



MONTREUX – SWITZERLAND 6TH – 8TH MAY 2026  
8th International Congress on Mountain and Steep Slopes  
Viticulture

**Matteo Perrone** – Cinque Terre National Park

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**Functional Biodiversity in Heroic Terraced Viticulture**  
A Heritage-Based Conservation Approach Across Italian National Parks

# Terraced agro-ecosystems in 5 Italian National Parks



# Capraia Island- Arcipelago Toscano National Park

## Conoscere i vini Ansonica e Inzolia

—La Guida Vini di Quattroclici—



Quattroclici



Ansonica Costa dell'Argentario DOC  
Maremma Toscana DOC  
Val di Cornia DOC  
Elba DOC



6.000 ha



0,4 milioni hl

Vittoria DOC  
Santa Margherita di Belice DOC  
Monreale DOC  
Sambuca di Sicilia DOC  
Menfi DOC  
Erice DOC  
Contessa Entellina DOC  
Alcamo DOC  
Contea di Sclafani DOC



Ansonica-Inzolia

# Vesuvio National Park (Campania)



**LACRYMA CHRISTI**  
— La Guida Vini di Quattroclici —  
Lacryma Christi del Vesuvio DOC

QUATTROCALICI  
LACRYMA  
CHRISTI  
DEL VESUVIO DOC  
Quattroclici

QUATTROCALICI

bianco    rosato    rosso

12.000 hl

Coda di Volpe    Greco    Falanghina    Piediroso    Aglianico    Sciascinoso

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The infographic features a light pink background with a repeating pattern of wine glasses. It includes a bottle of wine, a map of Italy, three wine glasses, a green bottle, and five bunches of grapes. The text is in various fonts and colors, including red, black, and white.

# Majella National Park (abruzzo)



Voila Voile BEE



Vini biologici con certificazione per la biodiversità

# CULTURAL Biodiversity: TANGIBLE & UNTANGIBLE HERITAGES

The dry stone walls, farming techniques, traditional tools, wine making processes

## Cinque Terre

*Pergola bassa* (Low pergola)



Engineered to protect vines from fierce sea winds while reflecting ground heat upward to maximize the sugar content of the grapes.

**SCIACCHETRA'**

## Majella

*A conocchia* / Tendone



Paired with historic no-tillage practices, this preserves the natural grass cover and soil eco-mosaic in steep mountainous terrain.

## Pantelleria

*Alberello Pantesco* (UNESCO Heritage)



Vines are planted deep in a hollow to survive severe drought (<350mm annual rain) and punishing island winds.

**ZIBIBBO PASSITO**

# NATURAL Biodiversity: Related to agro-ecosystems



# COLTURAL Biodiversity

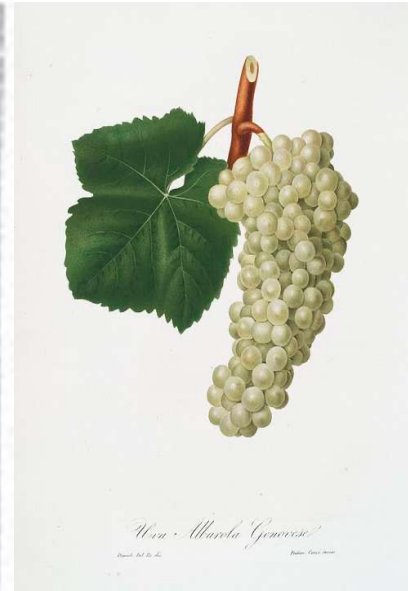
1827 – 22 grapes\vines  
varieties

1973 DOC – 3 varieties  
certified (Vermentino,  
Albarola, Bosco)

The park is exploring the  
area to identify carachterize  
and propagate old  
**UNKNOWN** historical  
genotypes



**GIORGIO GALLESIO**  
Finalborgo, 1772 – Firenze, 1839  
Botanic researcher



*Uva Albarola Genovese*  
*Uva Vermentino*

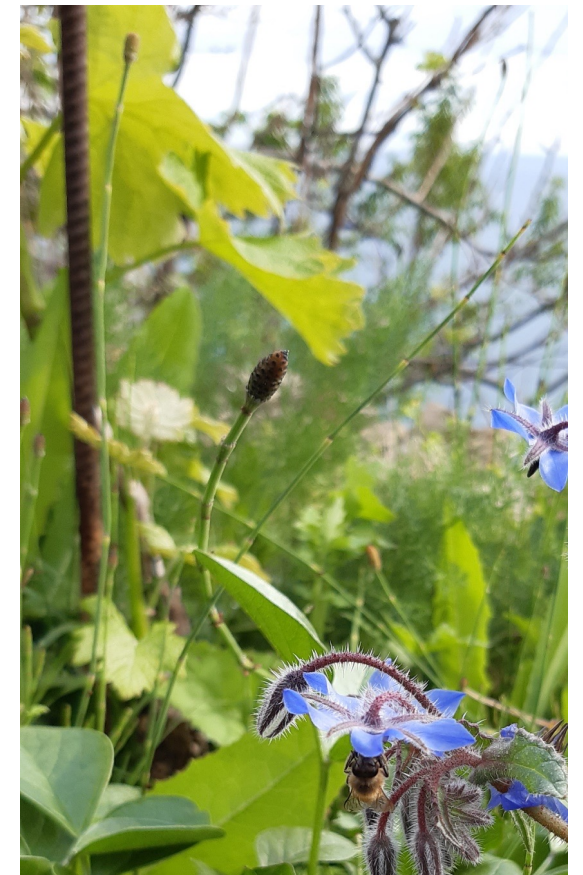
# FUNCTIONAL Biodiversity



Key biological components: The micro- and meso-fauna fundamental to ecosystem service delivery

First of all,

**POLLINATORS**



## MEDITERRANEAN TERRACES: THE ECOLOGICAL PRICE OF ABANDONMENT

Historically central to Mediterranean landscapes, terraced agro-ecosystems are vital for socio-economic and ecological stability. Current abandonment, driven by socio-economic shifts, has triggered severe environmental degradation, heightening risks of landslides, flooding, and biodiversity loss.

1968



2000



2025



# Critical points



Rising costs and lack of skilled workers threaten the economic viability of terraced viticulture.



Lack of knowledge about soil functionality in terraced ecosystems.



Inappropriate soil management can alter ecosystem services, nutrient cycles, pH and water availability, ultimately affecting productivity

## The aim

Terraces are not just scenic landscape; they are providers of key ecosystem services. Nature-based, heritage-informed management is essential to sustain **local economies** and build resilience to climate change.

## In agricultural context

Ecological factors and dynamics in terraced coastal mediterranean environments are extremely conditioned by antropic factors (terraced cultivations), climate and morphology

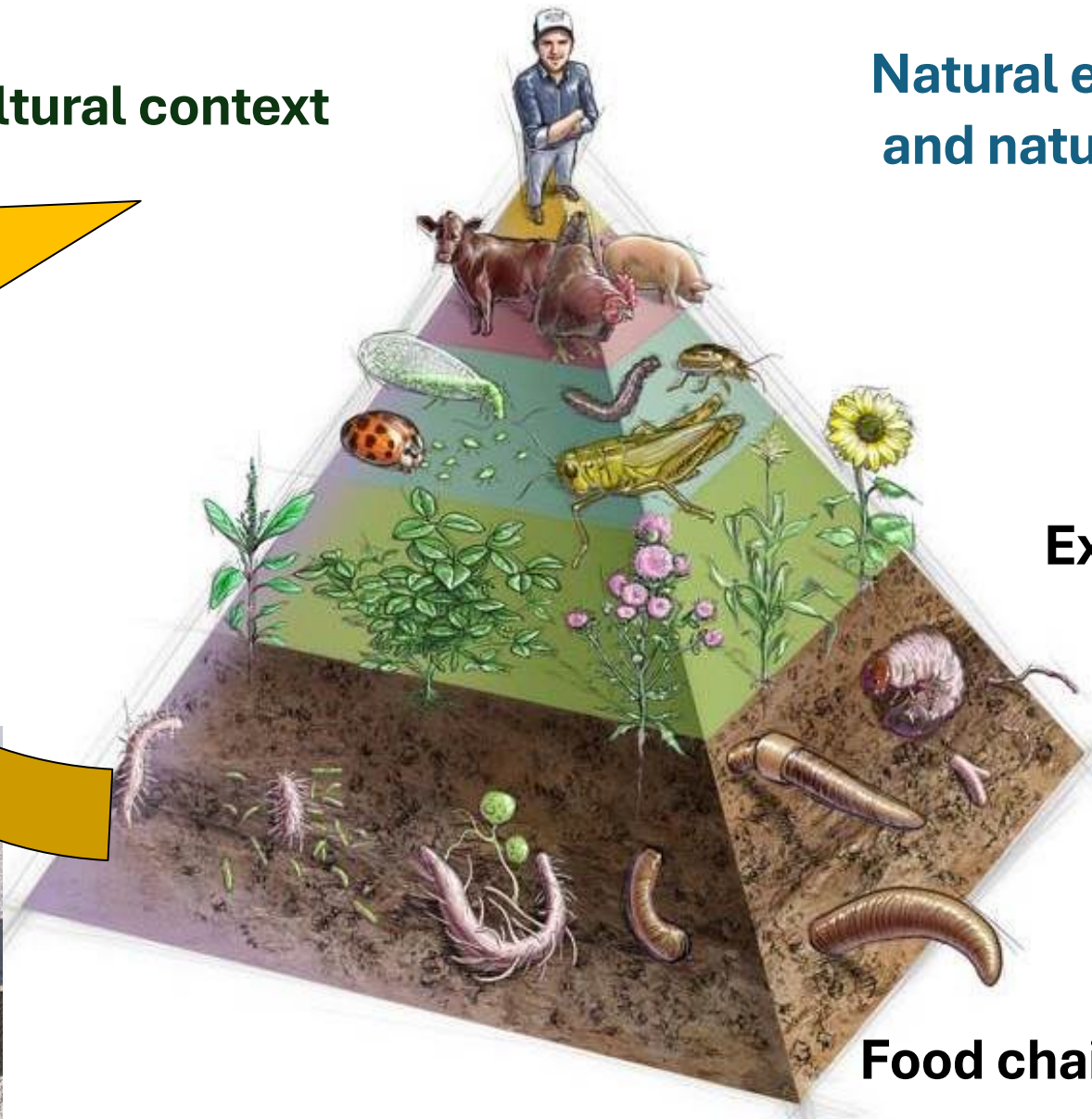


**FAST !!**

## Natural environments and natural dynamics



**Extremely SLOW**



**Food chain & Energy flows**



**EXTREME SLOPES**  
Up to 70-80%  
Terraced vineyards overlooking the sea

**EXTREME EXPOSURE**  
High solar radiation  
Salty winds  
Salt spray

**LIMITED WATER**  
Low rainfall  
No irrigation  
High water stress

**POOR AND SHALLOW SOILS**  
Very thin soils  
Exposed rocky substrate  
Low fertility  
Low water retention capacity

**EXTREME LABOR**  
Cultivation and harvesting entirely manual  
Difficult accessibility  
High maintenance costs

**HOSTILE ENVIRONMENT**  
Strong winds  
Temperature fluctuations  
Risk of erosion and landslides

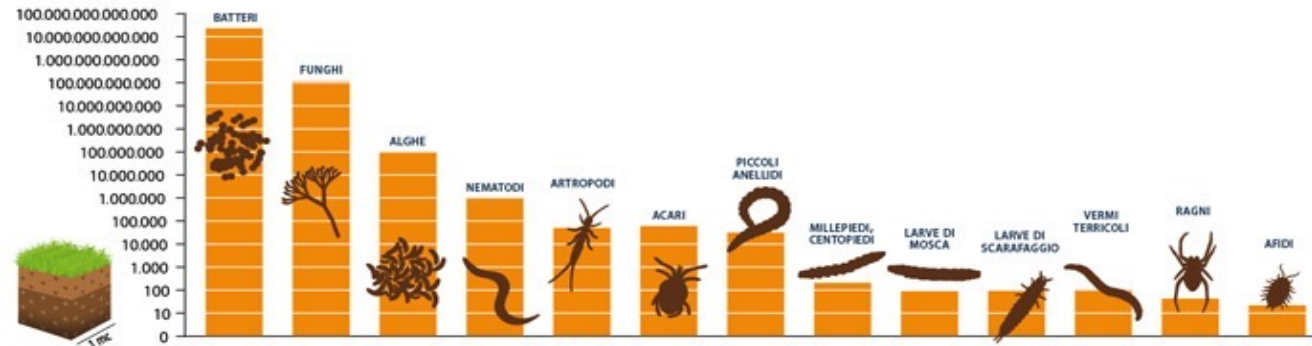
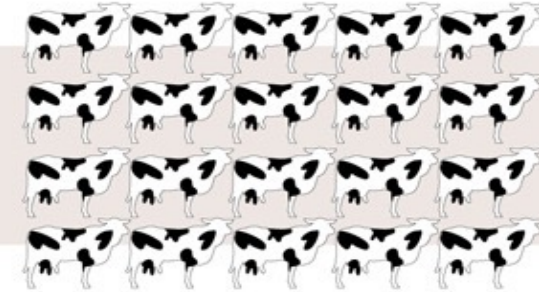


# Soil living component



un ettaro di terreno contiene

15 tonnellate di organismi viventi, equivalenti al peso di 20 vacche

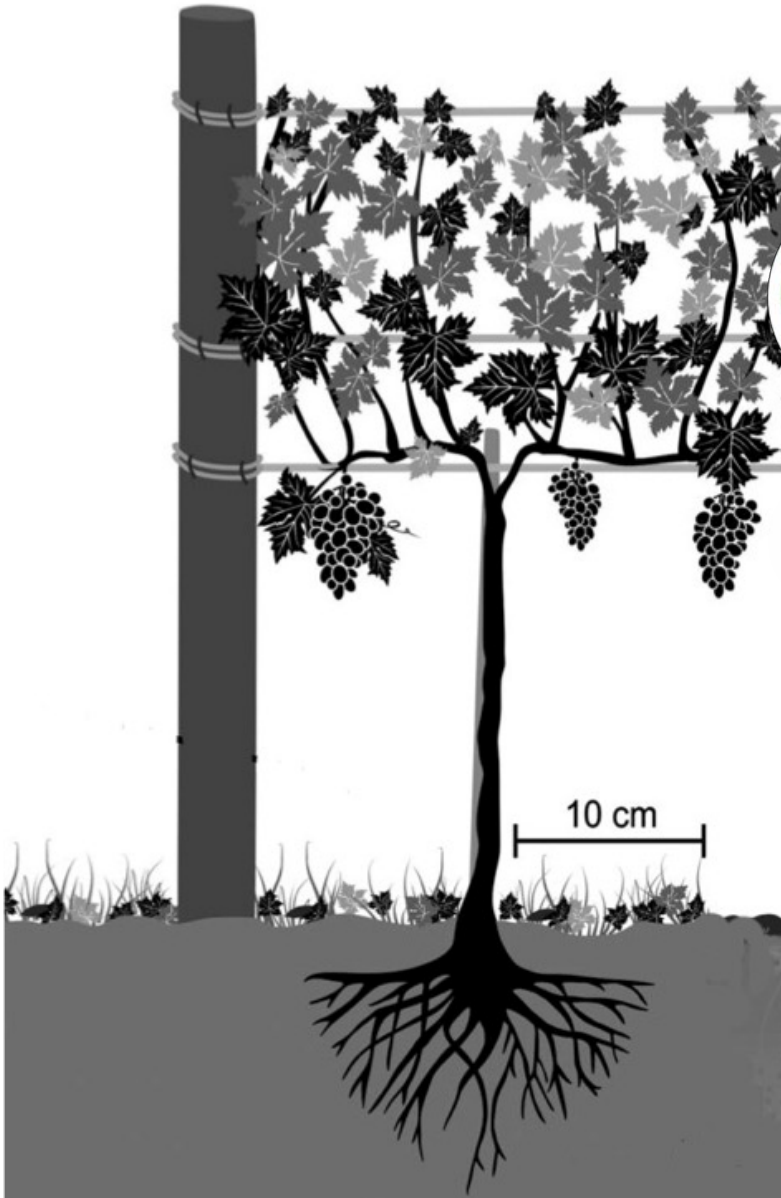


Numero di microrganismi viventi in 1 mc di terreno fertile in clima temperato (scala logaritmica).

Fonte: Soil Atlas 2015

**In a cubic cm of forest soil we can have up to 1 milion of root tips and up to another milion of micro organism from bacteria to arthropods**

# Soil-plant *continuum*



## SOIL BIODIVERSITY DRIVES MANY ABOVEGROUND PROCESSES

Equilibrium in soil ecosystem favors physiological conditions of the plants and their ability to respond to attacks of phytophagous or parasitic organisms (Gagic et al., 2015).

# SOIL above all



# The 5-RESTE Project: A Multidisciplinary Mission

Integrating biodiversity conservation with sustainable agricultural practices to protect terraced landscapes



Expanding conservation strategies for biodiversity and soil stability in vulnerable areas.



Strengthening the link between production and the environment, reducing agrochemical use.



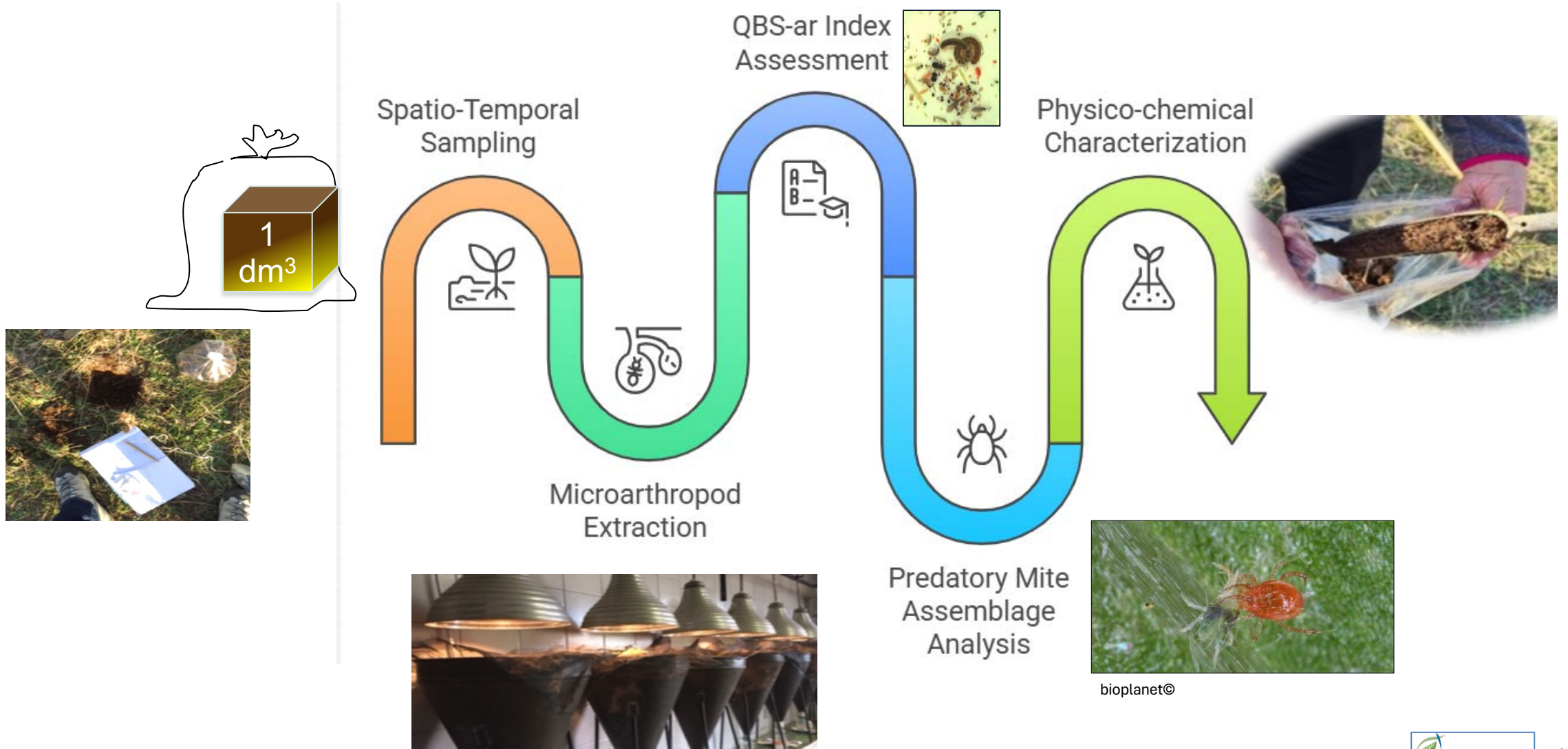
Uniting researchers, local administrators, "guardian" farmers, and environmentalists.



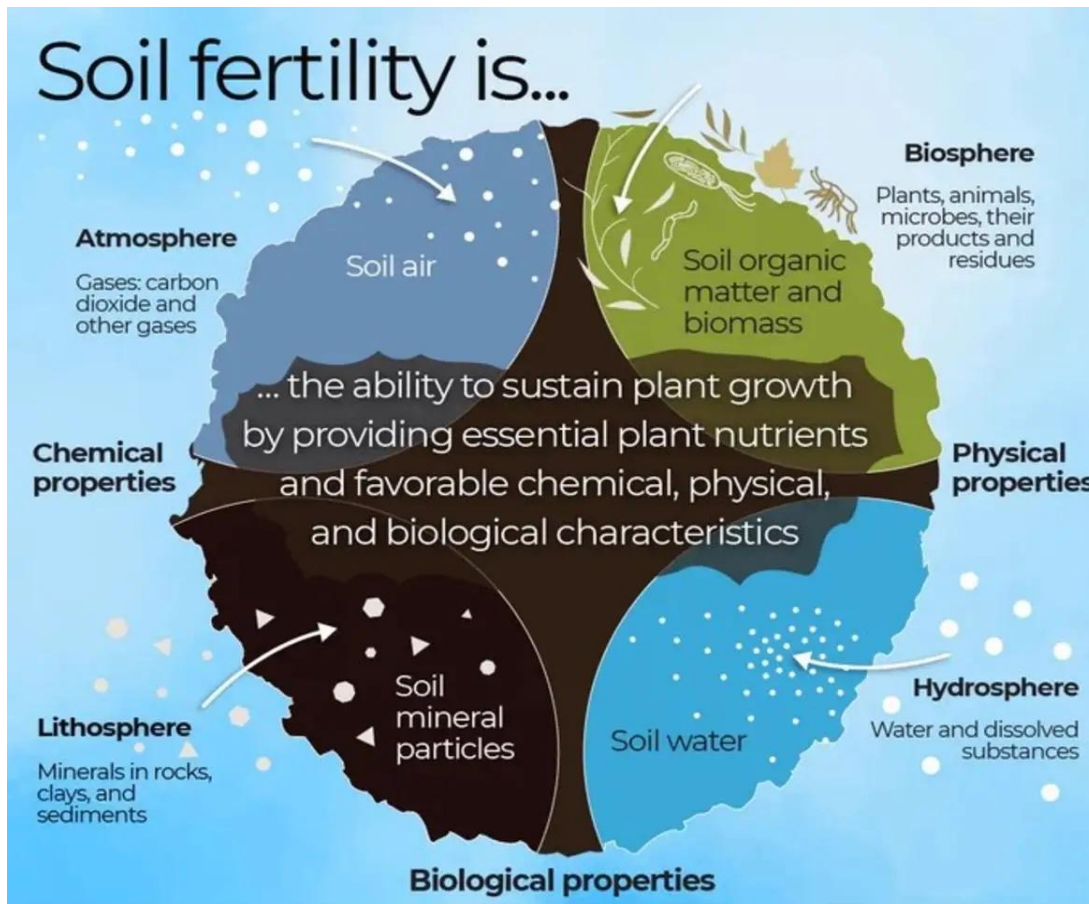
Aligning local realities with European and international conservation targets.

# Methodological framework

## Investigating traditional practices and soil quality



# Physical and Chemical soil properties



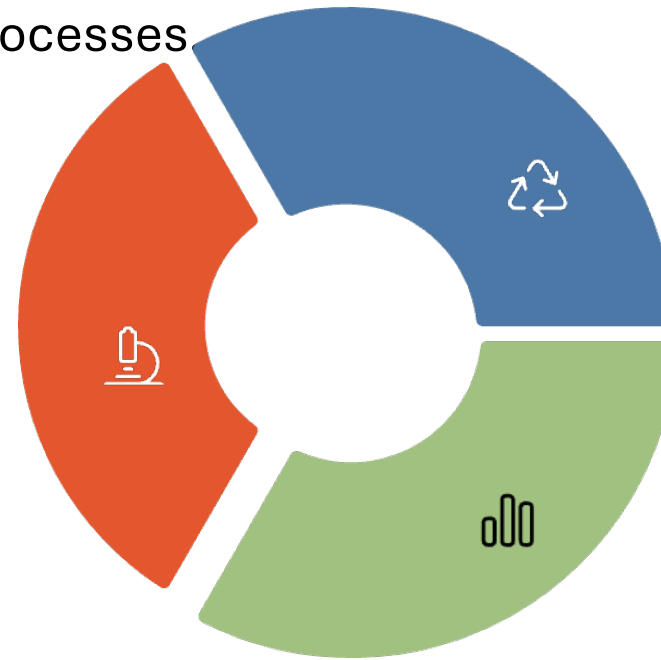
Parameter	Vesuvio	Capraia	Cinque Terre
Organic Matter (OM)	Moderate (>50 g/kg)	High (>70 g/kg)	Variable (53–72 g/kg)
pH Level	Neutral to Sub-acid	Sub-acid (5.8–6.4)	Sub-acid
TOC (%)	Moderate	Strong correlation with terraces	High in no tillage
Texture Class	Sandy (>80%; Andosol)	Sandy Loam (SL)	Silty–Clay–Loam

# Microarthropods as Bioindicators of soil functionality



## Drivers

Climate, Land use change, geographic position and other factors can affect soil processes



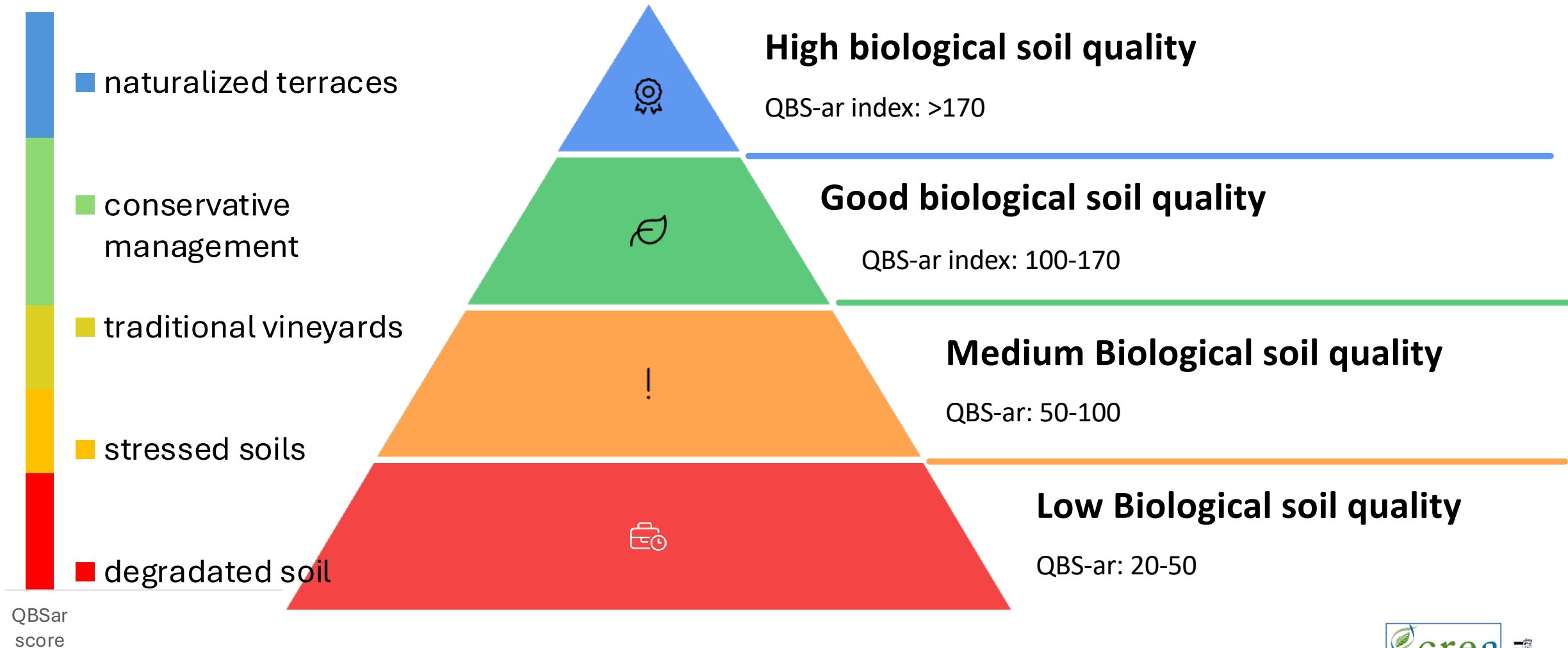
## Ecosystems functions

Arthropods contribute to the breakdown of organic matter and nutrient cycling

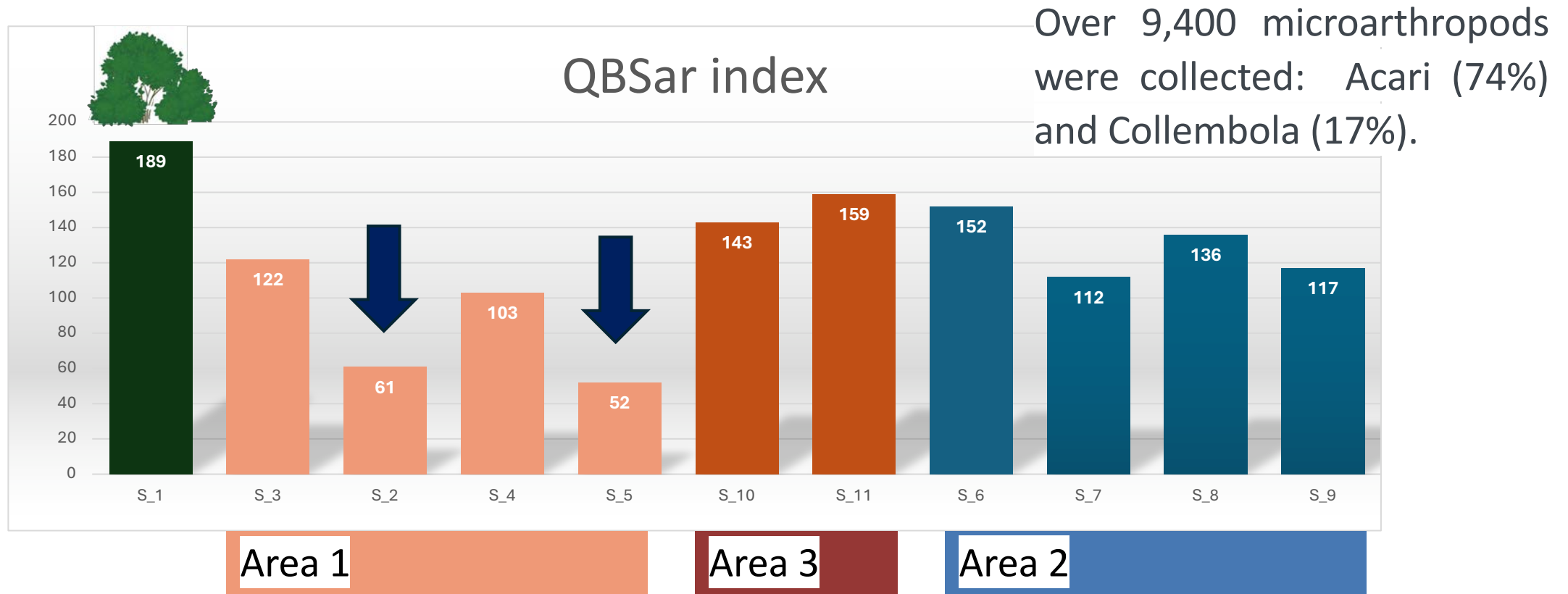
## Bio-indicators

Alterations in the community reveal changes in soil quality

# QBS-ar index to evaluate soil quality



# Restoring terraced vineyards

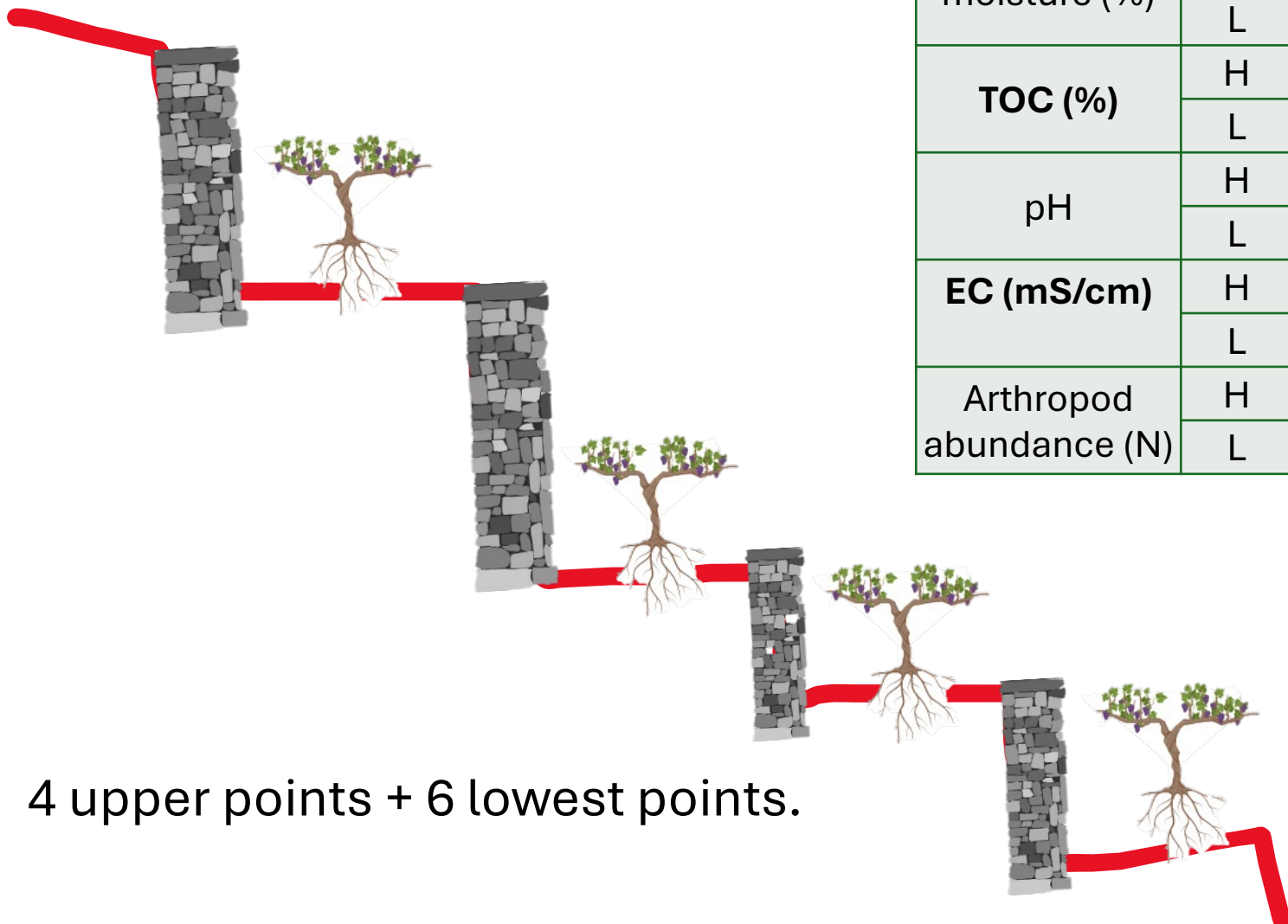


The planting of vineyards induce soil structural changes, which directly affect ecosystem services and biodiversity for a potentially long time but here after 5-8 years biological soil quality registered quite high values.



# Can altitude affect vineyard soil ?

Highest terrace (H)



4 upper points + 6 lowest points.

Lowest terrace (L)

	LT	N	Mean	SE	effect ALT
moisture (%)	H	8	5.68	0.11	P=0.053
	L	12	6.02	0.139	
TOC (%)	H	8	161.63	22.84	p<0,01
	L	12	329	40,99	
pH	H	8	1.46	0,24	P=0,096
	L	12	2.28	0.28	
EC (mS/cm)	H	8	0.84	0.08	p<0.01
	L	12	1.44	0.169	
Arthropod abundance (N)	H	12	278.83	46.64	P=0.618
	L	18	247,33	56.34	

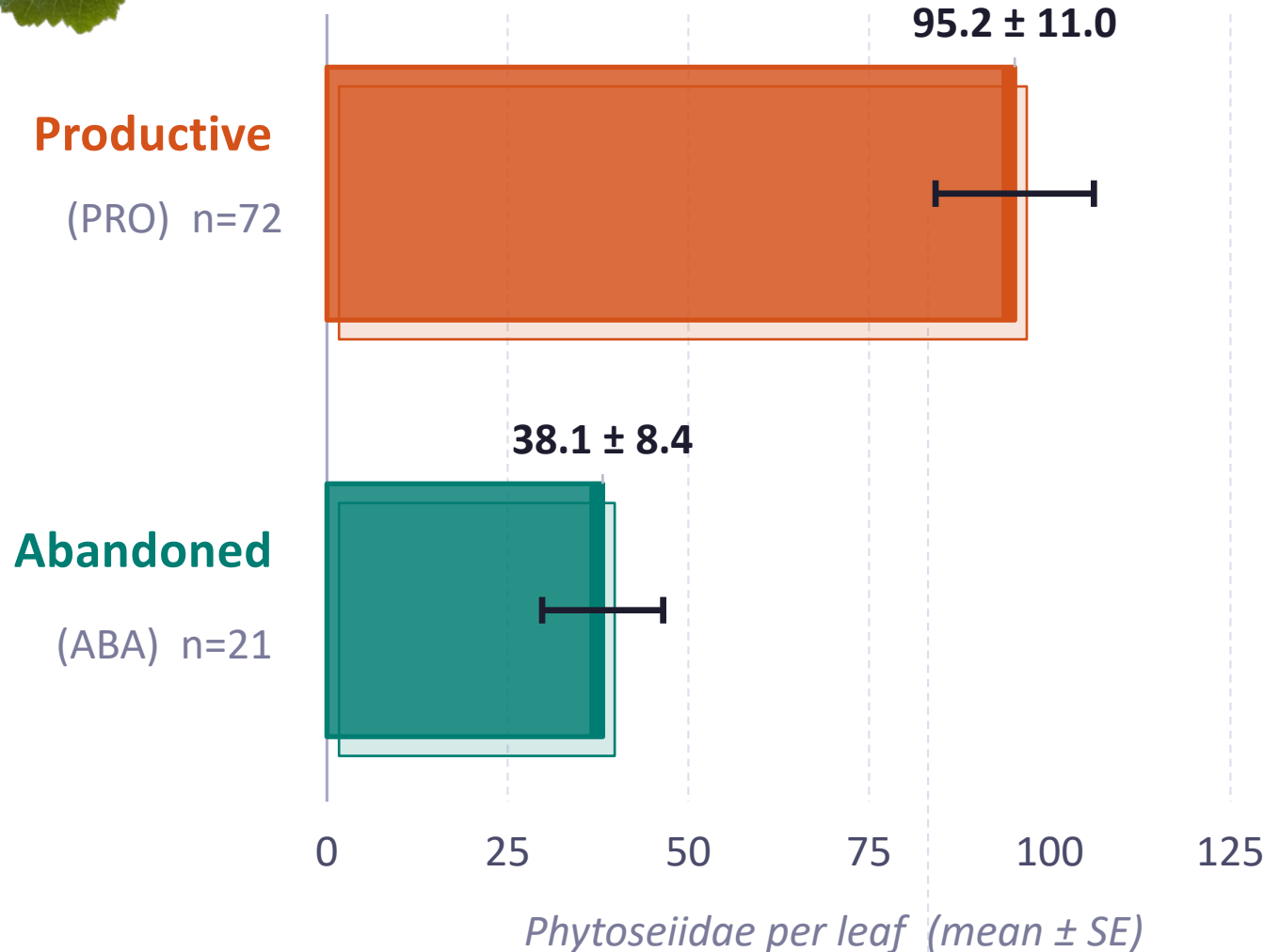
(One-way ANOVA)



# Productive vs Abandoned Vineyards



## *Phytoseiidae* density



### ACTIVE MANAGEMENT

**2.5× higher** phytoseiid density  
— stronger top-down biological control under active management.

### BIODIVERSITY RESERVOIR

**Rare species** found almost exclusively in abandoned vineyards — landscape-level biodiversity reservoirs.

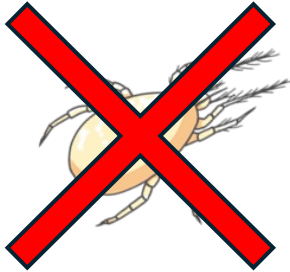
Statistically significant:  $p < 0.001$  | Error bars = SE | 93 observations · 6 samplings

# Discussion



## Grass cover

- Highest predator mites density among all sites (Natural pest control)



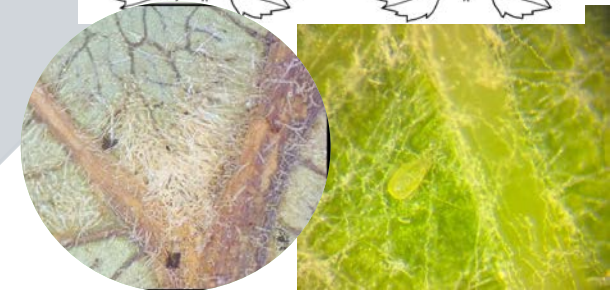
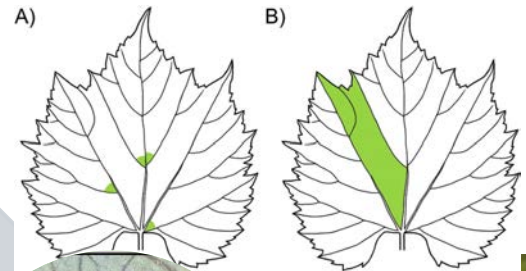
## bare soil + herbicide

- harms canopy predator communities lowest predator densities !



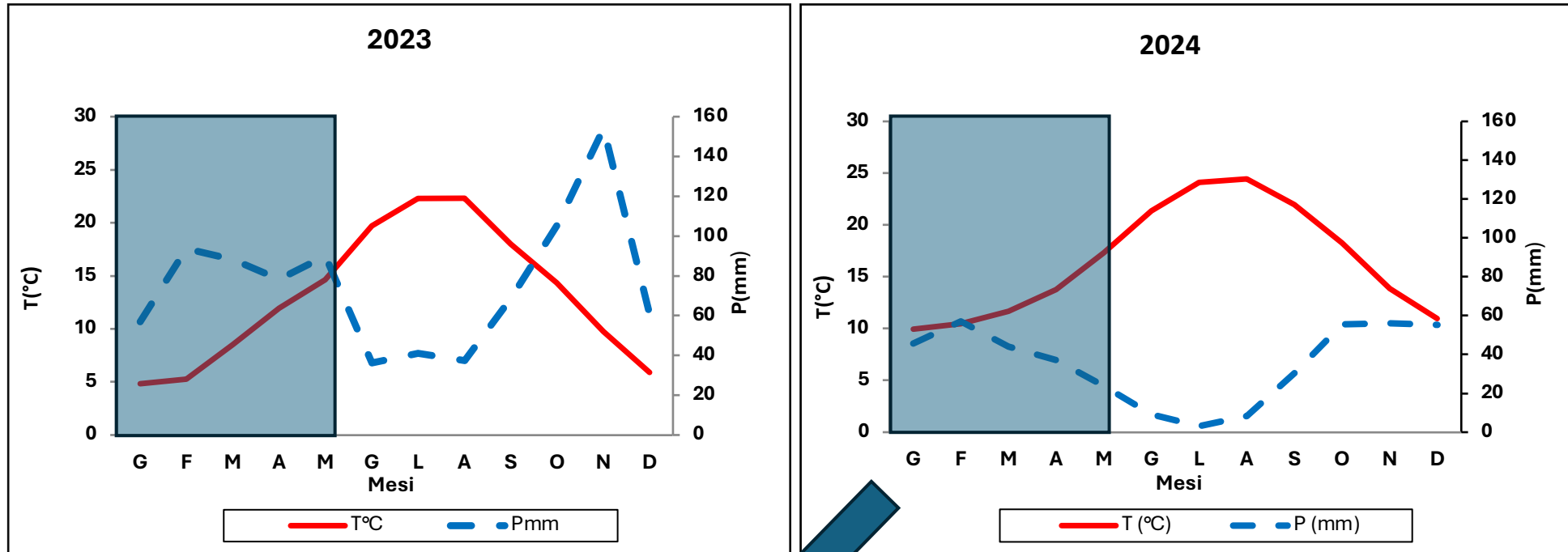
## Cultivar Effect

- High-trichome leaf vs under-surface glabrous offered different niches for predator mites



# Climate effect on Vineyards

Climate: Bagnouls-Gaussen



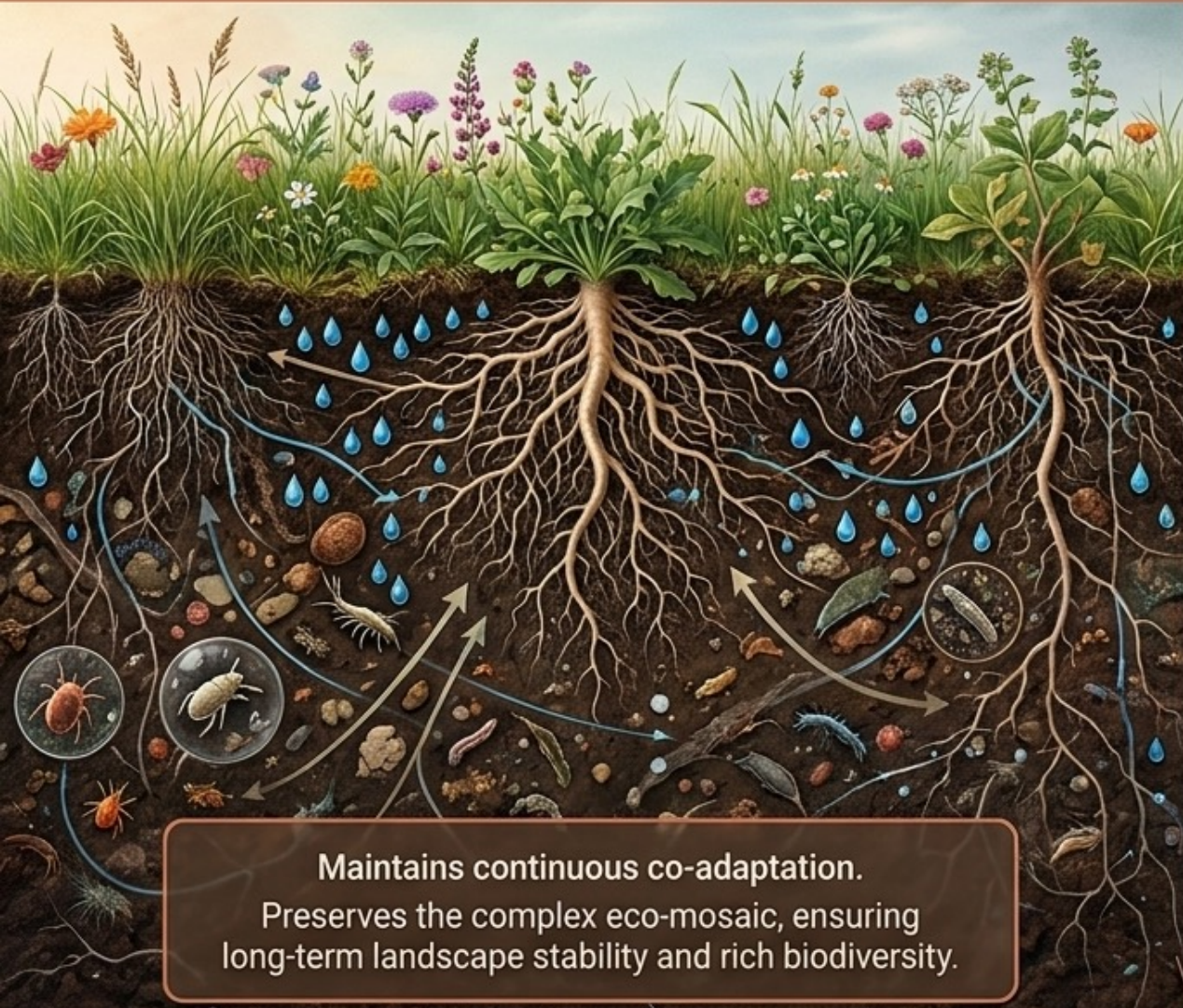
Winter-spring period 2024:  
- Air Temperature doubled  
- Precipitation almost halved

Severe drought led to:

- Decline of microarthropods (30%)
- Presence of phytophagous nematods
- Decrease of grape production

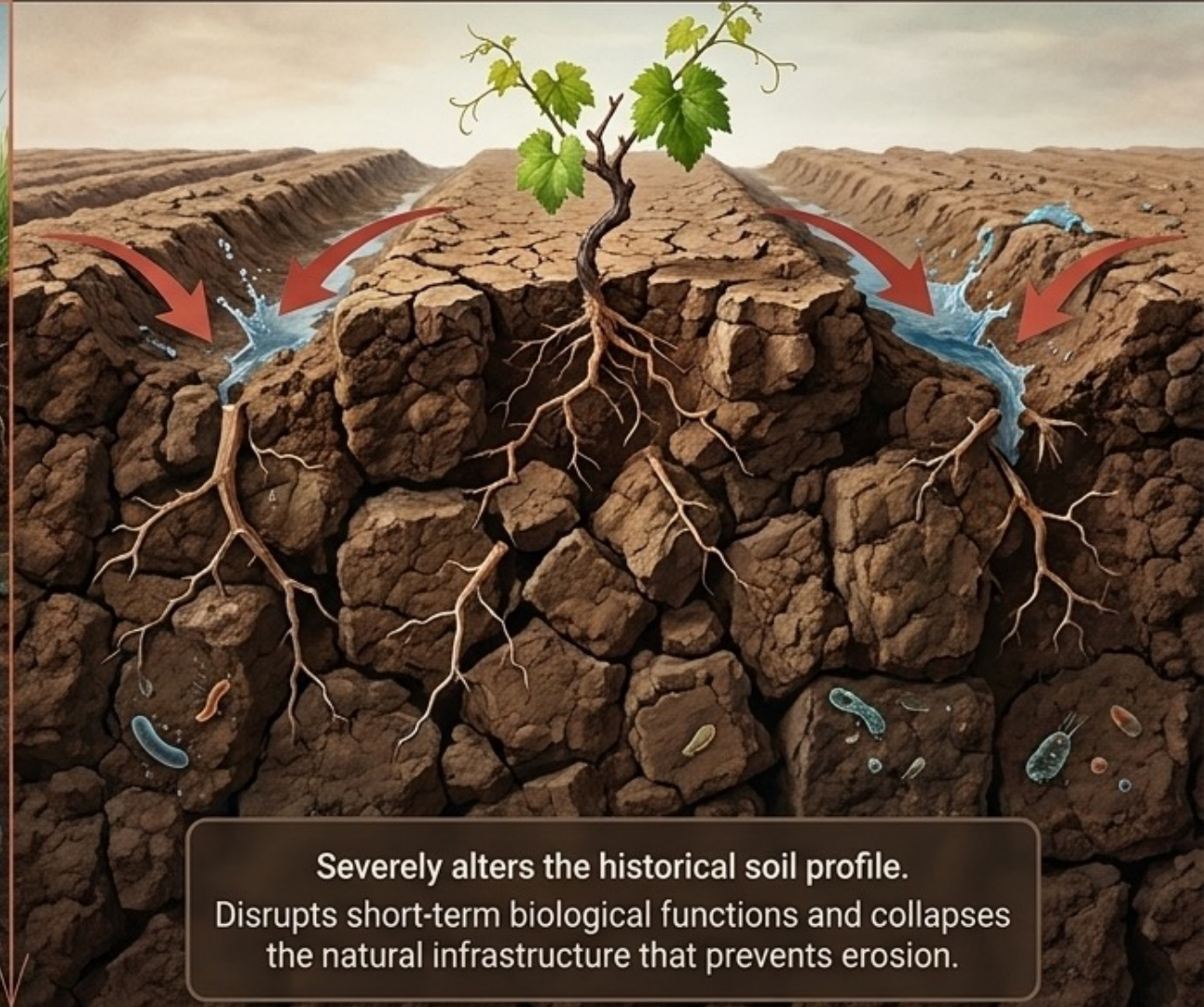
# The Subterranean Impact of Management Models

## Conservative Inter-row Management



**Maintains continuous co-adaptation.**  
Preserves the complex eco-mosaic, ensuring long-term landscape stability and rich biodiversity.

## Deep Tillage / Modern Vineyard Prep



**Severely alters the historical soil profile.**  
Disrupts short-term biological functions and collapses the natural infrastructure that prevents erosion.

# Crucial Ecosystem Services



## Erosion Control

Dry-stone walls and root systems of native cultivars maintain slope stability and prevent catastrophic runoff.



## Biological Control

Functional biodiversity supports predatory mite communities (e.g., Phytoseiidae), reducing chemical dependency.



## C-Sequestration

Organic matter (SOM) accumulation through conservative floor management aids in climate mitigation.

# Resilience through tradition

Traditional agronomic practices—**Cultural Biodiversity**—directly bolster soil resilience against environmental perturbations.

- **Dry-stone Wall Maintenance:** Regulates water drainage and thermal cycles.
- **Permanent Ground Cover:** Buffers hydric stress and supports euedaphic fauna.
- **Indigenous Varieties:** Adapted to local edaphic constraints and climatic variability.



# Cultural Biodiversity for Future Resilience



Traditional agricultural practices are not just history; they are a vital form of “cultural biodiversity.”

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These heroic agroecosystems actively mitigate soil degradation and provide critical ecosystem services that modern agriculture cannot replicate.

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Preserving the “guardian” landscapes of Italy perfectly aligns with the ambitious environmental targets set forth in the modern EU Nature Restoration Law.



# Thank you for your attention!



**Difesa e Certificazione** (CREA- DC -Firenze)  
**Agricoltura e Ambiente** (CREA-AA di Firenze e Roma)



**Parco Nazionale delle Cinque Terre,**  
Riomaggiore, La Spezia



**Parco Nazionale dell'Arcipelago Toscano,**  
Portoferraio, Livorno



**Parco Nazionale dell'Isola di Pantelleria,**  
Pantelleria, Trapani



**Parco Nazionale della Maiella,**  
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MINISTERO DELL'AMBIENTE  
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