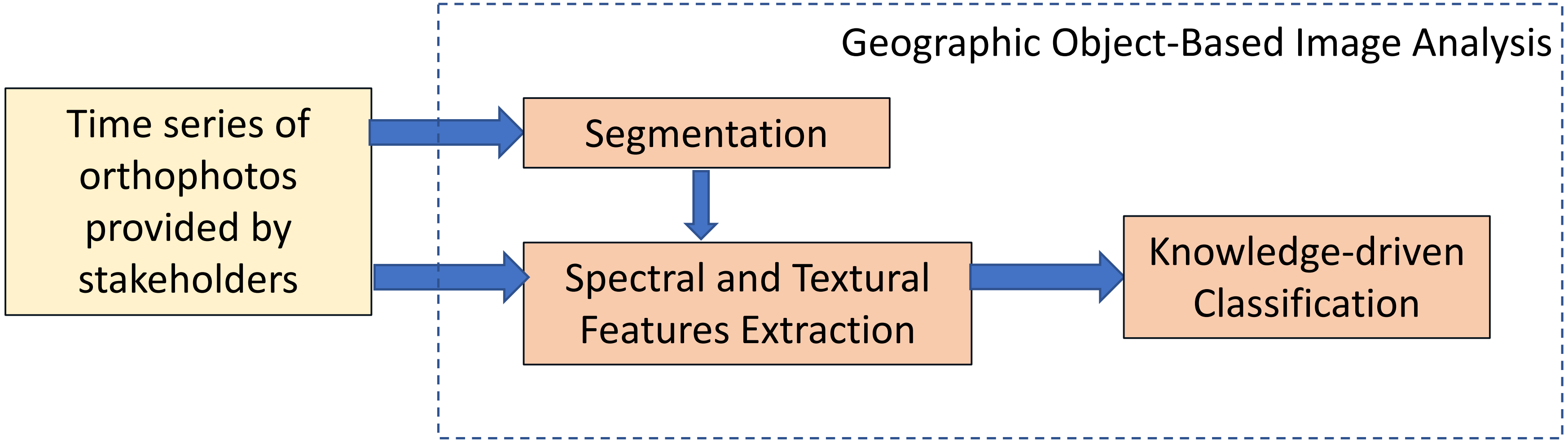


- Intra-annual Sentinel-2 Time Series
- Support Vector Machine
- Updated ground true acquired during the project

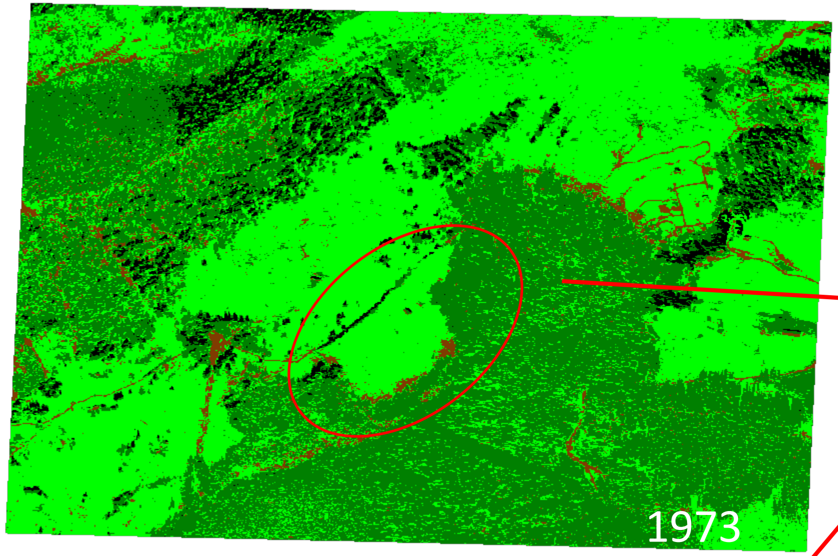
Forest⟷Pasture Transition

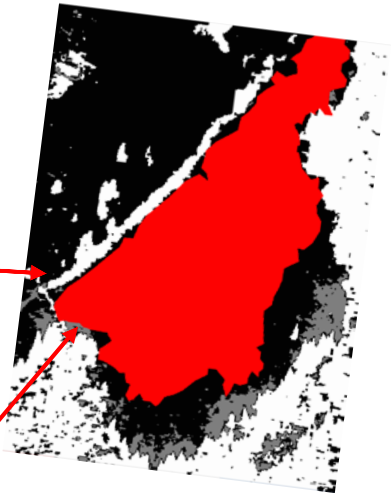
Do stakeholders acknowledge the real dynamics of Forest-Pasture transition?

- ❑ Very High spatial Resolution data
- ❑ Need to go far back in time

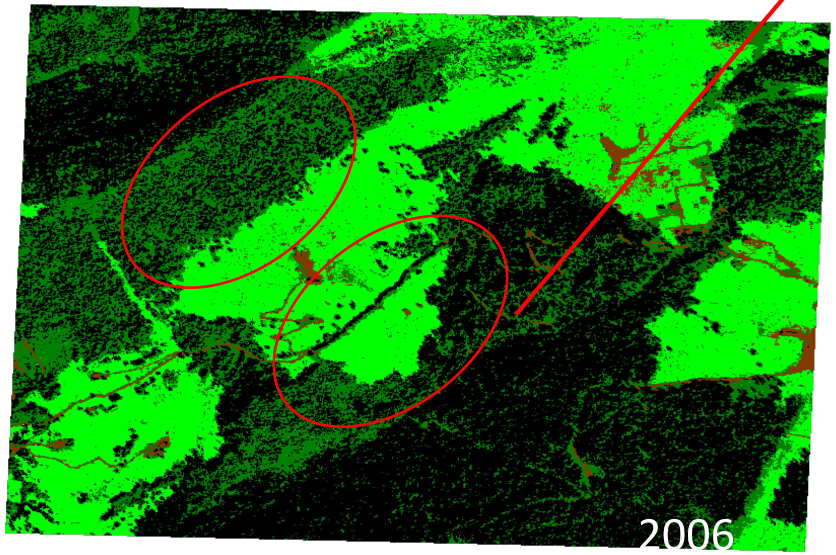


Forest⟷Pasture Transition

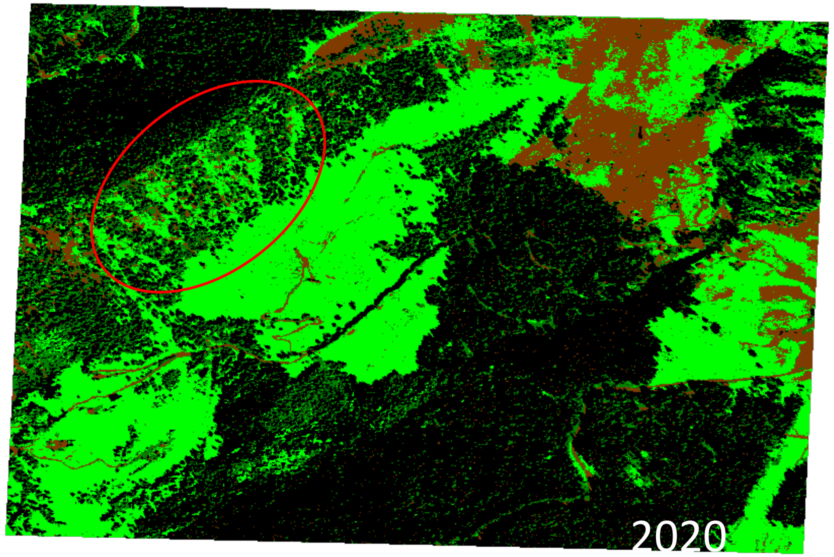


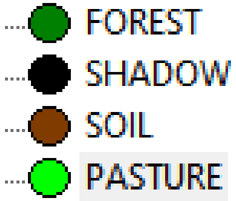


- Transition from grassland to forest until the early 2000s due to land abandonment. In particular:
  - o 2,6 ha of pasture-> forest transition in 1973 – 2006 over the original Malga 8,3 ha (about 31%)
- Management from the early 2000s



Malga Telvagola





Malga Telvagola

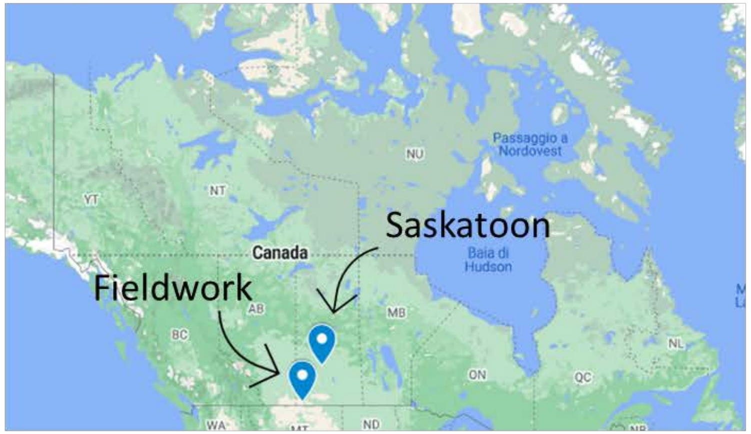
International scholarship

University of Saskatchewan

Prof. Xulin Guo's research group, 29 June - 30 September 2022

ABRESO
Land use: Social Views

BELMONT FORUM

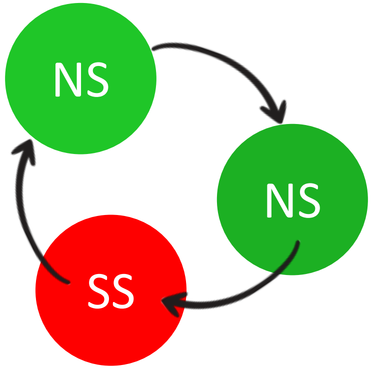


Chiara Richiardi, PhD student

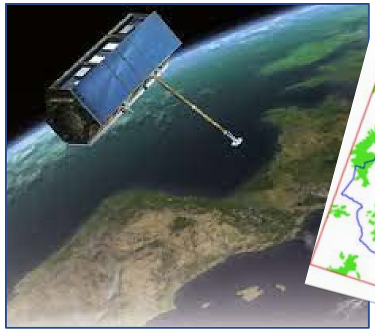
INTEGRATION of Natural & Social Sciences

Soil biochemistry
Environmental geochemistry
Sedimentology

ONE AIM:
Analysing
land use change &
its impacts



Plant physiology
Phenology
Remote sensing



Economics of complex systems
Policy evaluation
Territorial analysis and planning

DIFFERENT:
- Objects
- Methods
- Spatial and temporal scales
- Meanings
- Wordings
- Values, visions

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igg
UNIVERSITÀ DI PAVIA
ABRESO Land use: Social Views

INTEGRATION of DATA SOURCES

Consiglio Nazionale delle Ricerche

NATURAL SCIENCES

NS

Assessing the effects of land-use changes in Alpine sites on **plant biodiversity**, **carbon sequestration** and **nutrient cycling**

FIELD MEASUREMENTS

↕

REMOTE SENSING (SATELLITE)

STAKEHOLDERS

National Parks

Promotion offices

Municipalities

Associations

SOCIAL SCIENCES

SS

Mixed methods research

- Social context (economic, demographic trends)
- Review of local land use policies, land and water protection practices
- Collection historical photos of land use
- Literature review of social science contributions to CZ analysis

Qualitative Data

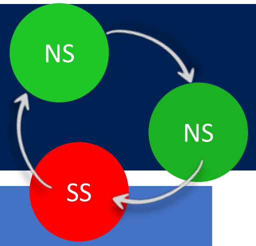
Semi-structured interviews to stakeholders (e.g., farmers, natural scientists, local government officials) aimed at investigating:

- Perceptions of land use change
- Drivers and evidences of land use change, services and disservices
- Management strategies and policies

Quantitative data

- Survey
- Questionnaires/interviews with stakeholders

INTEGRATION of RESEARCH QUESTIONS



OBSERVED	PERCEIVED
LAND USE CHANGE	
Remote sensing – land cover maps and related temporal changes from 1990s on *Ground truth* – plant biodiversity and bio-geochemical cycles	*Web-based survey (sites' oversampling)* *In-depth interviews to local stakeholders* *Analysis of socio-economic secondary data*
SNOW COVER and GRAZING SEASON	
Remote sensing – Snow cover monitoring (extent and duration); extraction of spectral indices for vegetation and soil analysis *Ground truth* – variation on water discharge	*In-depth interviews to shepherds* Are shepherds aware of effects on - grazing season (start, duration)? - phenology and quality of grazing? - water availability?
GRAZING INTENSITY (abandonment, grazing, overgrazing)	
Remote sensing – soil organic carbon, primary productivity extraction *Ground truth* – carbon and nitrogen cycling, plant physiology, phenology and biodiversity	*In-depth interviews to shepherds* Are shepherds aware of the effect of grazing on - biodiversity? - carbon and nitrogen cycles?
FOREST↔PASTURE TRANSITION	
Ortophotos, satellite imagery, ground truth	*In-depth interviews to local stakeholders* Analysis of territorial forest management plans