# Disturbs to the ground and to the stand in beech forest due to thinning treatment performed by different levels of mechanisation

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# Background

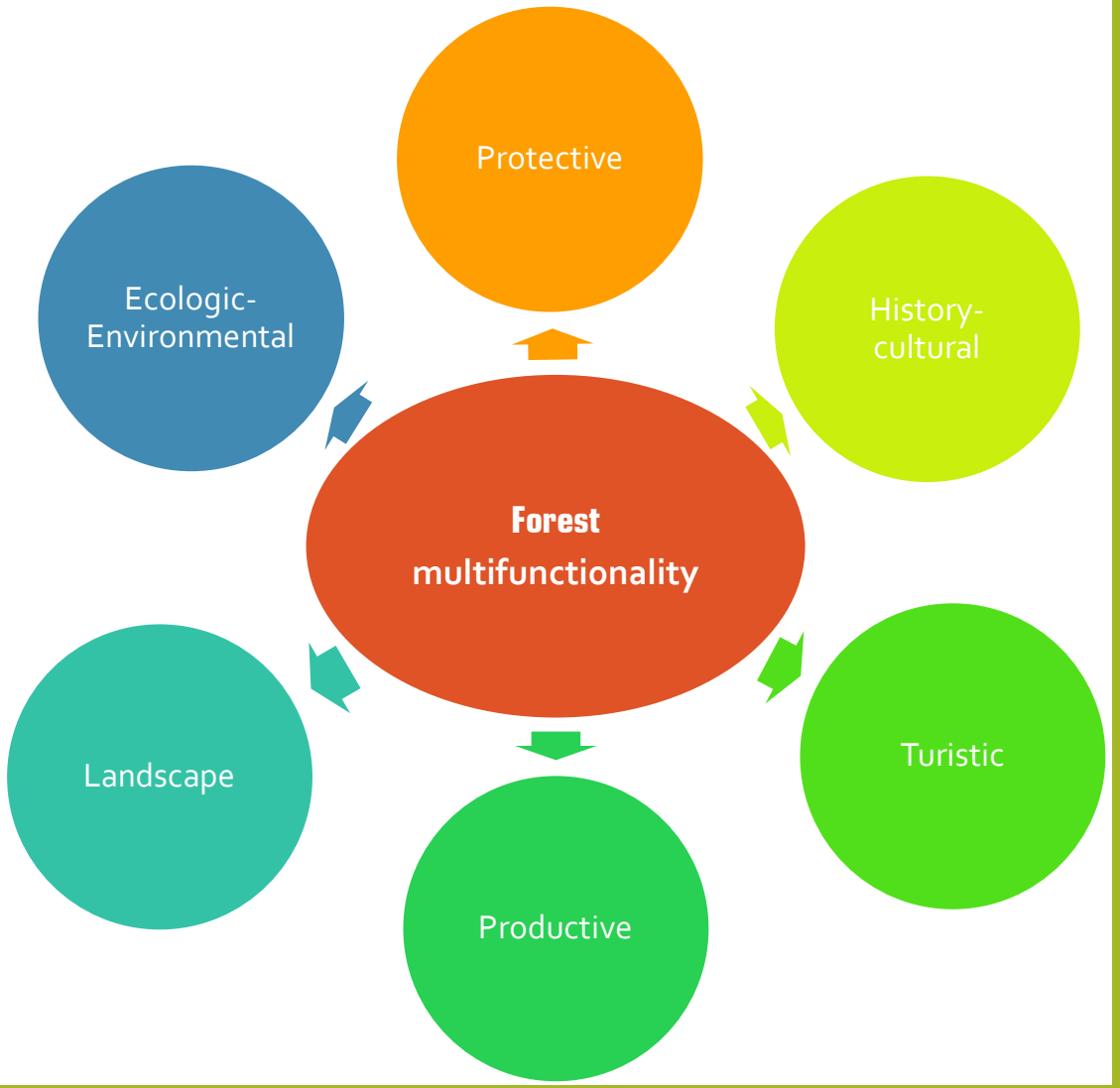
The Mediterranean beech forests and, in particular, the Italian beech forests are actually in a good state of conservation and are generally characterized with a good level of management.

However, the need to bring innovation in the forest management sector has been highlighted in recent years, for environmental and production reasons.

**Ecological distribution beech forests area**


# Sustainable forest management

The awareness of major environmental issues such as climate change, biodiversity loss, new knowledge in the field of biology and ecology and socio-economic and cultural changes, are changing the way of interpreting the concept of management and conservation of natural resources, paying more attention to the forest ecosystem.



# Sustainable forest management

The recognition of the "multifunctional" role of the forest in the production of goods and services has been increasingly consolidated in recent years.

Silviculture and management must increasingly take into account all the services performed by forests: from the conservation of biodiversity, to resilience and resistance to climate change, to the production of bioenergy, the balance must be kept as stable as possible

# The aim

One of the most important problems of the forest sector is to minimize the ground damage caused by forest operations and logging activities.

**The aim of this work was to assess the impact on soil according to two different silvicultural treatments applied.**

**The issue was: to increase forest management sustainability, the efficient use of forestry resources, to increase environmental benefits and technological qualities of the "wooden capital".**

In particular:

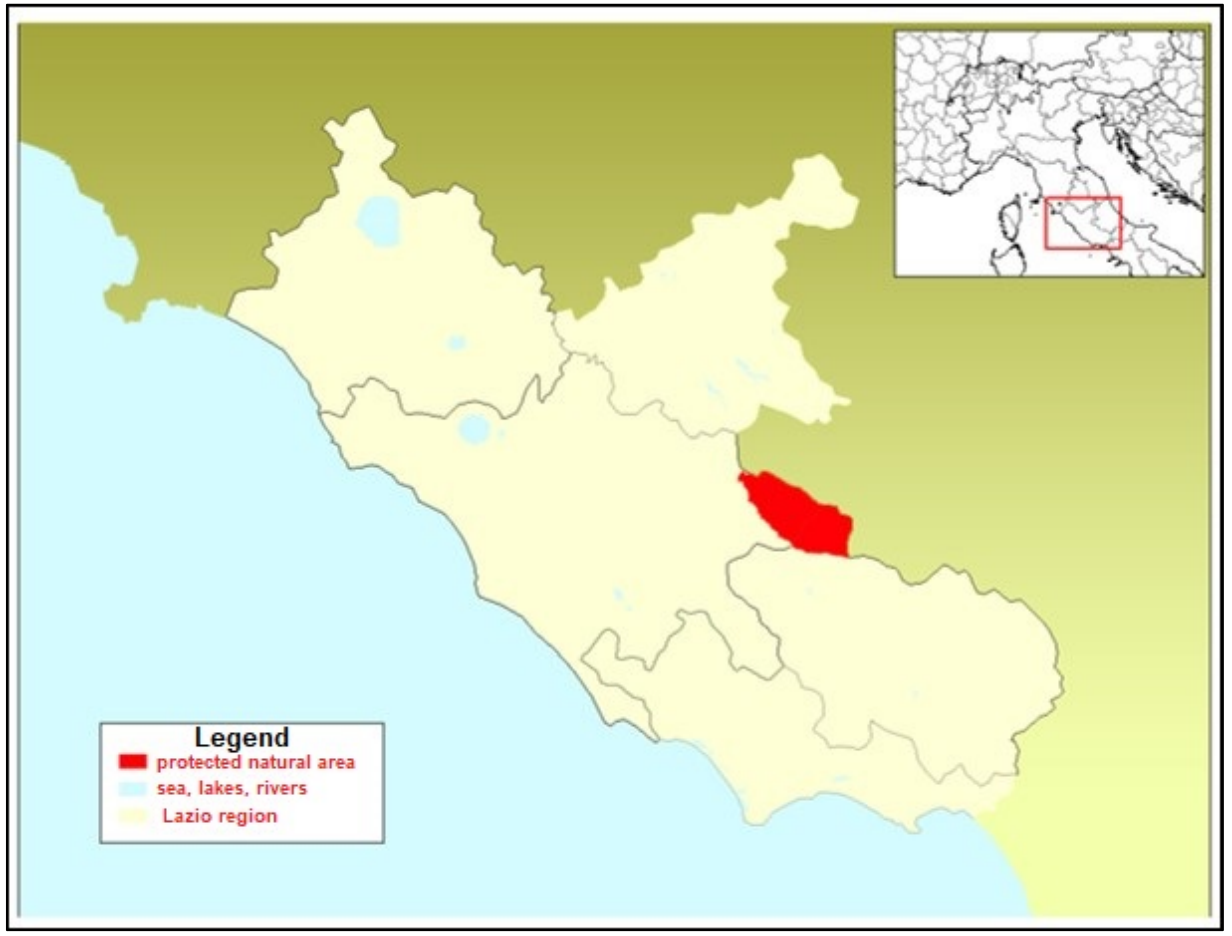
a. to investigate the impact of silvicultural treatment on soil condition
b. to find out how both silvicultural treatment and forest operations influence soil characteristics
c. to investigate the impact on soil condition due to different levels of mechanisation

# Study area

The study area is located between two Regions, respective Abruzzo and Lazio, in the Simbruini Mountains.

- **Cappadocia Municipality**, Camporotondo Locality, Abbruzzo Region, SIC/ZPS Simbruini Mountains IT7110207

- **Vallepietra Municipality**, Lazio Region, ZPS Simbruini-Ernici IT6050008, ZSC Autore Mountain e Central Simbruni Mountains, Regional Park of Simbruini Mountains.

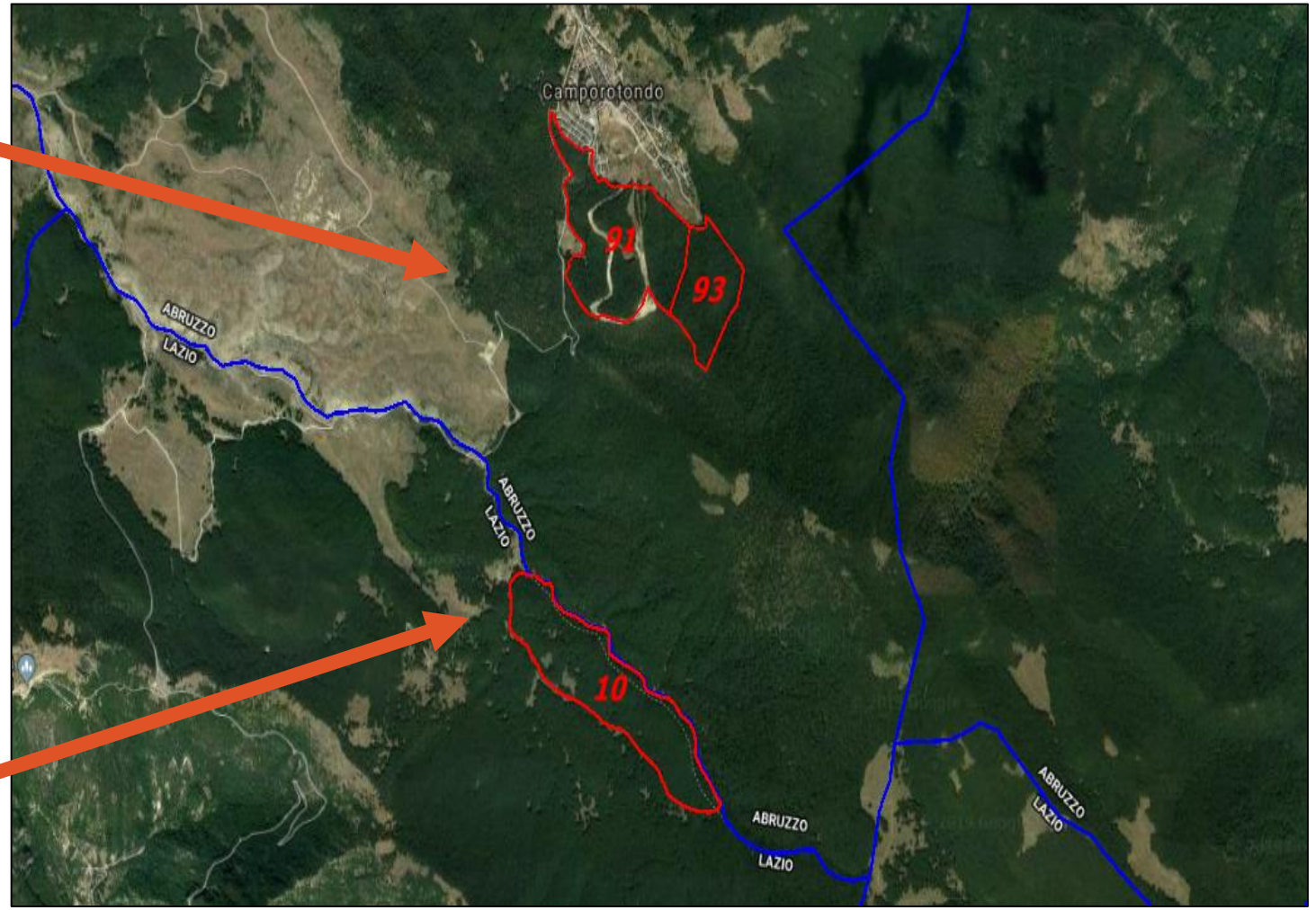


The forest parcels 91 and 93 in Cappadocia Municipality, Camporotondo locality.

- Altitude about 1500 m a.s.l.
- Mainly N exposure
- Slope from 50% to 60% and with weak soil roughness.

The forest parcel 10 Vallepietra Municipality.

- Altitude about 1400 m a.s.l.
- Mainly NE exposure
- Slope from 40% to 50% and with weak soil roughness.

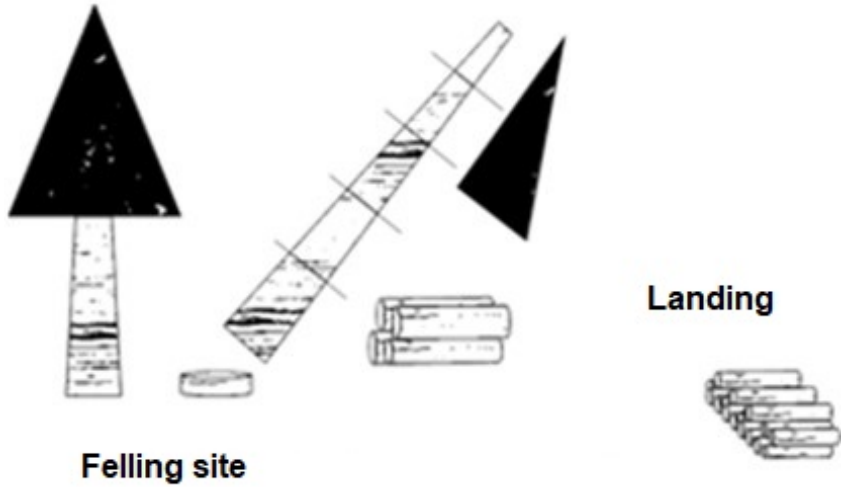


# Harvesting System

**Three harvesting method was "*Short Wood System*"**

## Silvicultural system

Thinning from below with removal of 20% in volume




## Felling and processing operations

The felling and processing operations were done by chainsaw

## Bunching and extraction operations

- Wheeled tractor equipped with forwarding bins on the front and rear sides
- Several teams of mules

# Extraction systems

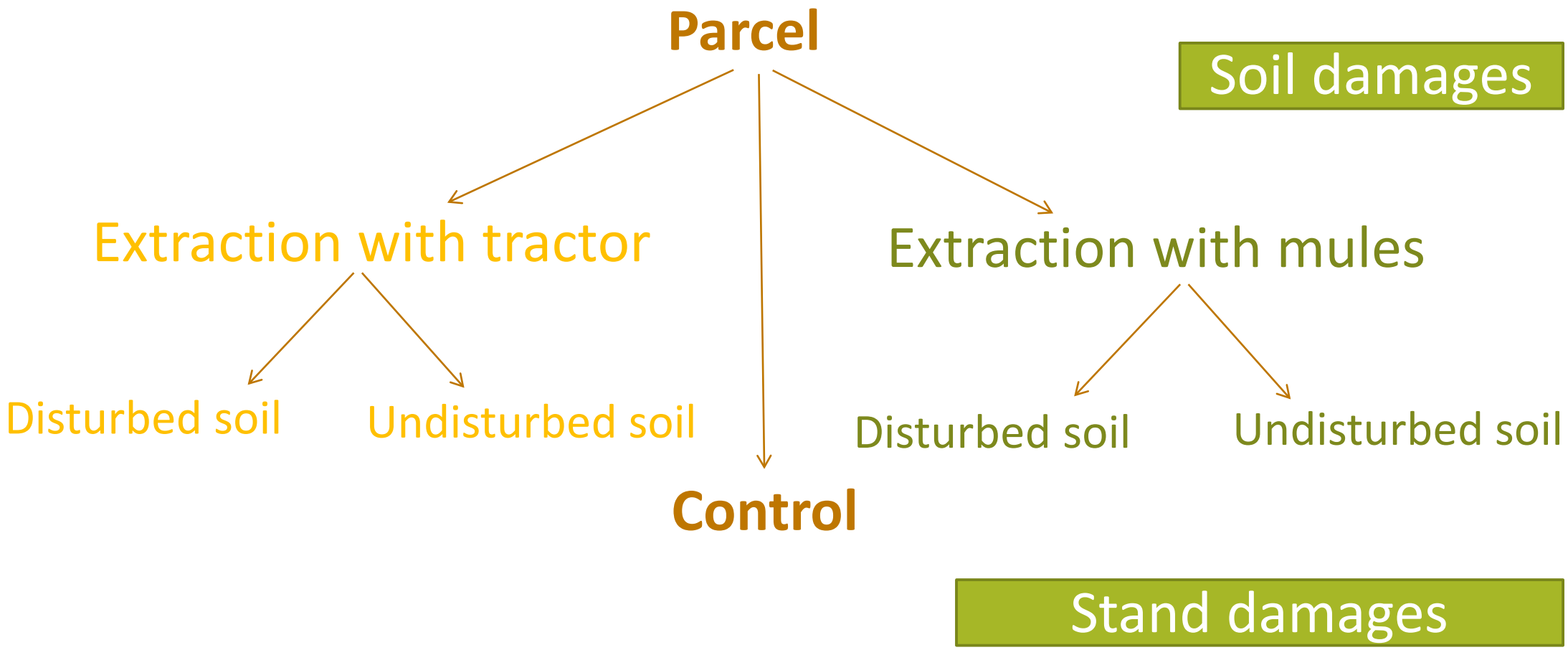
The forest operations are carried out from june to october 2018, from the same logging company.
Two different extraction systems have been used: in the most sloping areas have been used mules while the areas with better accessibility have been used machines.

Wheeled tractor John Deere 6130M

Extraction with mules

# Samples

# Experimental design




**In each parcels were made surveys of damage to the stand**

# Research methodology

**Stand damages**

- Damaged plants

**Soil physical and chemical analysis**

- Impacted area surface
- Bulk Density
- pH
- Organic Matter content
- Inorganic carbon
- Penetration Resistance
- Shear Resistance (or strength)

**Soil microarthropods-community analysis**

- QBS-ar index (based on microarthropod communities)




**In the field…..**



**In the lab…..**



# Statistical analysis

The collected data were analyzed (Statistics 7) to validating the results

- for the ex-ante analysis, non-parametric tests were used for QBS-ar (Kruskal Wallis test) and parametric tests (ANOVA e MANOVA) for the soil impact analysis

- for the post-hoc analysis, the parametric tests were used (Tukey test o HSD) for the possible subdivisions into statistically homogeneous groups

# Results

# Stand damages

| Description | Unit of measure | Camporotondo | | Vallepietra | | p-value |
|---|---|---|---|---|---|---|
| | | Tractor | Mule | Mule | Tractor | |
| **Damaged trees** | % | 39,6a | 38,0a | 45,6b | 32,8c | **<0,05** |
| **Diameter** | cm | 38,8 | 42,9 | 39,2 | 40,8 | >0,05 |
| **Hierarchical Position** | Index | Co-dominant | Co-dominant | Dominant | Co-dominant | >0,05 |
| **Localization** | Index | Tree collar | Tree collar | Tree collar | Tree collar | >0,05 |
| **Extension** | Index | 10-50 $cm^2$ | 10-50 $cm^2$ | <10 $cm^2$ | 10-50 $cm^2$ | >0,05 |
| **Affected Tissue** | Index | Bark | Bark | Bark | Bark | >0,05 |
| **Severity of injury** | Index | Moderate | Moderate | Non-invasive | Moderate | >0,05 |
| **Cause** | Index | Extraction 57% | Extraction 58% | Extraction 54% | Extraction 52% | >0,05 |
| **Distance from forest tracks** | Index | 0-2 m | 0-2 m | 0-2 m | 2-4 m | >0,05 |

The injuries were classified according to:

1. Cause
2. Injurie position
3. Wound depth
4. Wound extension and nature

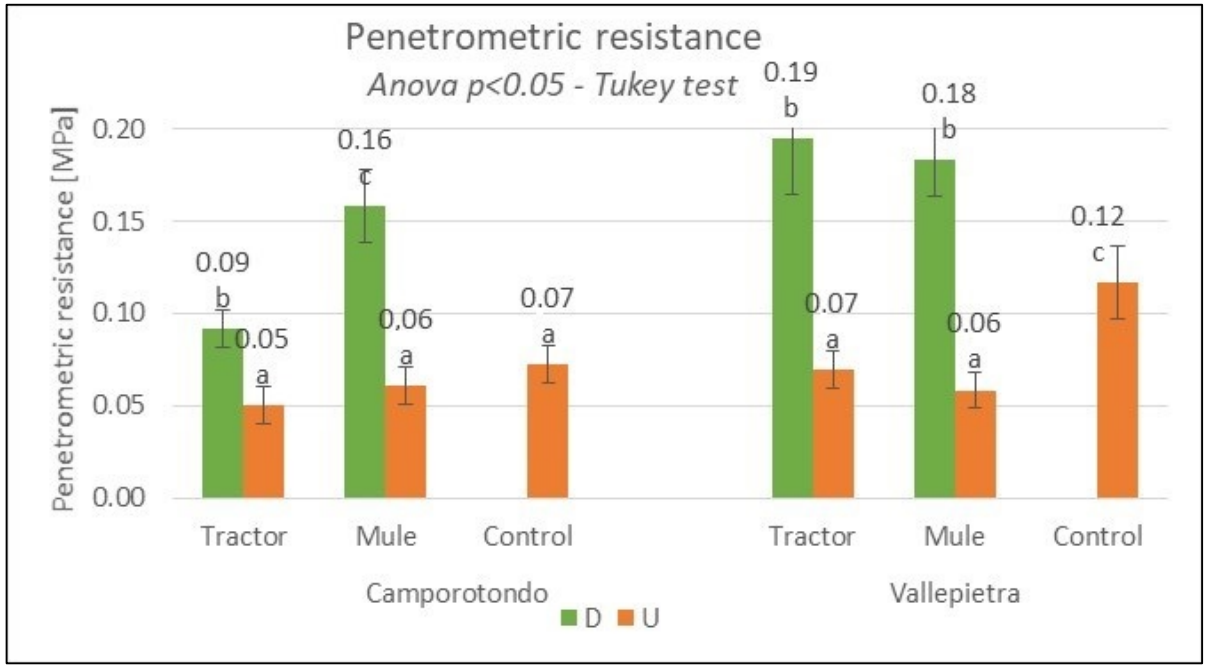
# Impacted area

| *Locality* | *Area* | *p-value* | *Tukey test Inter locality* | *Impacted surface* | *p-value* | *Tukey test Intra locality* | *Not Impacted surface* |
|---|---|---|---|---|---|---|---|
| Camporotondo | Tractor | >0,05 | - | 24,2±4,5% | <0,05 | A | 75,8% |
| Camporotondo | Mule | | - | 27,8±8,3% | | A | 72,2% |
| Vallepietra | Mule | <0,05 | a | 11,1±3,2% | | B | 88,9% |
| Vallepietra | Tractor | | b | 23,0±2,8% | | A | 77,0% |

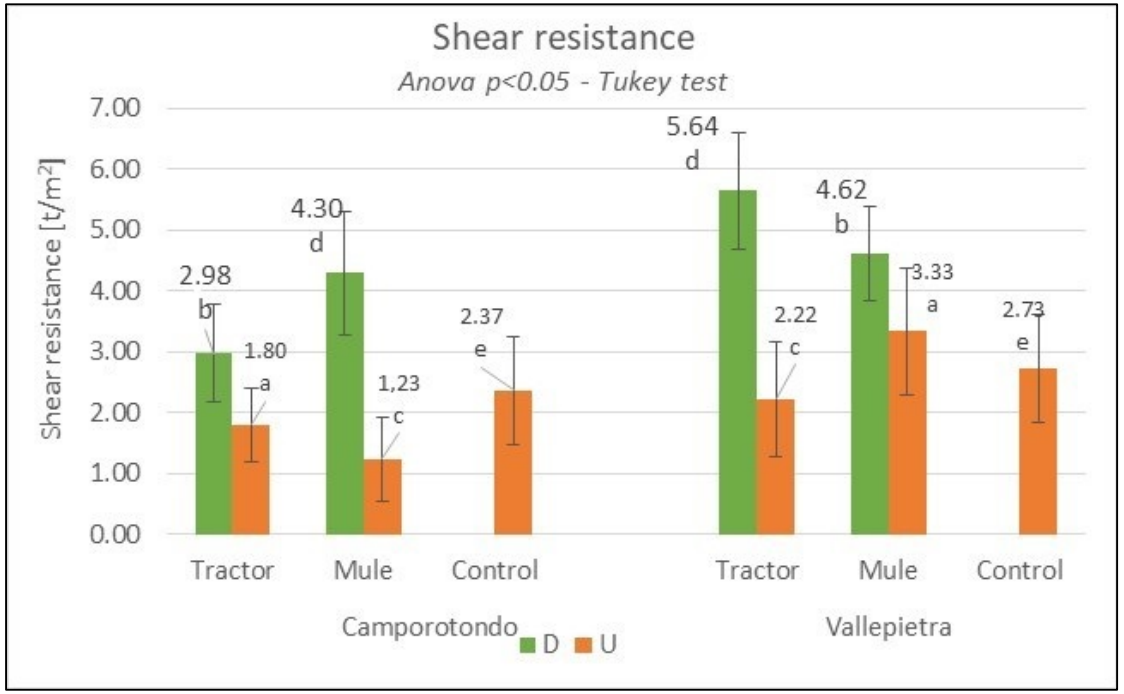
The forest soil surface clearly impacted by forest operations (presence of bent understory, crushed litter, ruts or soil disturbance) differed between the two different logging systems applied. The statistical analysis showed significant differences between the average values in Vallepietra.

# Soil physical and chemical analysis

## Penetration Resistance

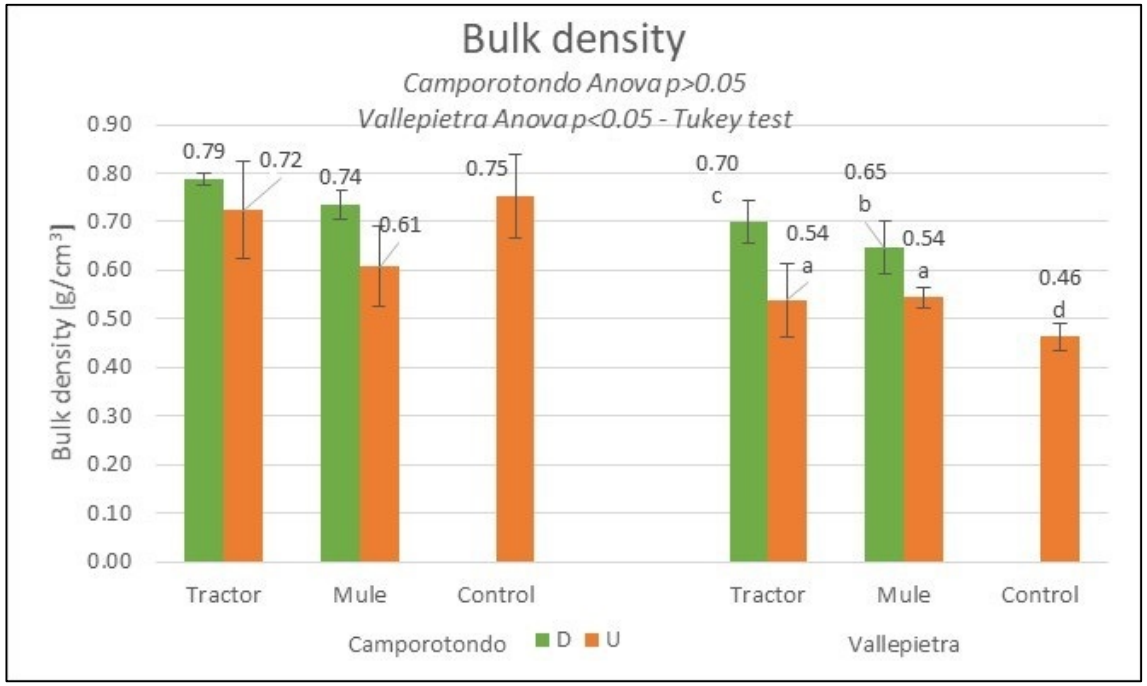



## Shear Resistance

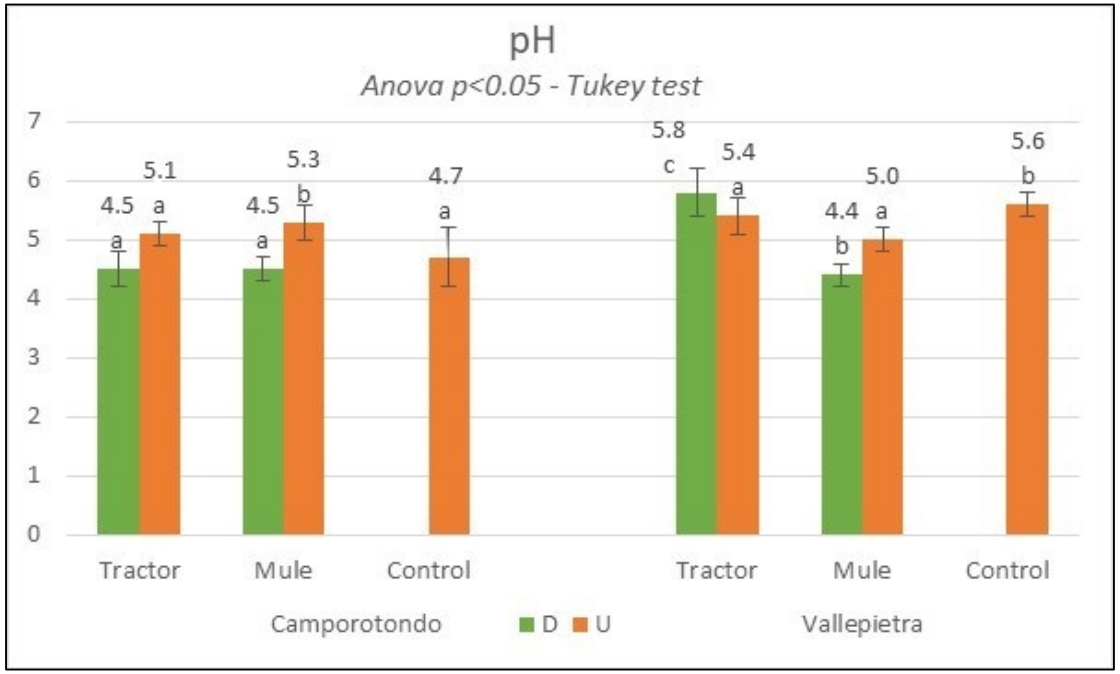


# Soil physical and chemical analysis

## Bulk Density

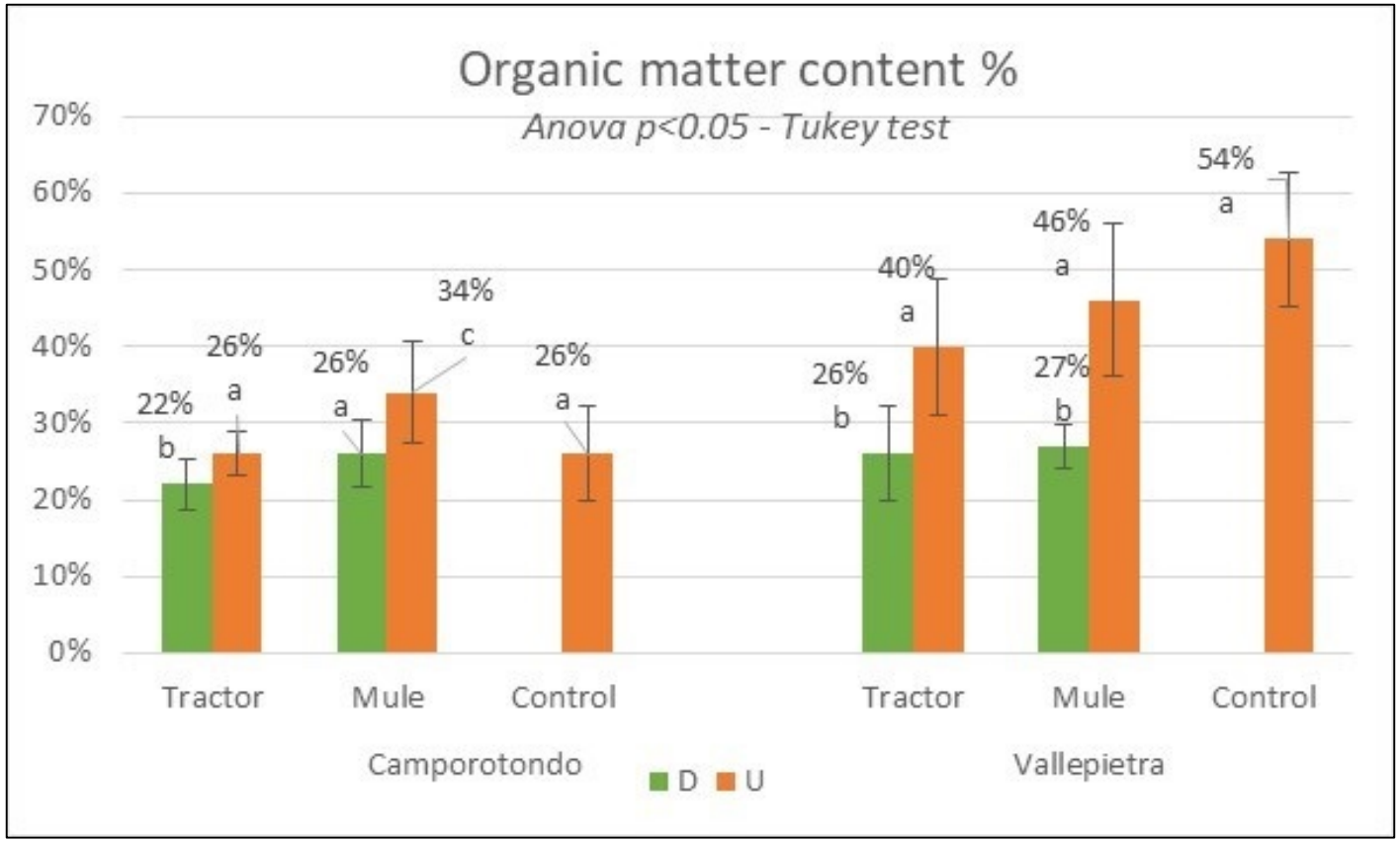



## pH



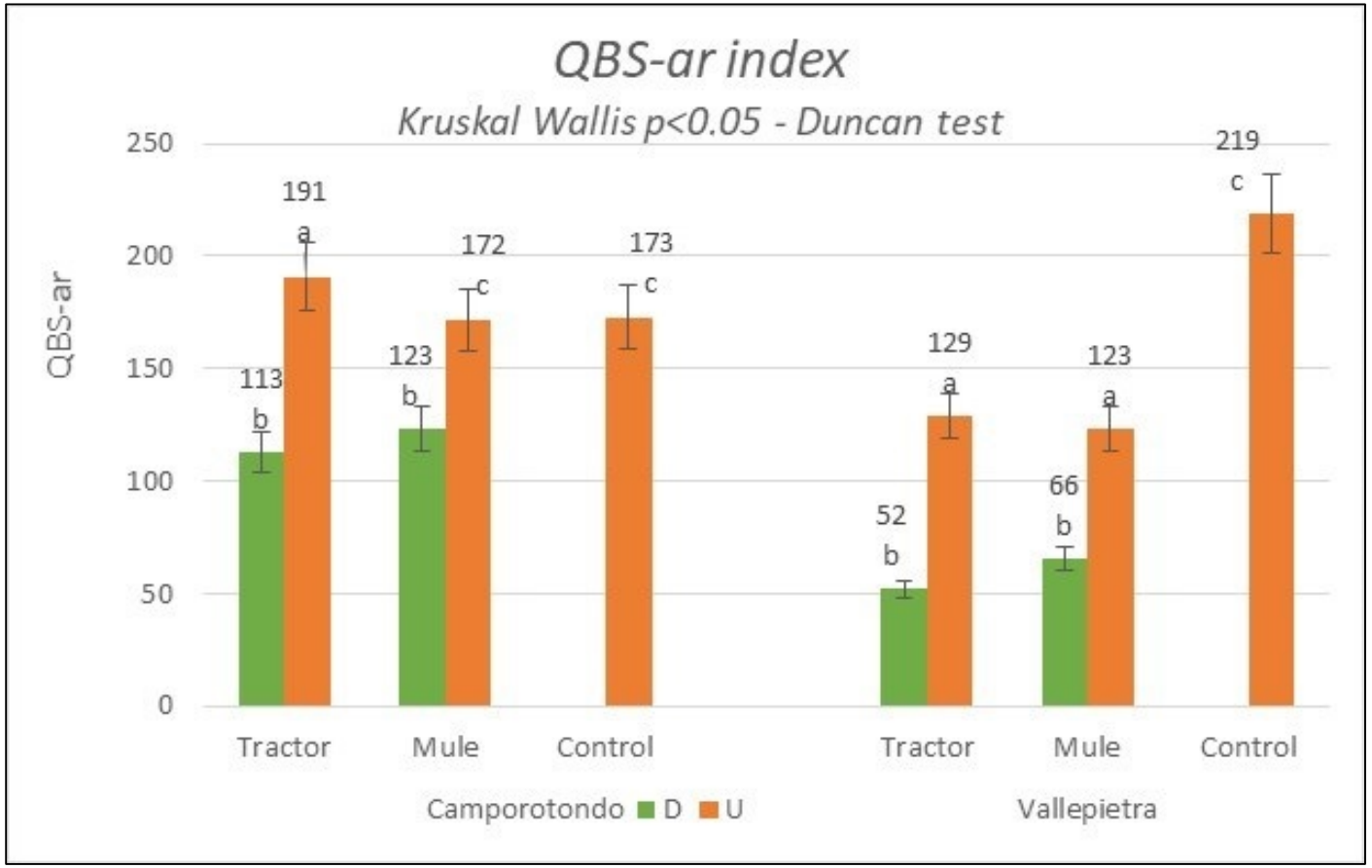
# Soil physical and chemical analysis

## Organic Matter



# Soil biological analysis

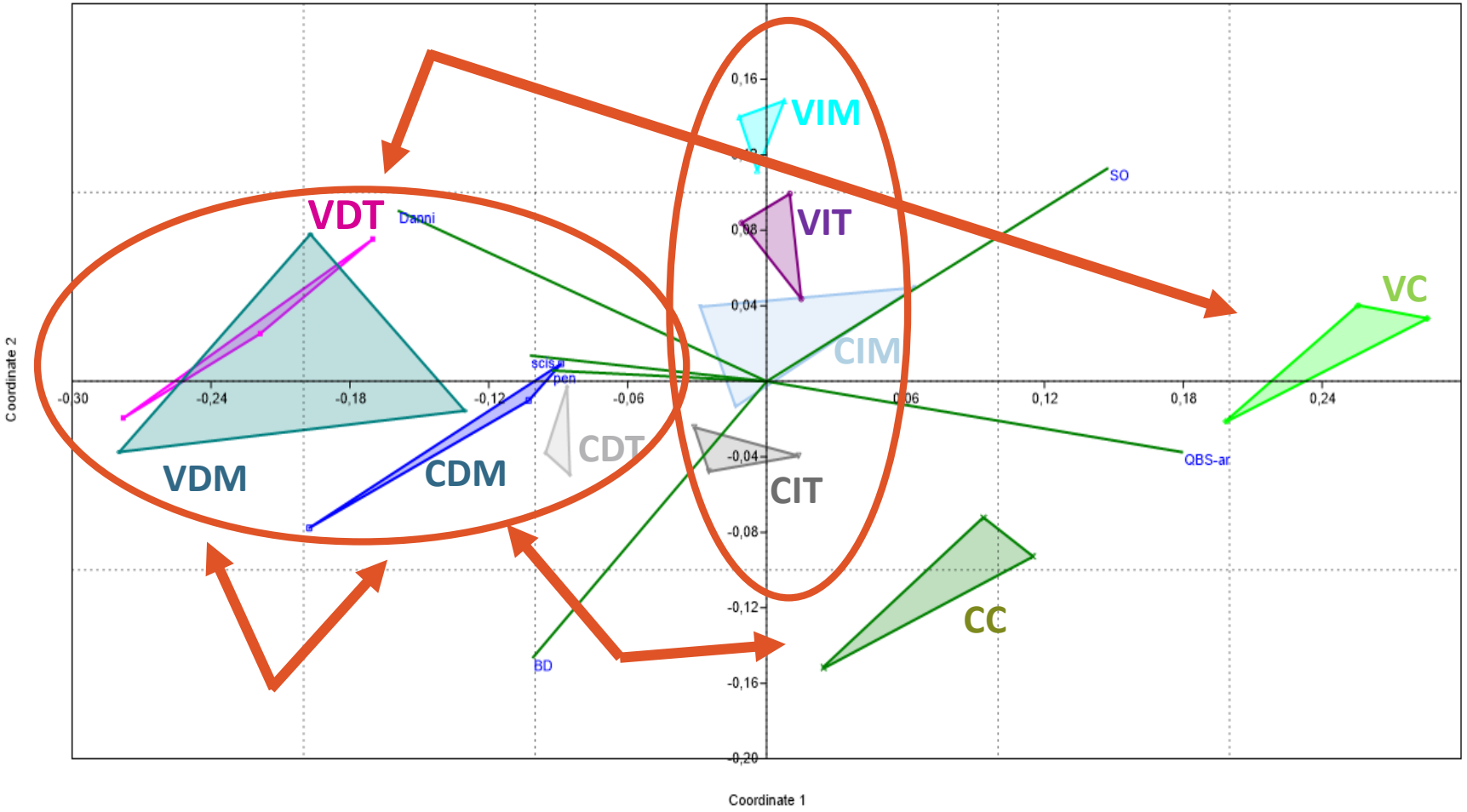
## QBS-ar Index



# Discussions and Conclusions

# Analysis of impacts

nMDS analysis is referred to all significant physical, chemical and biological soil parameters and summarize the complex situation.




- The impact due to sylvicultural treatment is clearly for both area and for both extraction system mainly in Vallepietra site.
- Doesn't seem to be clear differences between the use of the tractor and the mule
- The impact due to sylvicultural treatment seems minimal for both sites and for both extraction system.
- **In general, no significant difference in impact soil and topsoil was found between extraction with mules and tractor.**

Applying silviculture is impossible not to cause damage to the forest ecosystem but we repeat the need to minimize and promptly remedy these anthropogenic disturbances

Our findings demonstrated that, in silvicultural treatments, the methodologies of felling, processing and extraction have to be planned on a larger scale; they cannot be sporadic events, not connected to the social, environmental and economic contexts.

Will be very interesting to assess how this management approach can be reflected on recovery capacity of the forest ecosystem

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