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Driving factor of European beech treelines distribution along the Apennines in Italy

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What is a treeline ?

Treeline is a well identifiable ecological boundary present in mountains

Representing the upper ecological limit for forest growth and development

In equilibrium with the environmental factor

Climate change





Temperature during the vegetative period is broadly considered as the main factor driving the global position of the treeline (Körner, 1998; Jobbágy & Jackson, 2000; Körner & Paulsen, 2004)

Other factors affecting treeline elevation



- Climate
- Geography and Topography
- Anthropogenic activity

Worldwide, treeline is commonly formed by evergreen conifers species in mountains of boreal and temperate regions (Körner, 2012)

But there are some exceptions:

Betula of the Himalayas

Nothofagus in Chile

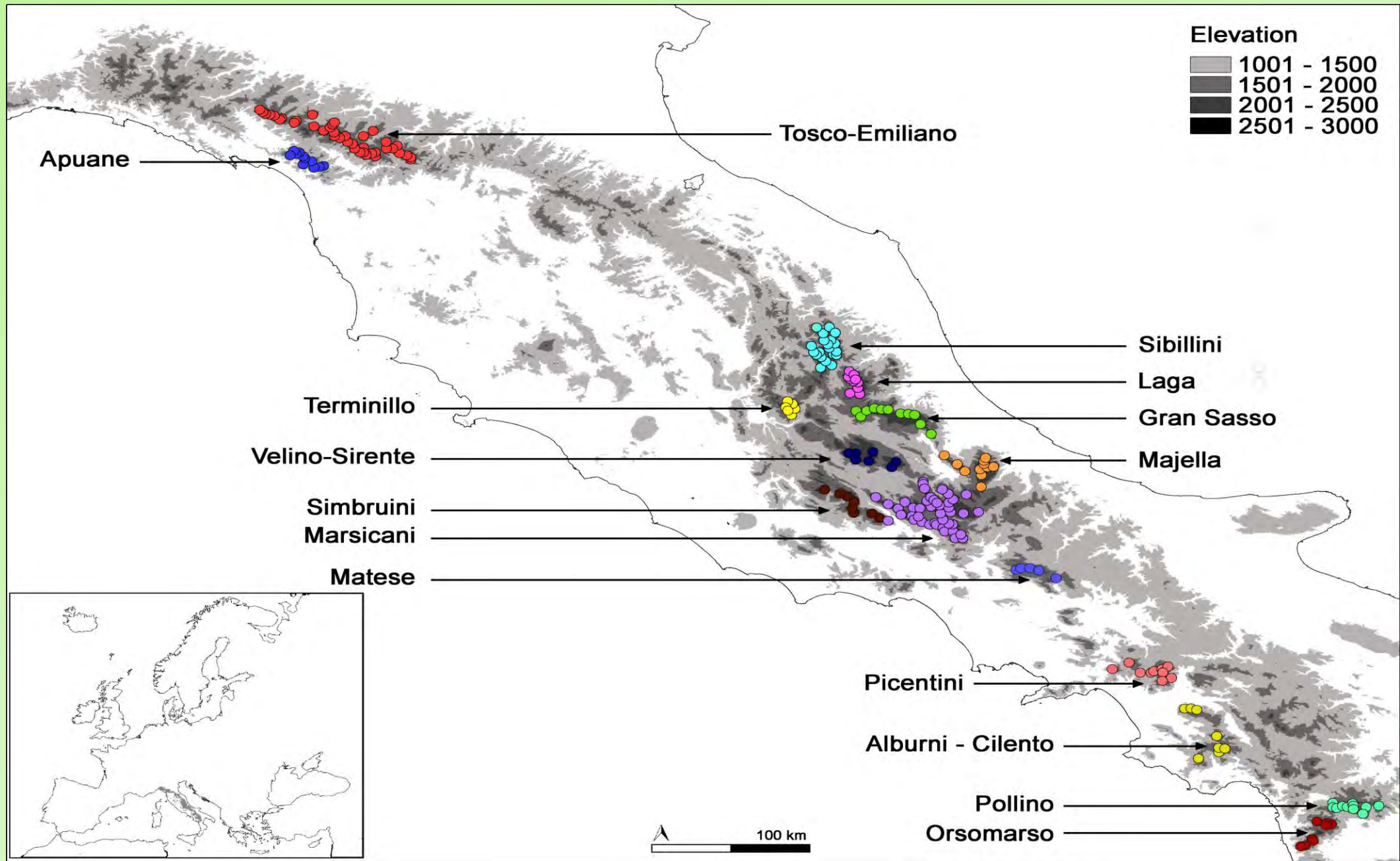
Fagus sylvatica in Italy



We tested the following hypotheses in Apennine mountains

- The treeline is higher in the cooler northern aspect compared to the warmer southern sides;
- Mountain groups surrounded by human population have more depressed treelines;
- Treeline elevation is more variable in mountain groups more subject to human pressure.

STUDY SITES



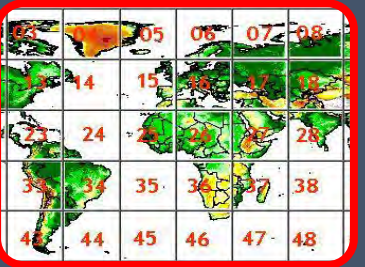
TREELINE IN APENNINES

- Apennines treeline: *European beech*
- Diffuse and abrupt treelines
- From 800 up to 2141 m a.s.l.
- 261 major and secondary peaks above 2,000 m a.s.l., with the highest point at the Gran Sasso 2,930 m a.s.l





1. TREELINE MAPPING ON GOOGLE EARTH PRO™
 (GOOGLE, INC. MOUNTAIN VIEW, CA, USA),



2. ANALYZED AND EXPLANATORY THE VARIABLES TO PREDICT TREELINE DISTRIBUTION ACROSS THE APENNINE.

	min.		max.	leng	sea_	sea_	ue.
	tl	av.tl	tl	ht	east	west	aN
1	0.11	0.29	0.40	0.27	-0.23	0.18	###
0.11	1	0.90	0.76	-0.14	-0.58	0.19	0.1
0.29	0.90	1	0.95	0.12	-0.70	0.26	0.1
0.40	0.76	0.95	1	0.12	-0.72	0.26	0.1
0.27	-0.14	0.12	0.90	1	-0.23	0.18	0.0
0.23	-0.58	###	-0.72	-0.23	1	-0.58	###
0.18	0.19	0.26	0.27	0.18	-0.58	1	0.3
0.08	0.19	0.15	0.14	0.05	-0.26	0.33	
0.18	0.65	0.76	0.78	0.17	-0.78	0.09	0.1
0.19	0.66	0.77	0.79	0.22	-0.86	0.33	0.1

3. STATISTICAL DATA ANALYSIS

1 Treeline mapping: geographic and topographic variables

- Treeline elevation
- Slope
- aspect
- Treeline length
- Distance from the sea
- Geographic coordinate
- Mountain peak



2 Climatic variables

ANNUAL TEMPERATURE

TEMPERATURE OF THE WARMEST QUARTER

TEMPERATURE OF COLDEST QUARTER

CUMULATED ANNUAL RAINFALL



Data were extracted from global climate database WorldClim 2.0 (<http://www.worldclim.org>; Hijmans & Jarvis, 2005)

2 Human impact

We used the population that inhabitant an area of 10 km of radii around each mountain peak in three dates:

- 1860
- 1921
- 2011

Source is population census



3 Statistical data analysis

Data Matrix

Pearson's
Index

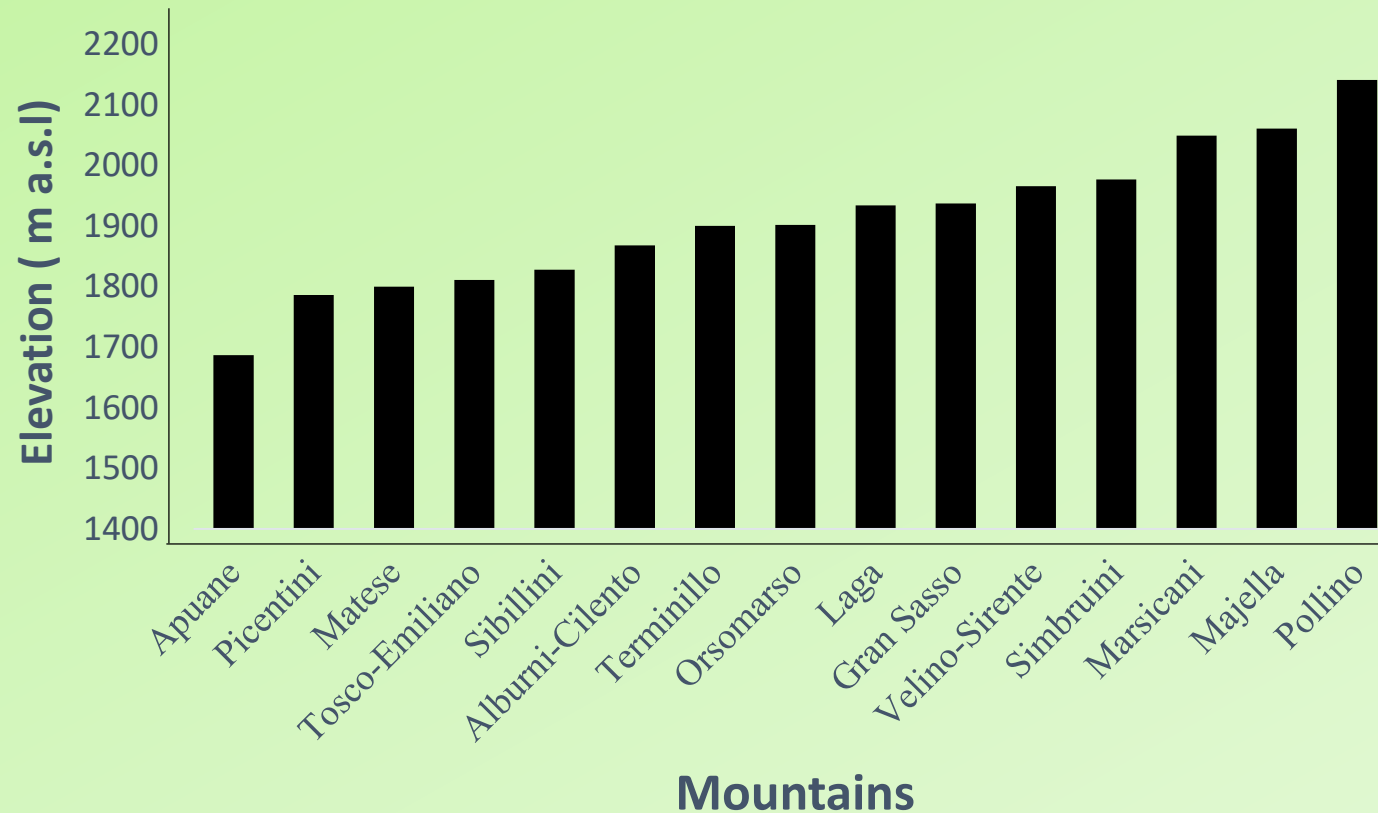
Δ analysis
North -
South) values

PCA

Dataset of treelines



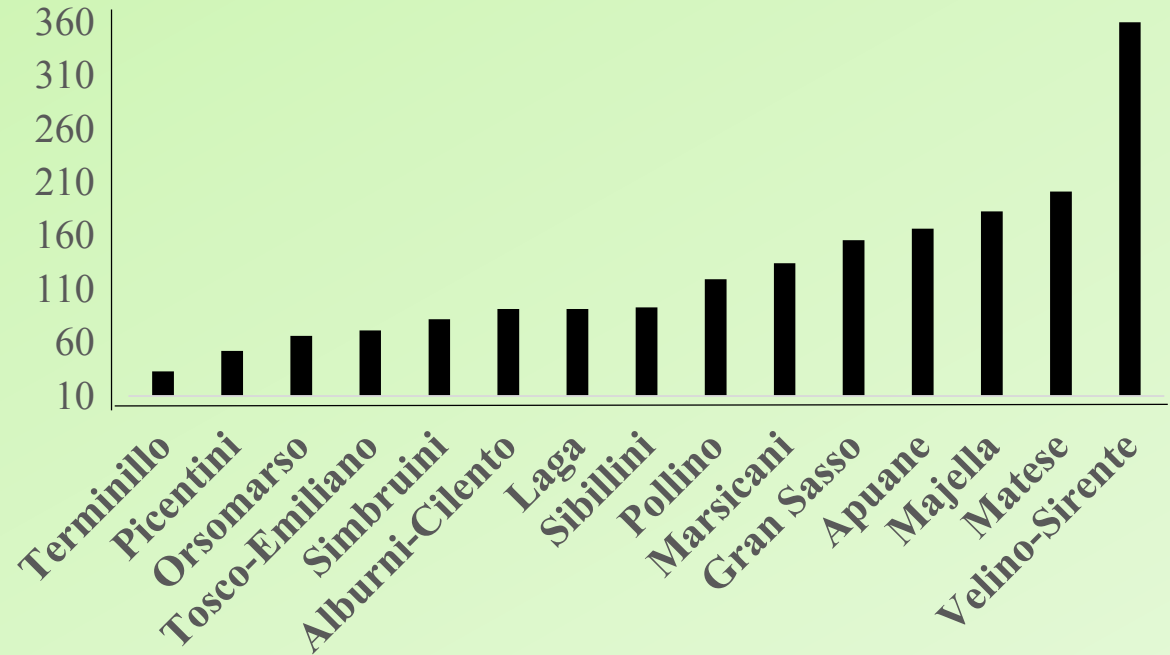
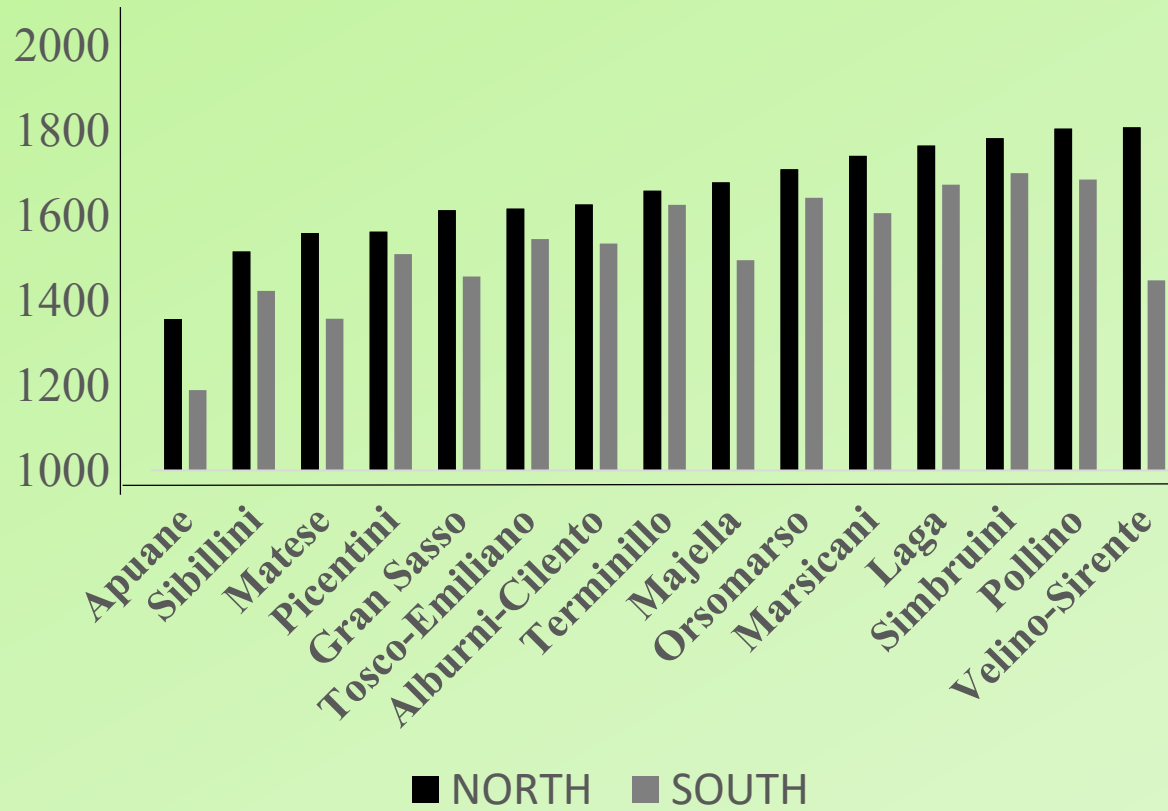
Maximum treeline elevation



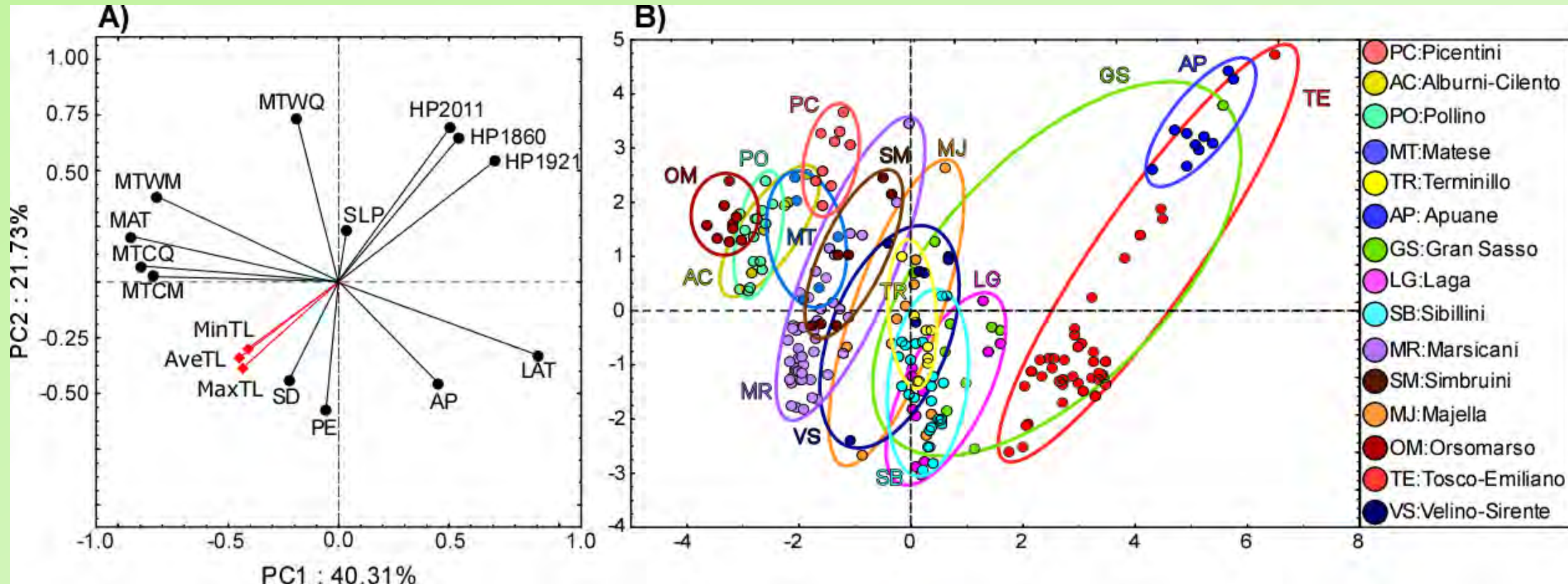
LOW
APUANE, 1687 m a.s.l

HIGH
POLLINO, 2141 m a.s.l

North Vs South



PCA of 15 Apennine mountain ranges



TREELINE DEPRESSED

North Italy

- high population density
- marble extraction

Central Italy

- *F. sylvatica* steep
- rocky slopes
- direct agriculture
- intensive grazing

South Italy

- peak elevation as a physical limiting factor for treeline elevation
- human impact
- precipitation



NORTH VS SOUTH

This counterintuitive pattern, considering the current theory proposed to explain treeline elevation (Körner, 2012), has been hypothesized to be the result of a combination between water shortage

South



North

NORTH ASPECT HIGH TREELINE



MAJELLA, 2081 m a.s.l



MARSICANI, 2050 m a.s.l

Including the highest site ever recorded for continental distribution of *F. sylvatica* at 2,141 m a.s.l. in Mont Serra del Prete (Pollino National Park)

Indicating that *F. sylvatica* climatic potential is much higher than previous thought.

CONCLUSION

Fagus sylvatica treeline across the Apennine is shaped by the multifaceted interactions among winter temperature, human disturbance, and summer precipitation, with their relative importance that depends by the considered mountain group and peak (Bonanomi et al. 2018).

THANKS FOR THE ATTENTION

THE HIGHEST EUROPEAN BEECH TREE LINE IN CONTINENTAL DISTRIBUTION

POLLINO NORTH FACE 2141 m a.s.l.



Photo Antonio Saracino