Afforestation and Natural Afforestation in Mountain Areas

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LANGOUE 1
Profile 1
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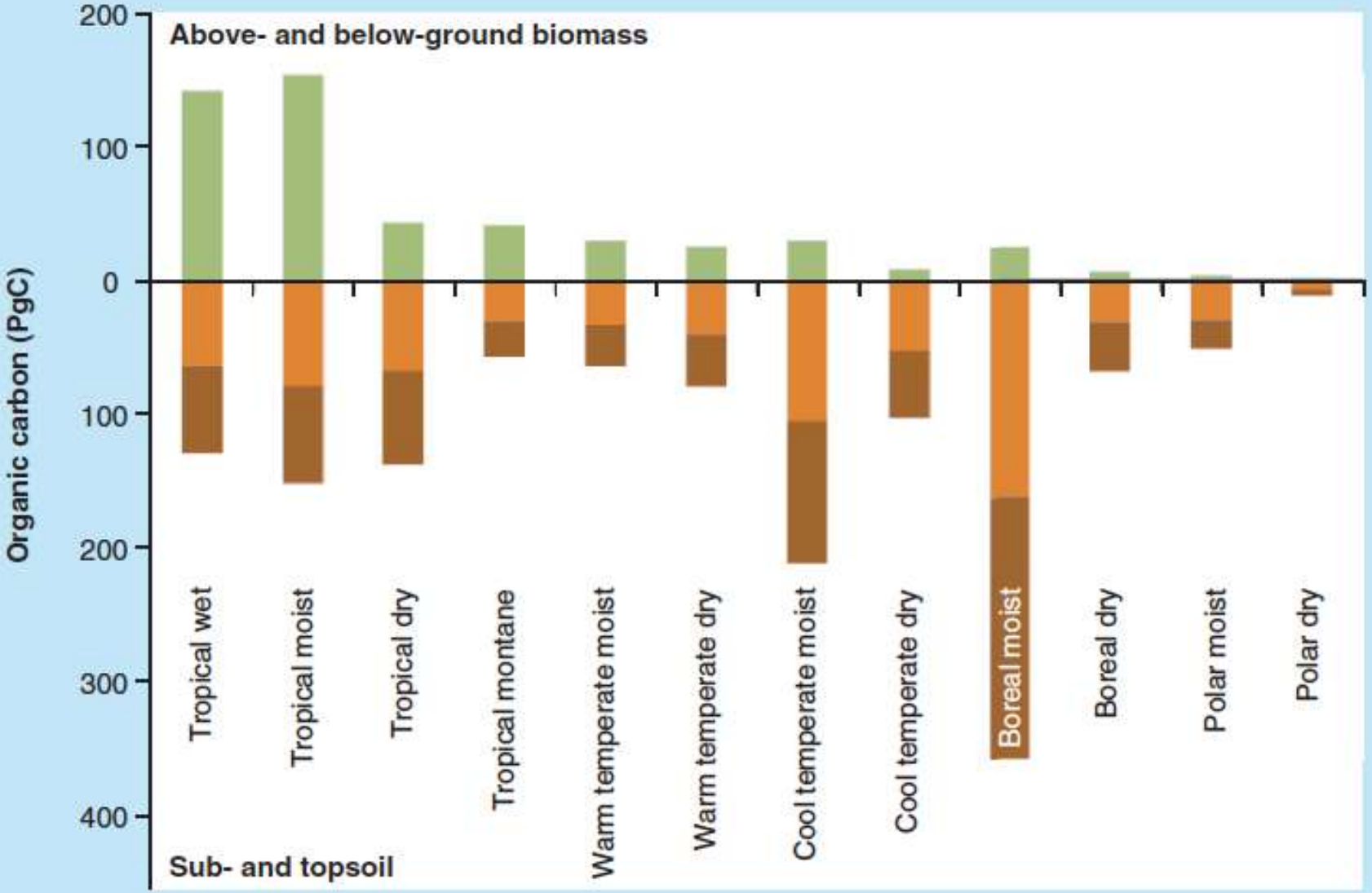
Fonte: FAO

FORESTS

- **Forests contain 90% global biodiversity**
- Water regime and soil protection against erosion

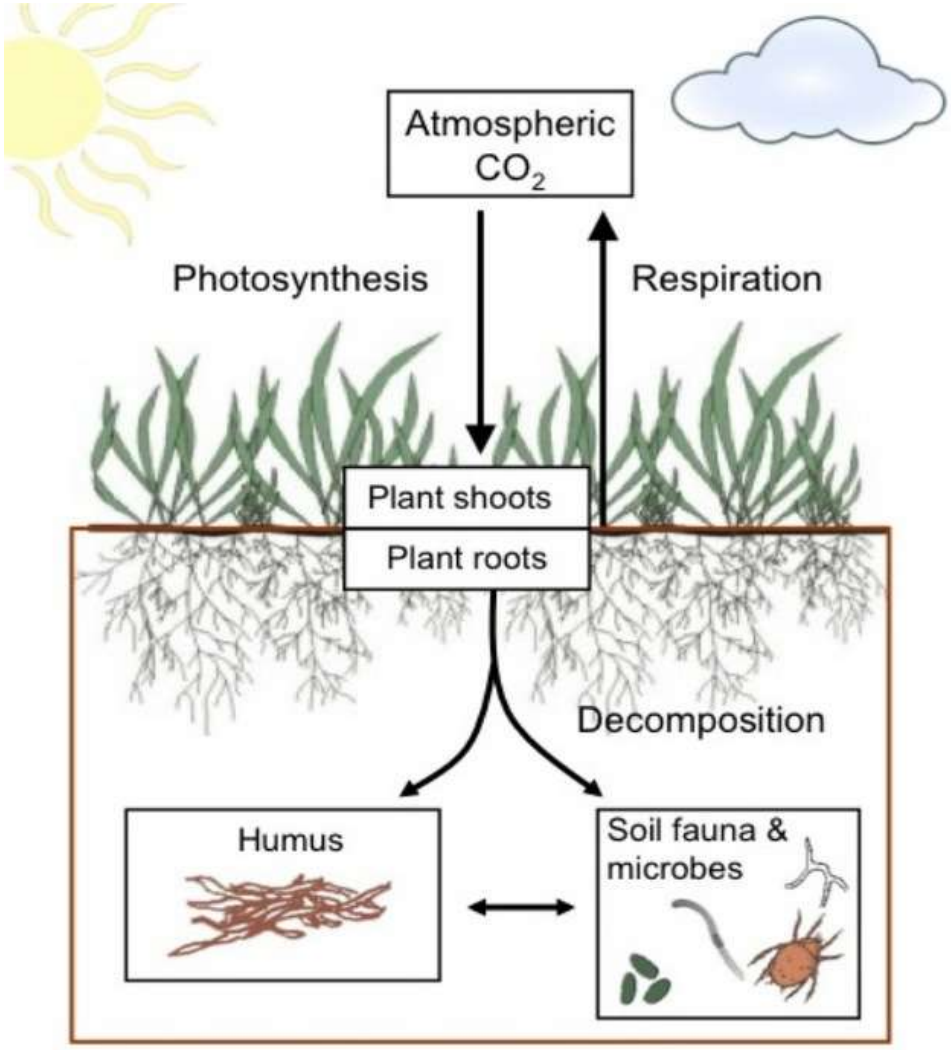
- **More than 1 billion people depend directly from forest resources**

- Wood is the primary energetic source for cooking and heating for more than 2 billion people covering the 70% of the dayly energetic needs of the population in Africa and south east Asia.



Scharlemann et al. 2014

Atmospheric C is a primary source of C for soil



The amount of biomass arriving to soil varies according to climatic conditions

Above ground Biomass

1.0 – 4.0 Mg C ha^{-1} yr^{-1} Artic and Alpine Tundra

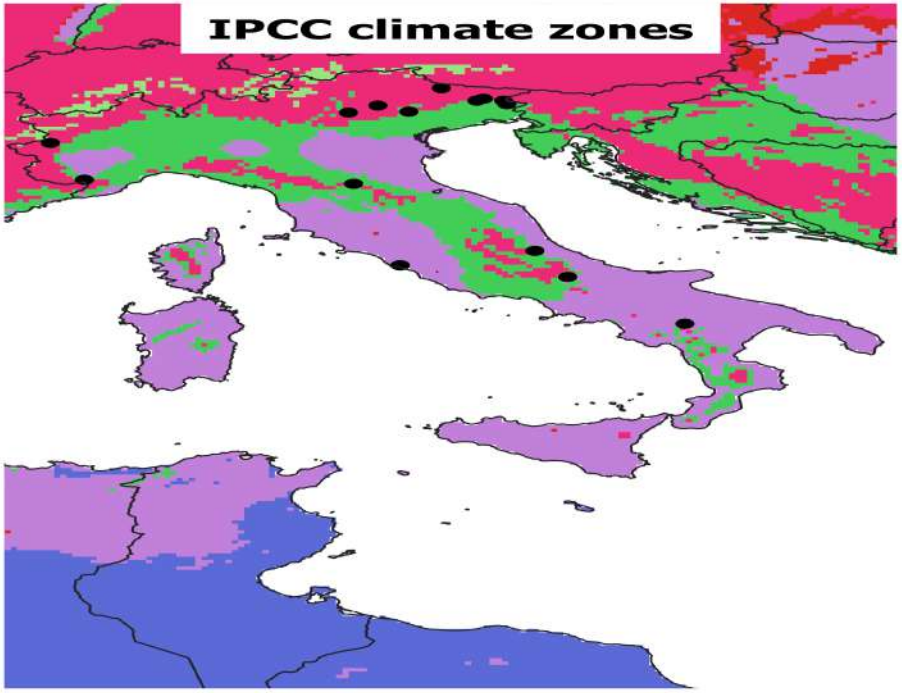
3.0 – 7.5 Mg C ha^{-1} yr^{-1} Broaleaves Boreal Forest

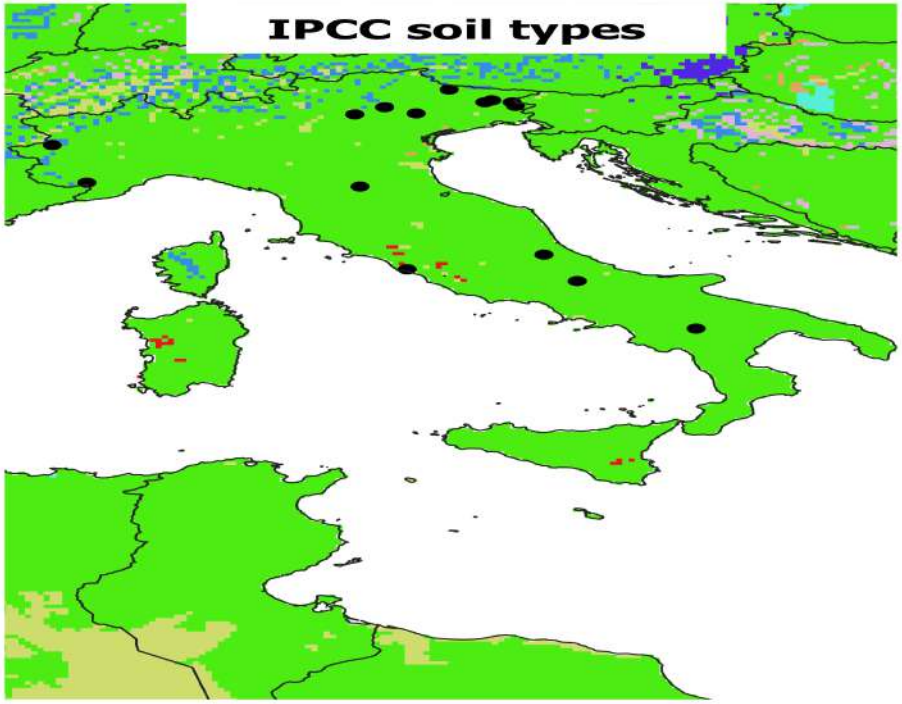
5.0 – 11.0 Mg C ha^{-1} yr^{-1} Broadleaves Temperate forests

3.0 – 6.0 Mg C ha^{-1} yr^{-1} Temperate Grasslands

Root production

- 2.3 – 10 Mg C ha^{-1} yr^{-1} Temperate forests
- 5.0 Mg C ha^{-1} yr^{-1} Temperate Grasslands





Legend

- Site location

IPCC climate zones

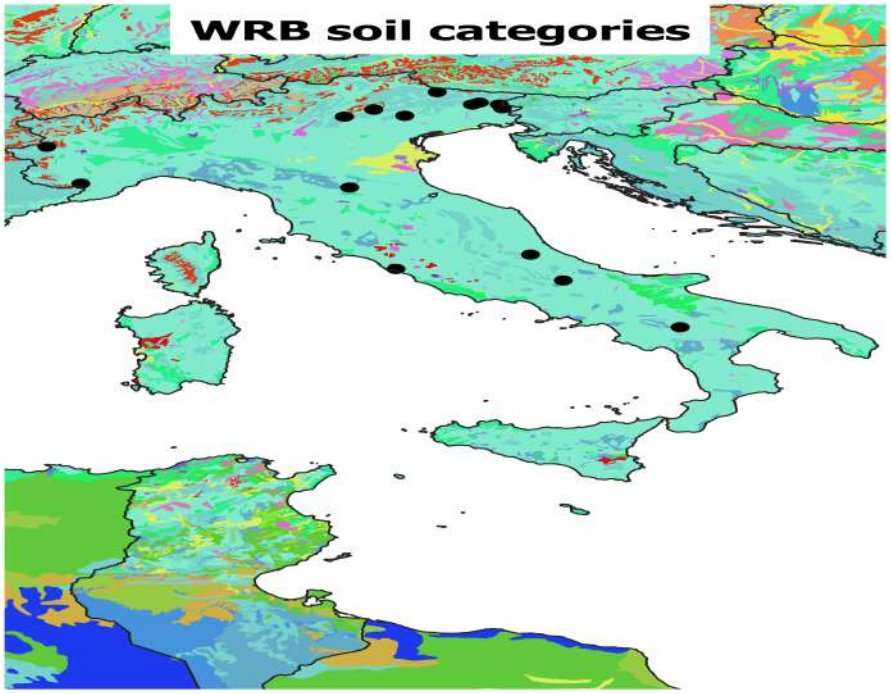
- Cool Temperate Dry
- Cool Temperate Moist
- Polar Moist
- Warm Temperate Dry
- Warm Temperate Moist

IPCC soil types

- High Activity Clay Soils
- Low Activity Clay Soils
- Sandy Soils
- Volcanic Soils

WRB soil categories

- Andosols
- Cambisols
- Fluvisols
- Histosols
- Leptosols
- Luvisols
- Podzols
- Regosols
- Vertisols
- Water bodies
- Urban, mining, etc.
- Glaciers



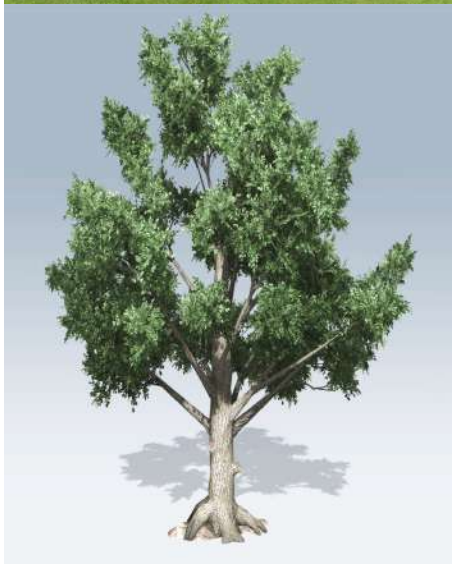
Main indigenous species

16 main species that cover at least 20.000 ha

1) Spruce
2) Larch
3) Silver fir
4) Scots pine
5) Black pine
6) Beech
7) Maritime Pine
8) Domestic pine
9) Aleppo pine
10) Chestnut
11) Sessile Oak
12) Turkey oak
13) Hornbeam
14) Holm Oak
15) Cork Oak
16) Euro-American Poplar

Conifers

Broadleaves



Prevalence

1) Sessile oak
2) Beech
3) Spruce
4) Chestnut
5) Turkey oak

1)

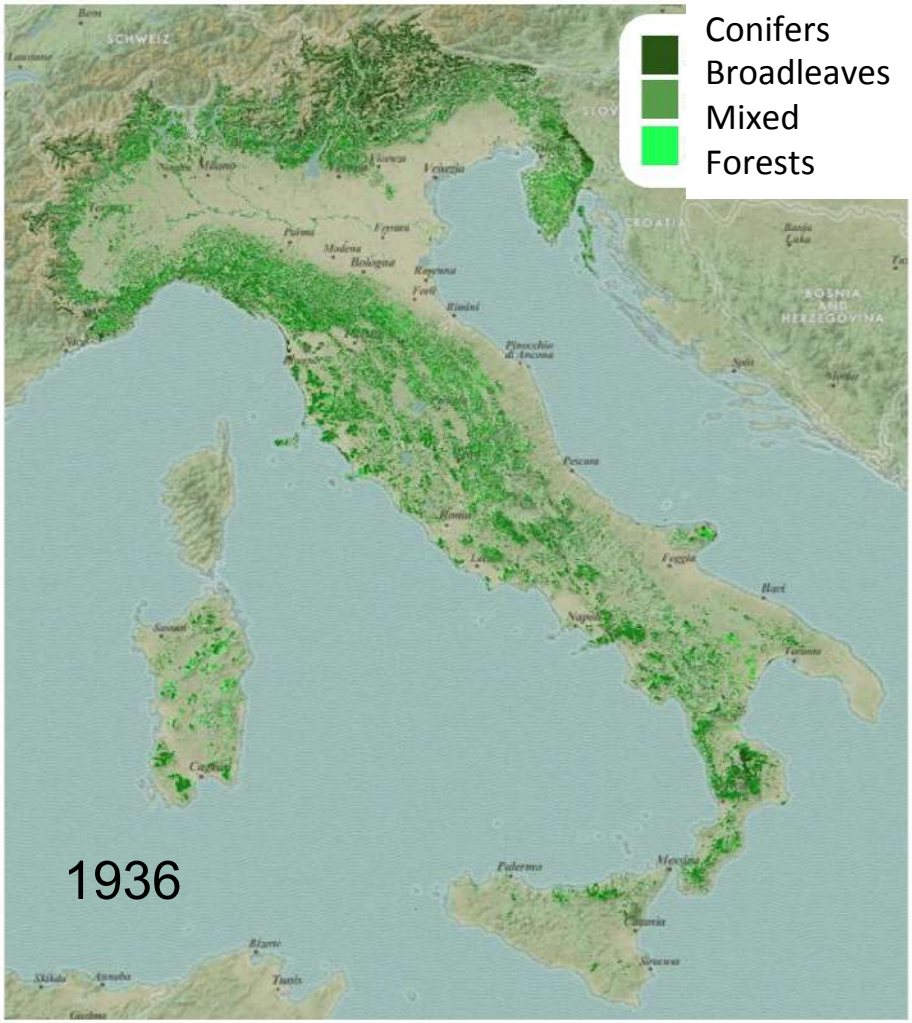
2)

3)

4)

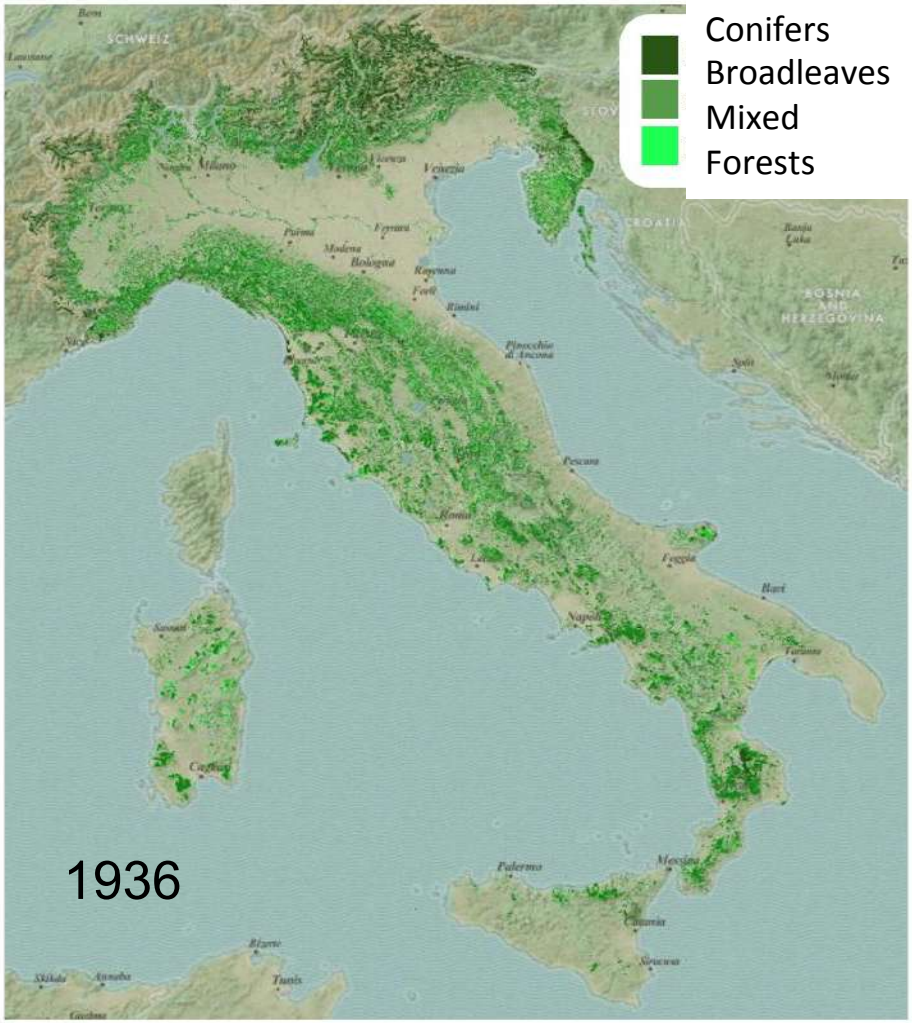
5)

Forest Cover - Italy



Carta forestale del Regno d'Italia, realizzata nel 1936 dall'allora Milizia Forestale. (Ferretti at al., 2016 modificata)

Forest Cover - Italy



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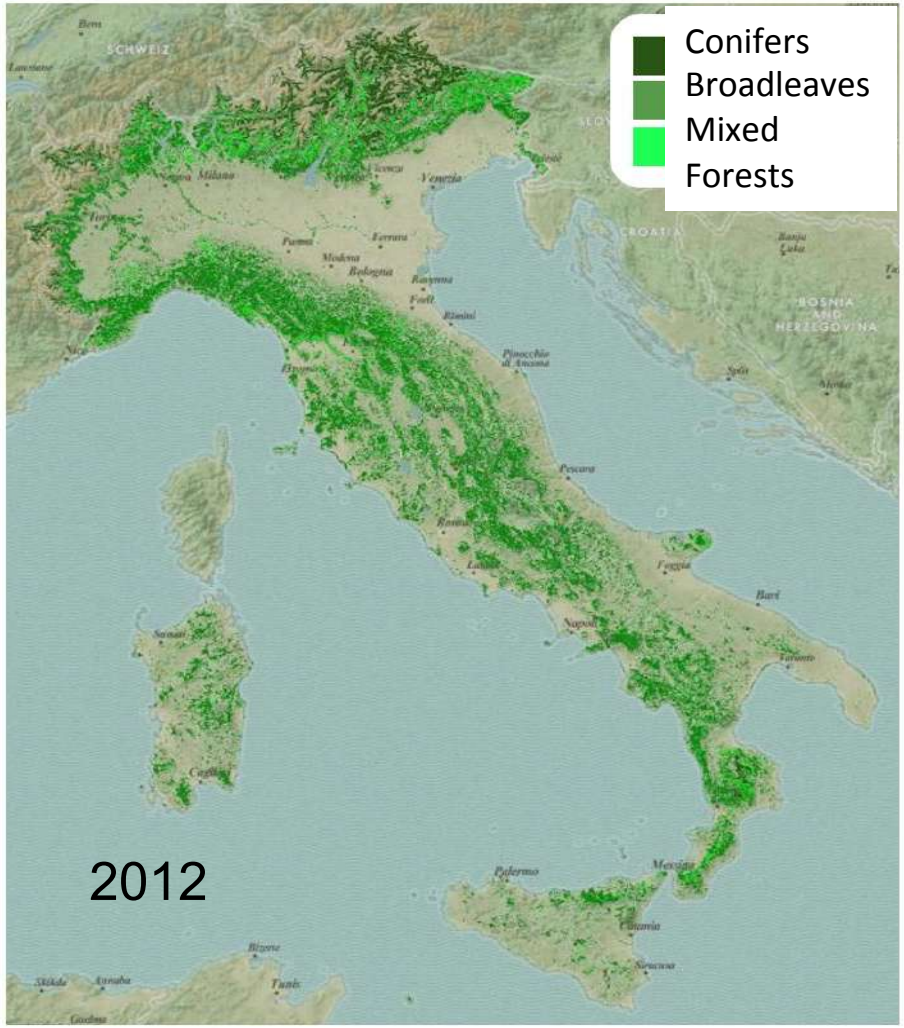


Formazioni Forestali in base al Corine Land Cover 2012 (CLC, 2012)

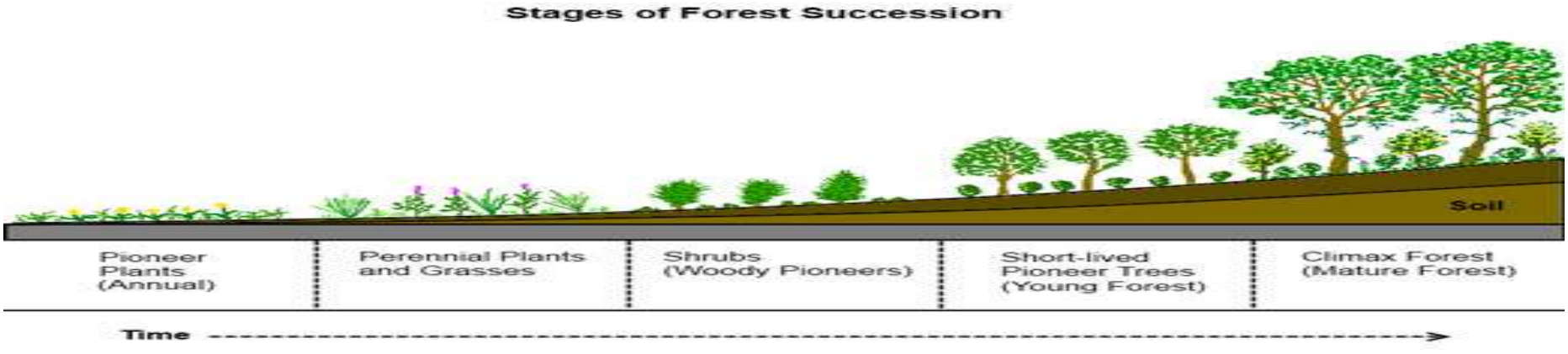

SVIZZERA
AUSTRIA
UNGHERIA
SLOVENIA
CROAZIA
BOSNIA HERZEGOVINA
Alpi Centrali
Alpi Orientali
Alpi Occidentali
Pianura Padana
Pianura Veneta
Golfo di Venezia
Golfo di Genova
MAR LIGURE
MARE ADRIATICO
Appennino Settentrionale
Appennino Centrale
Appennino Meridionale
Corsica (Francia)
Sardegna
Sicilia
MAR TIRRENO
MAR MEDITERRANEO
MAR IONIO
Canale di Sicilia
Canale di Malta
Golfo di Taranto
AFRICA
MALTA
Isole Eolie o Lipari
Isole Egadi
Isole Pelagie
Pantelleria
Lang. Est 15° da Greenwich
km

Carta forestale del Regno d'Italia, realizzata nel 1936 dall'allora Milizia Forestale. (Ferretti at al., 2016 modificata)

Formazioni Forestali in base al Corine Land Cover 2012 (CLC, 2012)

Succession

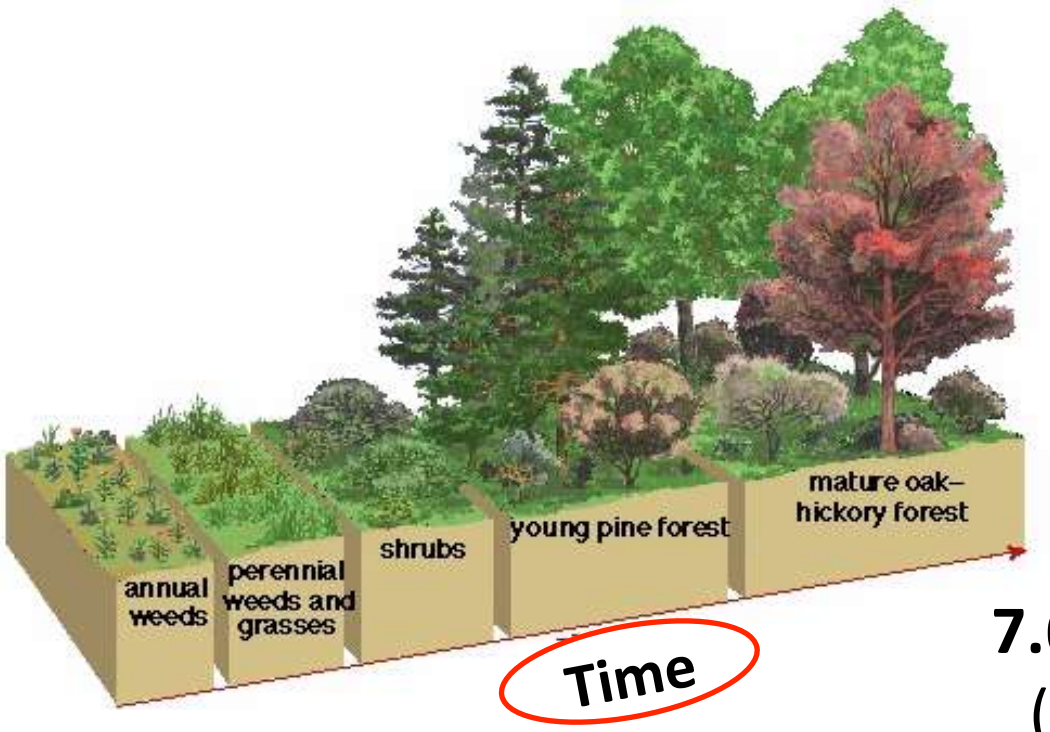
- The change in species composition that occurs in a stand over time.
- An area is colonized by shade intolerant, fast-growing species. Eventually, tolerant trees become established in the understory and start growing into the canopy.
- One of two things then happens. Either (1) the intolerants die naturally and are replaced by the tolerants that have been present in the understory for some time, or (2) the tolerant trees finally overtop the intolerants and shade them out, causing them to die.



Woody encroachment over pastures and grasslands

- Secondary succession
- Woody vegetation expansion
- Land Use Change (LUC)

Release/absorption of GHGs (IPCC, 2014)



Mountain and rural territories after WWII

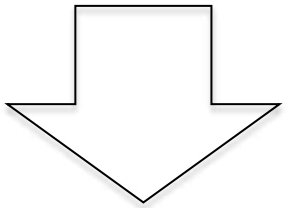
7.6% S Europe (1950-2010)

1.1% Italy (1990-2008)

Physical properties

possible increase in soil erosion

reduction of soil moisture



Related to desertification process

No any change in soil compaction

Chemical properties

lower soil pH

- Increase in acidity in old forests litter,
- Litter strongly contribute to soil acidification

higher soil carbon and nitrogen pools

Increase particularly below 30 cm depth

- higher potential nitrogen mineralization

Cation exchange capacity

- No any change observable in term of nutrients

Biological properties

Higher biodiversity in grasslands

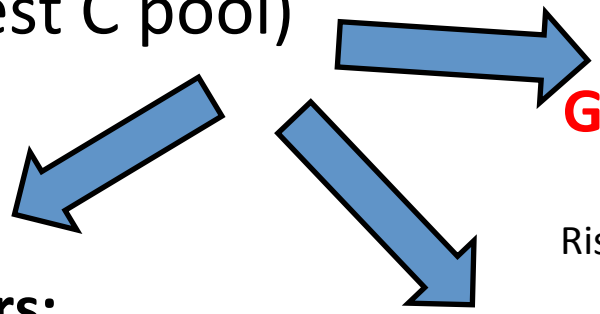
Natural afforestation is favoring fungal communities to the detriment of bacterial ones, and the activity of the soil microbial community

Plant species composition change is, probably, the dominant factor affecting soil biochemical properties

Conifers release a less palatable organic substance for microbial communities

Background

- Increment in biomass and necromass C stocks
- Discordant results for Soil organic C stocks (largest C pool)



Limitations:

Generally topsoil (0-30 cm) only

(Thuille & Schulze, 2006; Alberti *et al.*, 2008; Risch *et al.*, 2008; Fonseca *et al.*, 2011; La Mantia *et al., 2013;* Guidi *et al.*, 2014)

Pair plot (pasture vs. forest)

Drivers:

Climate (MAP)

Time from abandonment

Plant species

Aspect or exposure

Soil properties

…

Italian case studies:

(Jackson *et al.*, 2002; Guo & Gifford ,2002; Alberti *et al.*, 2011)

Alps → decrease / no changes

(Thuille & Schulze, 2006; Alberti *et al.*, 2008; Risch *et al.*, 2008; Guidi *et al.*, 2014)

Sicily → increase / decrease / no changes

(La Mantia *et al.,* 2013)

Apennines → no data

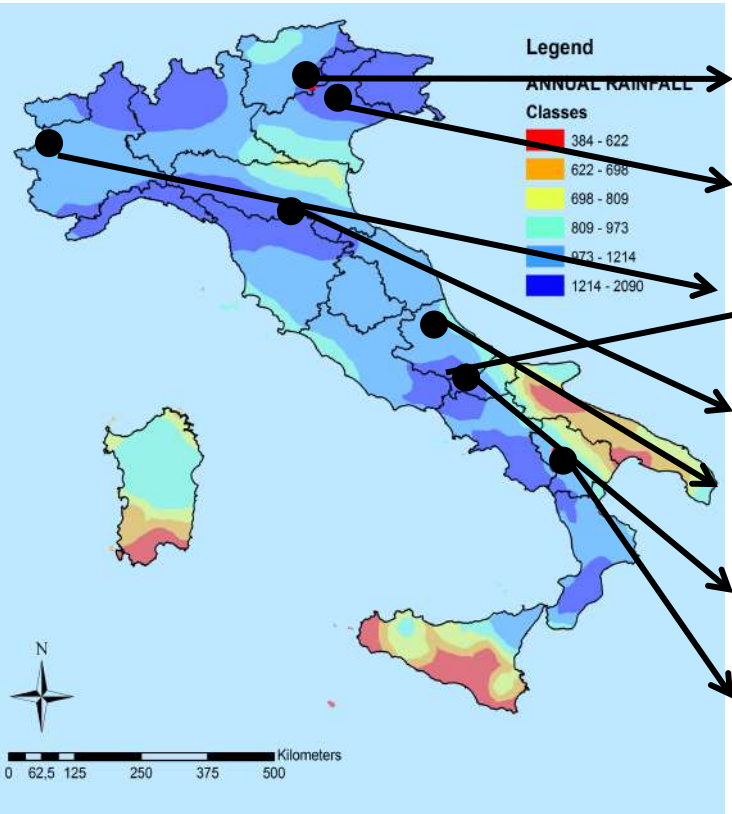
Objectives

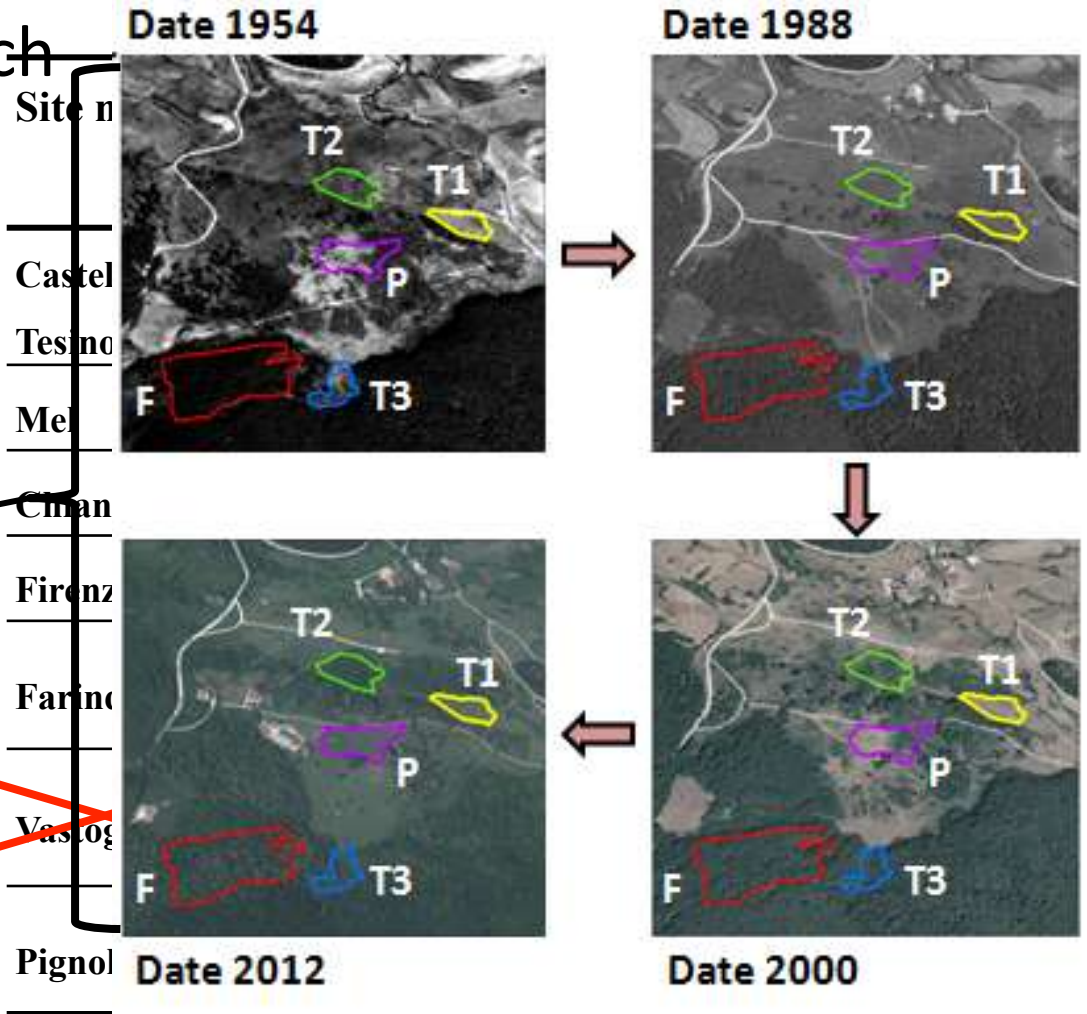
1. Estimate **SOC stock changes** along woody encroachments (WEs) in some Italian sites
2. Investigate the role of **subsoil**
3. Test the **MAP** key role in SOC stock changes along Italian peninsula
4. Evaluate the WE effect on **ecosystem C stocks** (i.e. sum of above and belowground biomass, litter, dead wood, soil pools)

Sites selection

Seven sites with different climatic conditions

Chronosequence approach





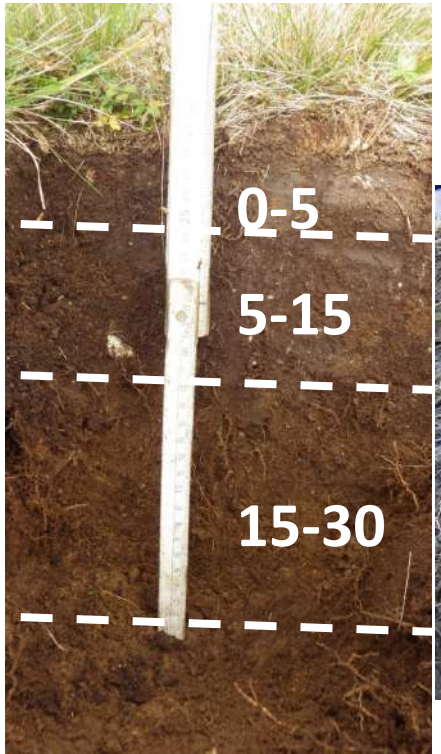
Carbon Pools

Aboveground
Belowground
Litter
Deadwood
Soil carbon

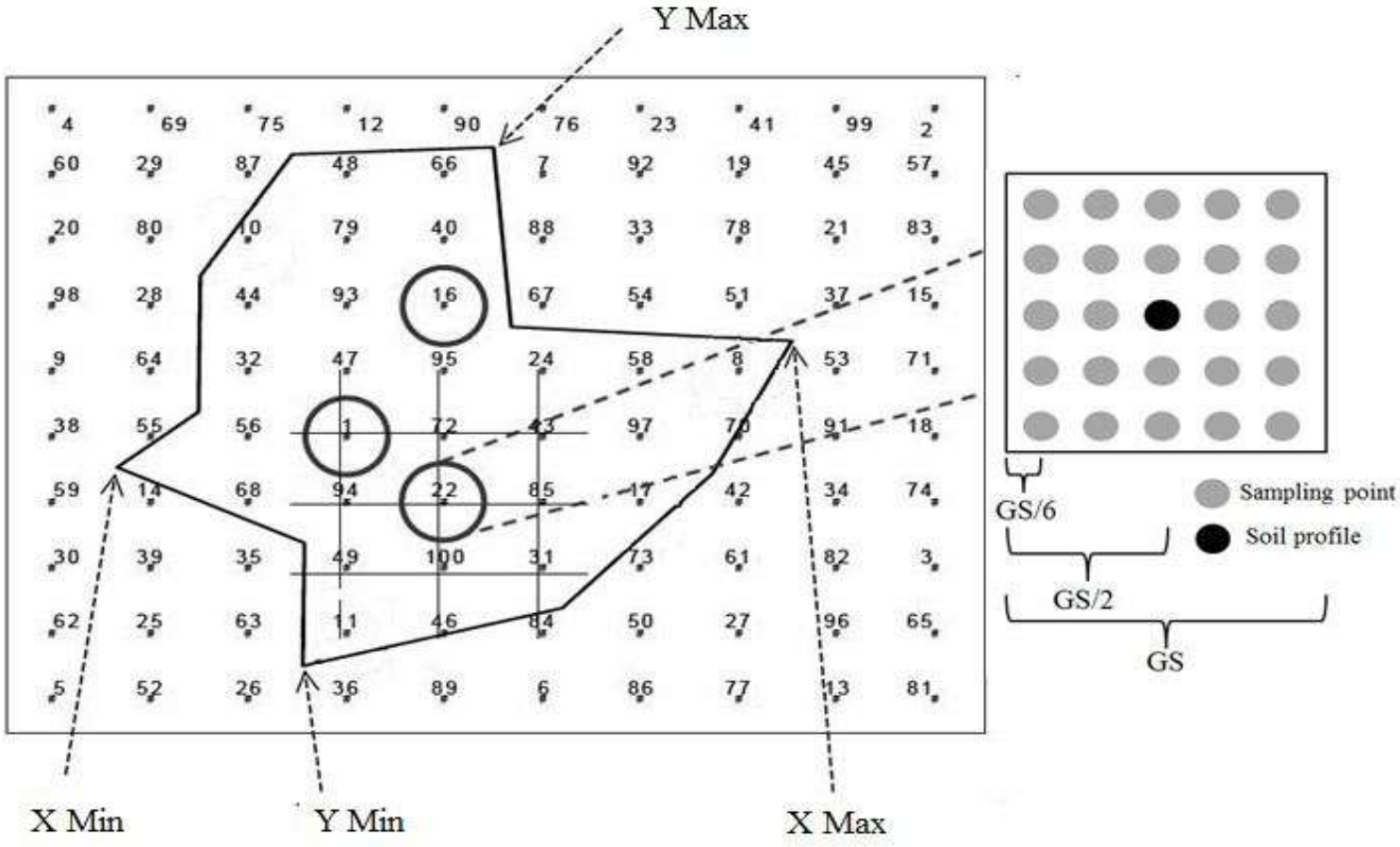
SOC stocks

- Sampling protocol: suggested by JRC for EC (Stolbovoy et al., 2007)
- Depth intervals: 0-5, 5-15, 15-30, 30-50, 50-70 cm
- Composite samples
- $SOC_{stock} = C_{conc} * BD * depth * [1-(\%rock\ volume/100)]$

Subsoil



Soil Organic Carbon

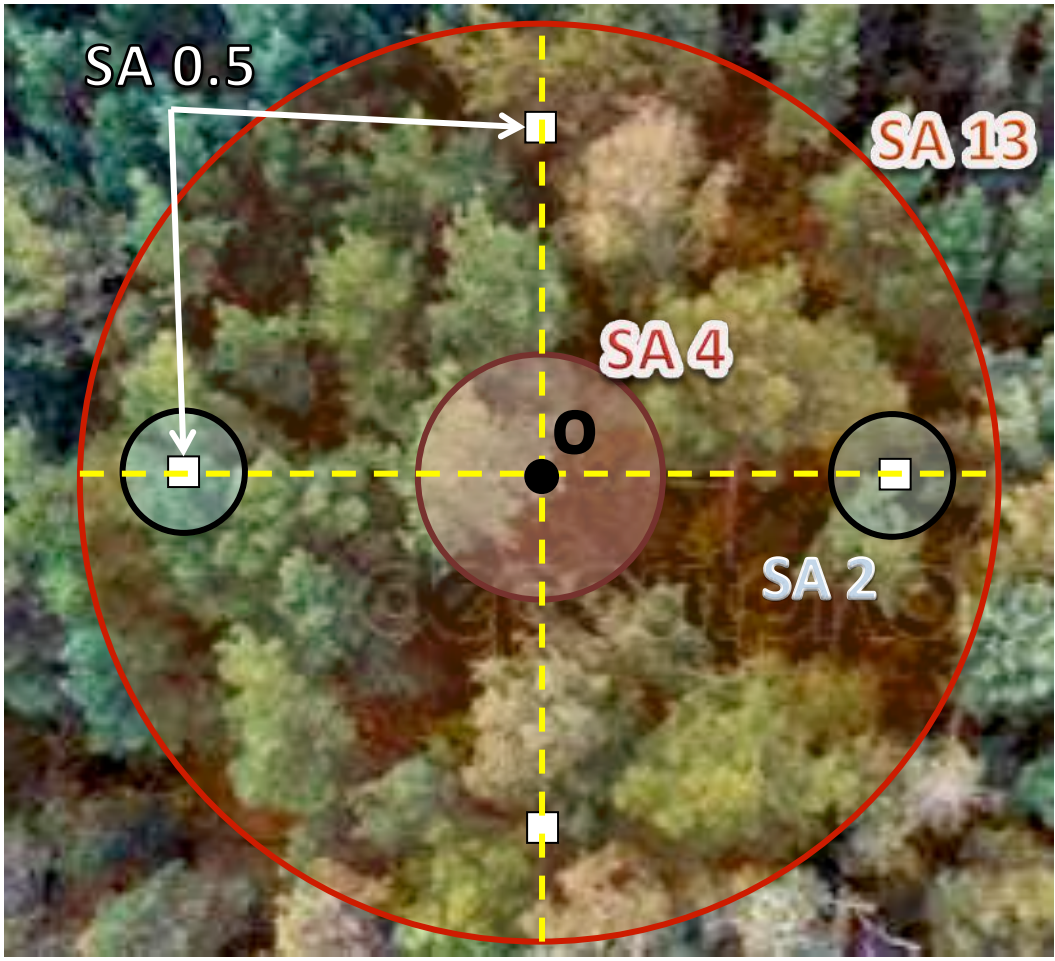


- Depths-> 0-5; 5-15; 15-30; 30-50; 50-70 cm
- 3 plots per site -> 3 composite samples per depth and per site
- C concentration by dry combustion

Biomass and necromass

In *Pasture* (P), *Intermediate* (T2), *Forest* (F) stages

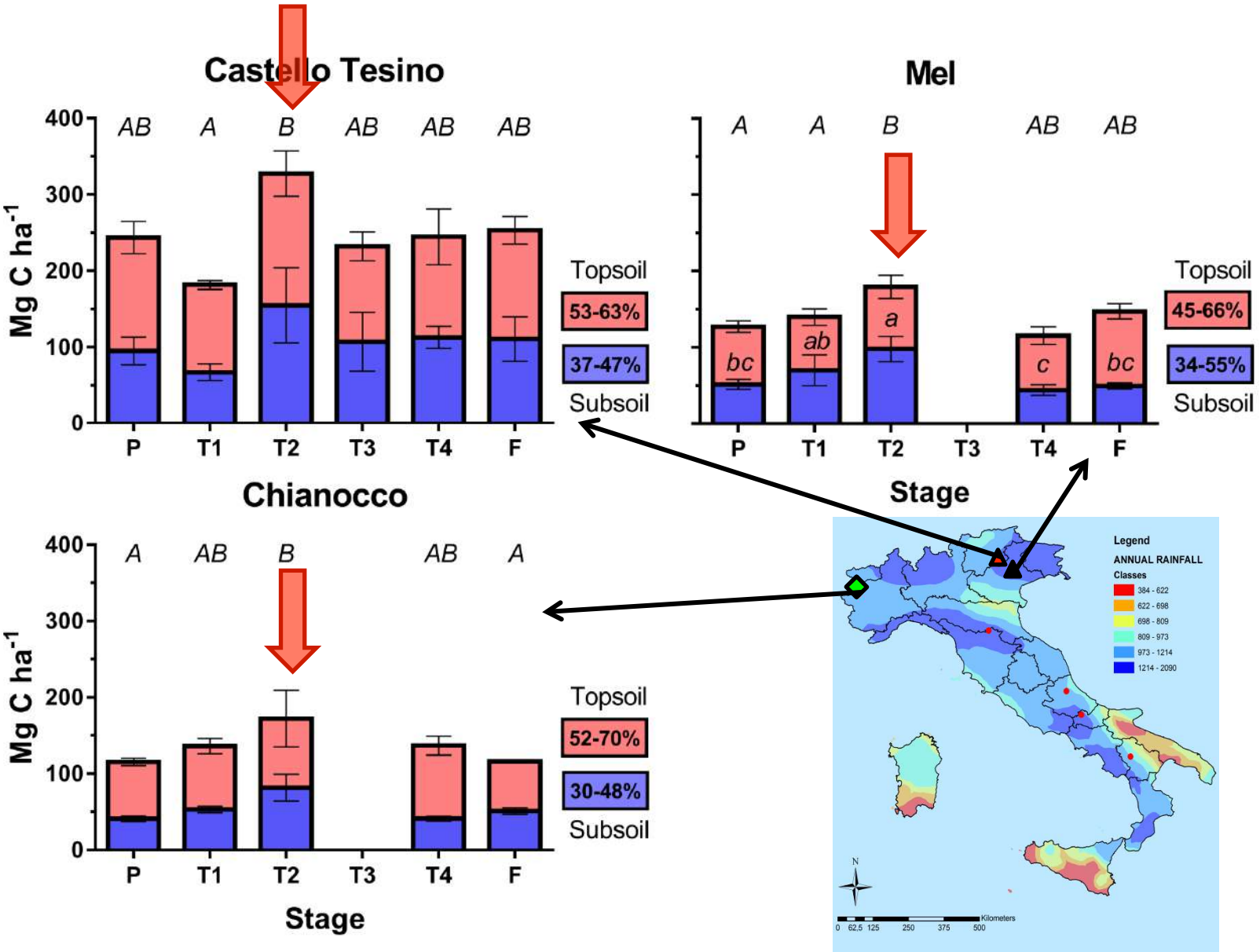
Graphic element	Pool
Central point **O**	Litter – mass
SA 0.5	Grasses and Fine Woody Debris (FWD) – mass
SA 2	Shrubs – mass
SA 4	Trees, 9.5 < DBH < 2.5 cm – mass
SA 13	Trees, 9.5 < DBH – mass
Dotted diameters	Coarse woody debris (CWD) – volume Density decay classes



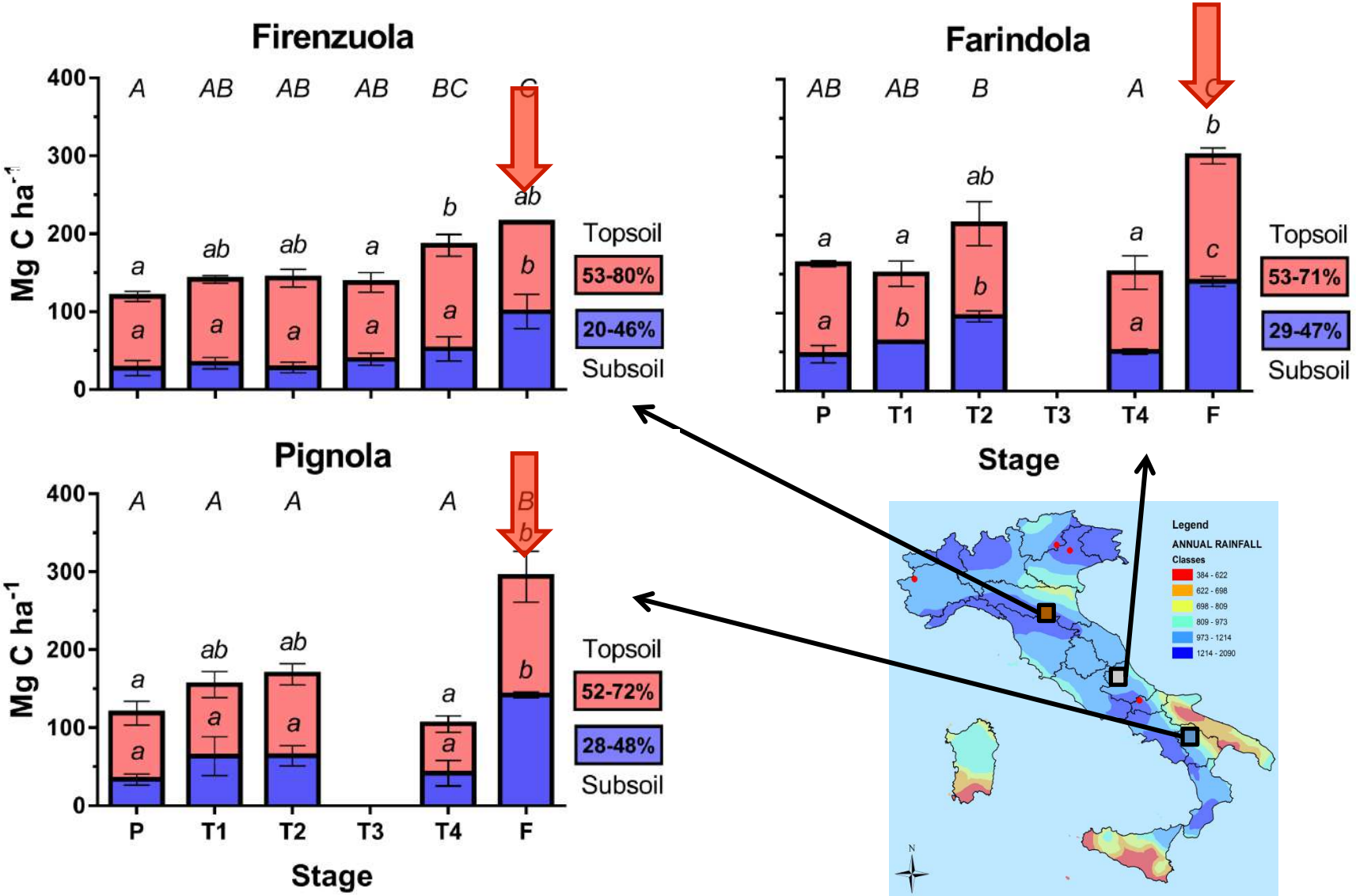
Belowground biomass:
Root-to-Shoot ratio

Inspiderd by MPAF (2006), Bovio *et al.* (2014)

SOC stock Alps changes

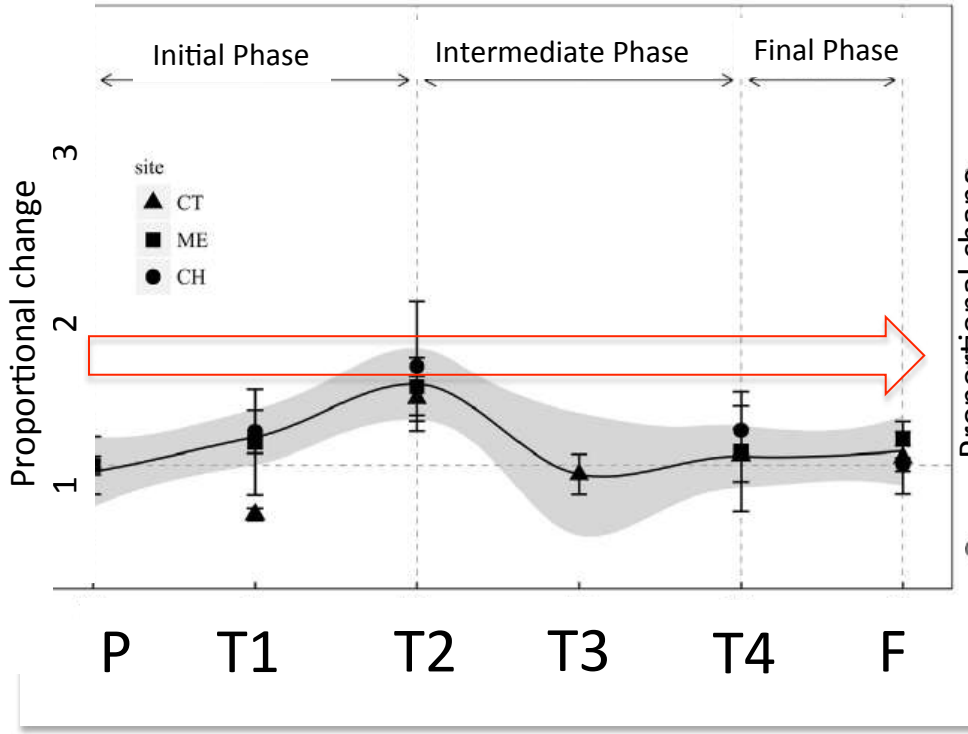


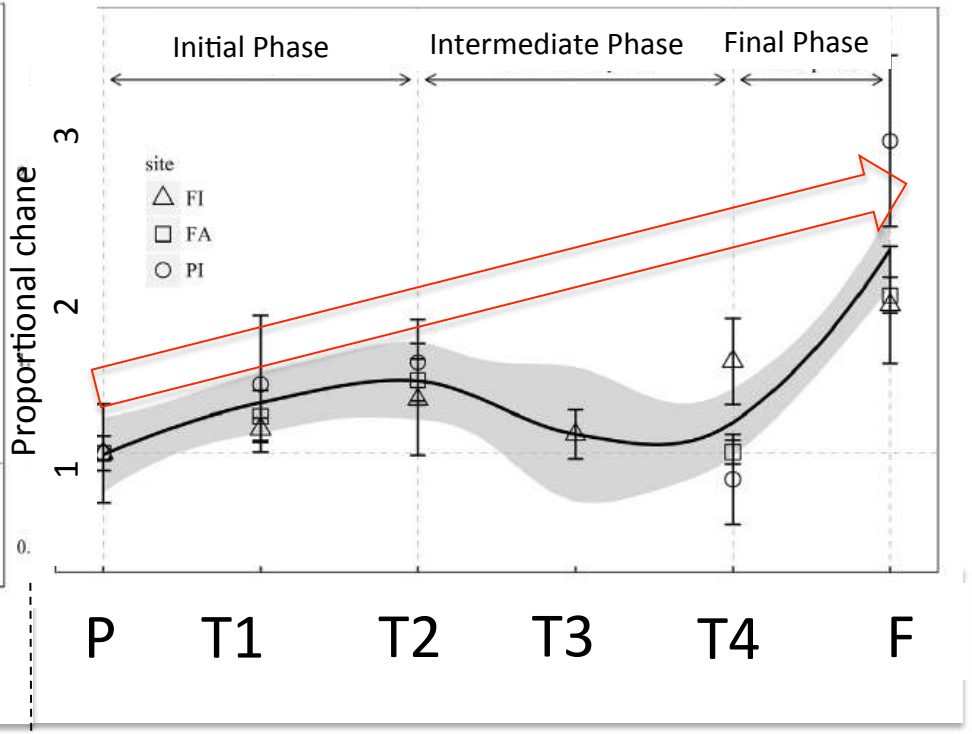
SOC stock Apennines changes



SOC summary

(*National Gradient*)





Alps - Conifers

Δ SOC stock in Mg C / ha

- Topsoil: +2.1 (18.1)
- Subsoil: +7.3 (17.4)
- Total: +9.4 (24.4)

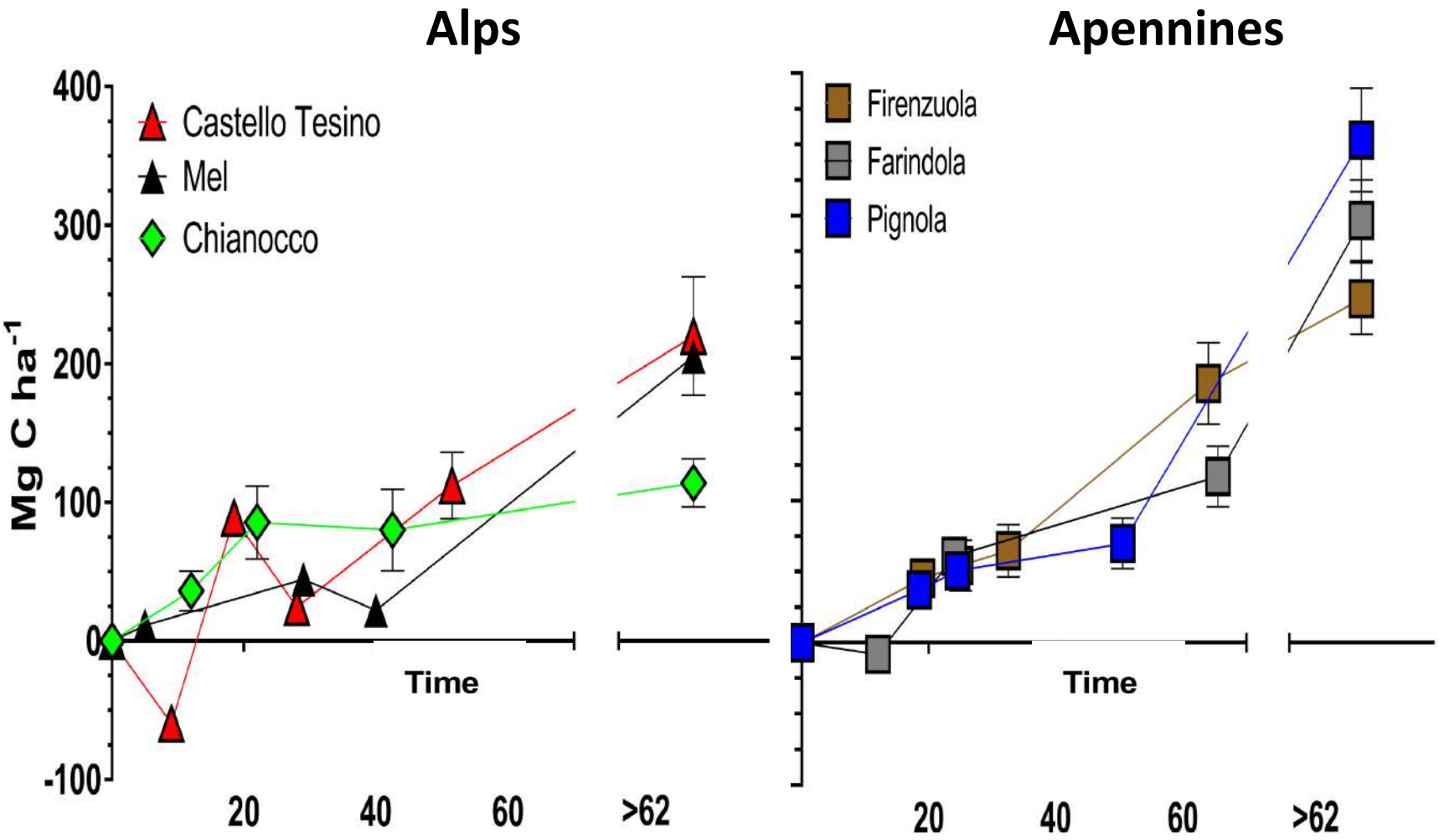
Appennines - Broadleaves

Δ SOC stock in Mg C / ha

- Topsoil: + 50.1 (25.2)*
- Subsoil:+ 93.2 (29.7)*
- Totale: +143.3 (51.0)*

Ecosystem C stocks changes

Soil + aboveground biomass + belowground biomass + litter + dead wood



CONSIDERATIONS

1. **SOC stock changes vary among sites** – Alps and **Apennines** very different
2. The **subsoil is a large pool** (30-40%)
3. **Temperature** (not precipitation) is the best climatic predictor for SOC changes
4. The **woody encroachment acts as a C sink at ecosystem level**
5. **Importance of the intermediate stages**

General Conclusions

No general rules can be derived for extrapolating general data that describe the effect of a disturbance because of various factors

Important to **measure the SOC along the whole profile** (0-100 cm depth) not only in the Topsoil.

THANKS FOR YOUR ATTENTION

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