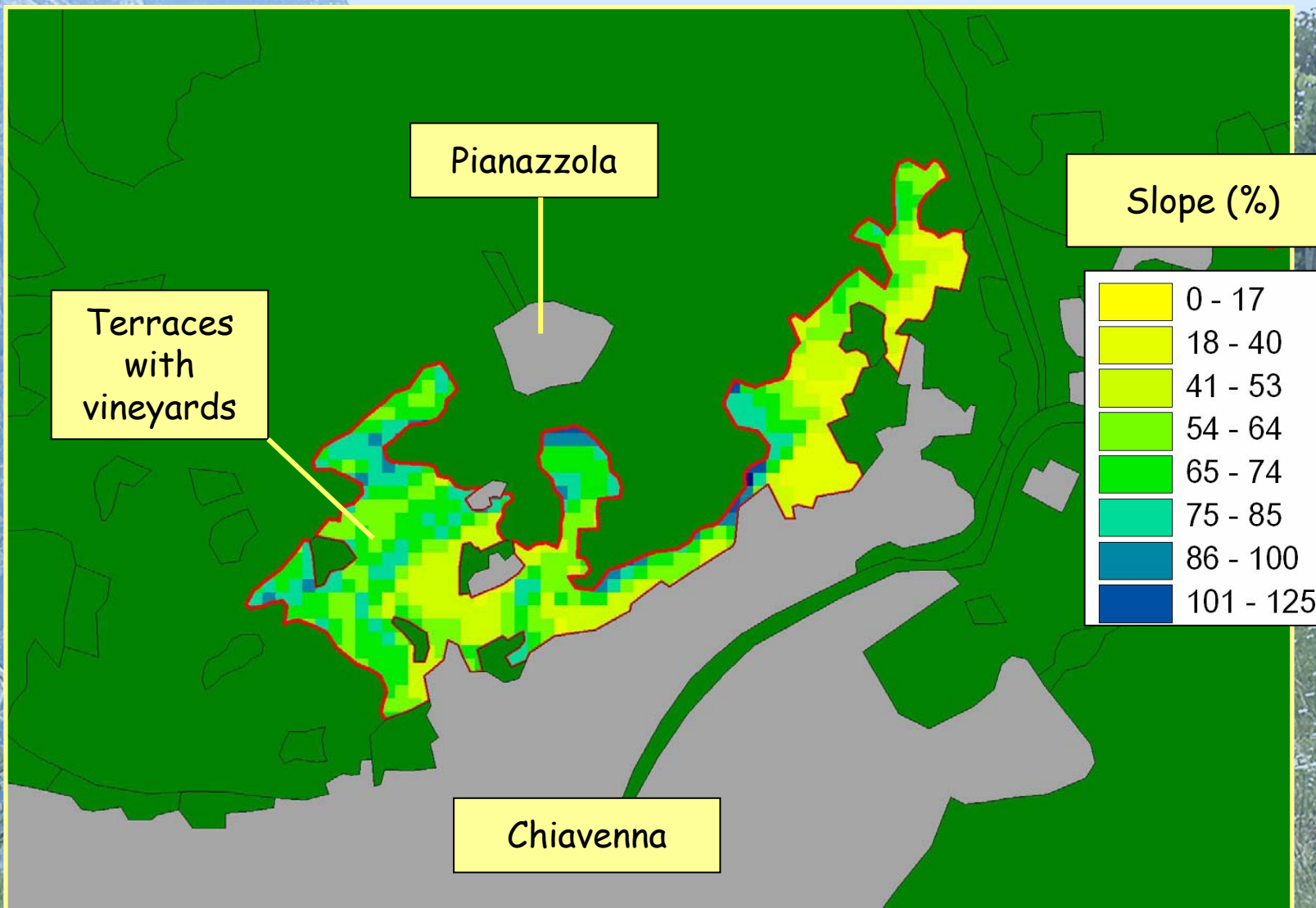
A scenic view of a mountain valley. In the foreground, there is a wooden fence and a field of tall green grass with some purple flowers. The middle ground shows a valley with terraced fields and a wooden fence. The background features a range of mountains with some rocky peaks and dense green forests. The sky is clear and blue.

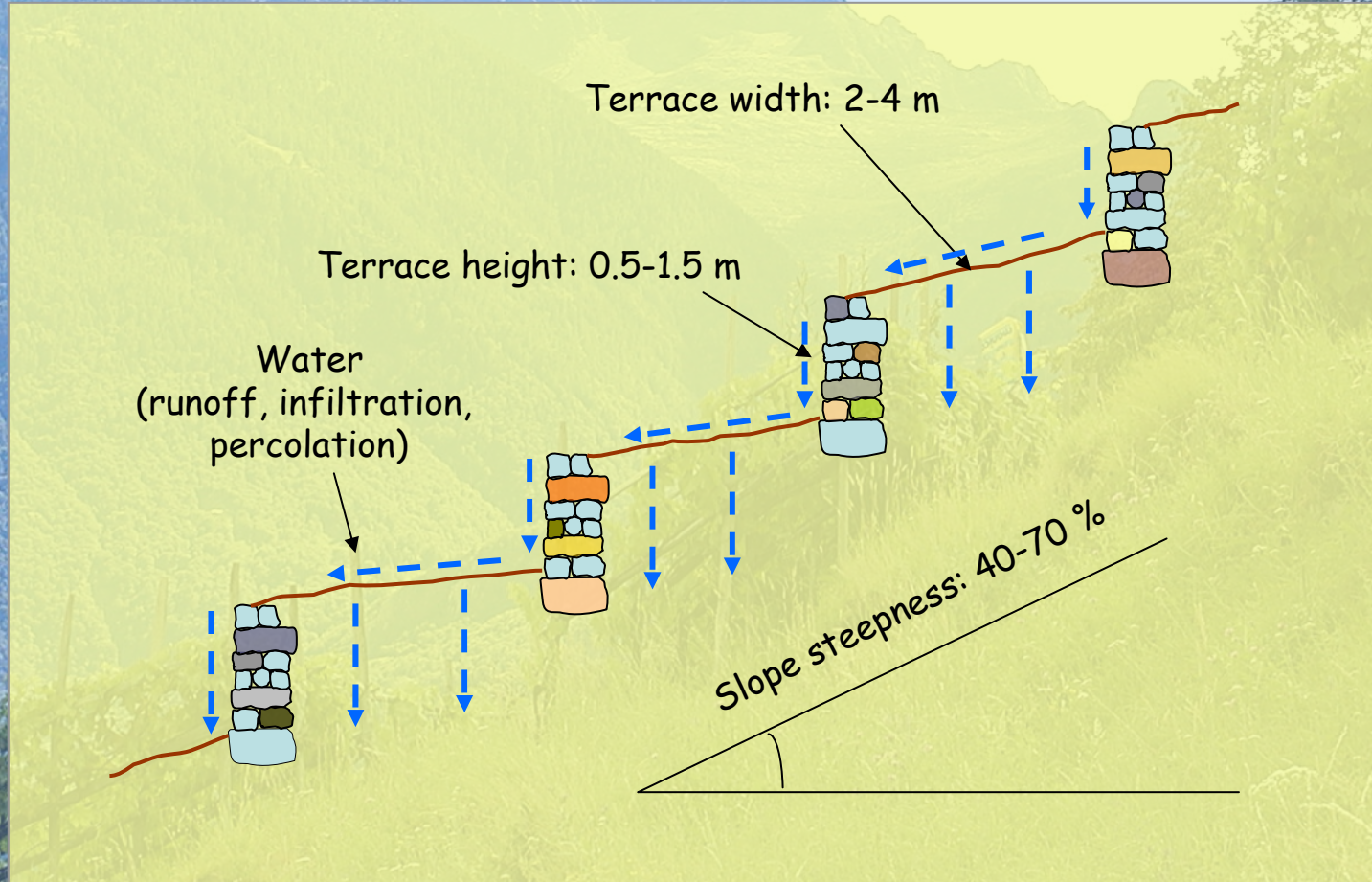
Soils and man-made terraces  
in Sondrio Region:  
pilot area of Pianazzola

*Roberto Comolli*  
*Department of Environmental and Land Sciences*  
*Milano Bicocca University*

# The study area



# Man-made terraces



## Natural Soils



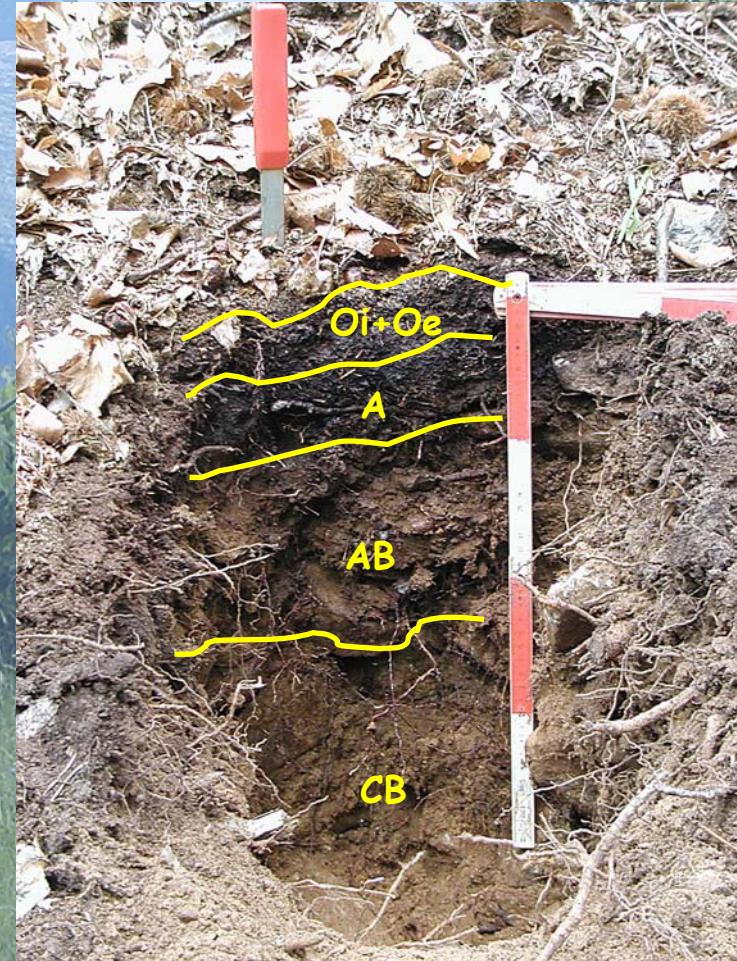
800 m a.s.l.  
Castanetum

*Castanea sativa*, *Pinus sylvestris*, *Pteridium aquilinum*

**Skeletal Umbrisol**  
(WRB 1998)

A, AB = pH 4.0 (H<sub>2</sub>O)

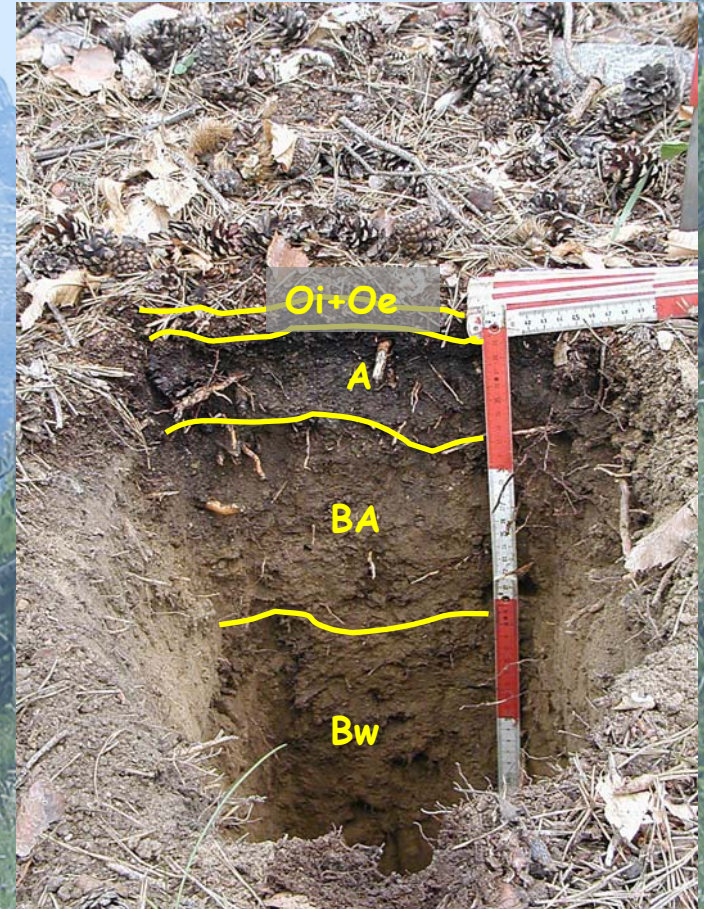
CB = pH 4.5 (H<sub>2</sub>O)



## Old Anthropogenic Soils → Semi-natural Soils



680 m a.s.l.  
terraces with chestnut woods  
*Castanea sativa*, *Pinus sylvestris*, *Luzula nivea*, *Vaccinium myrtillus*



**Cambic Umbrisol (WRB 1998)**

Ap = pH 4.1 (H<sub>2</sub>O)

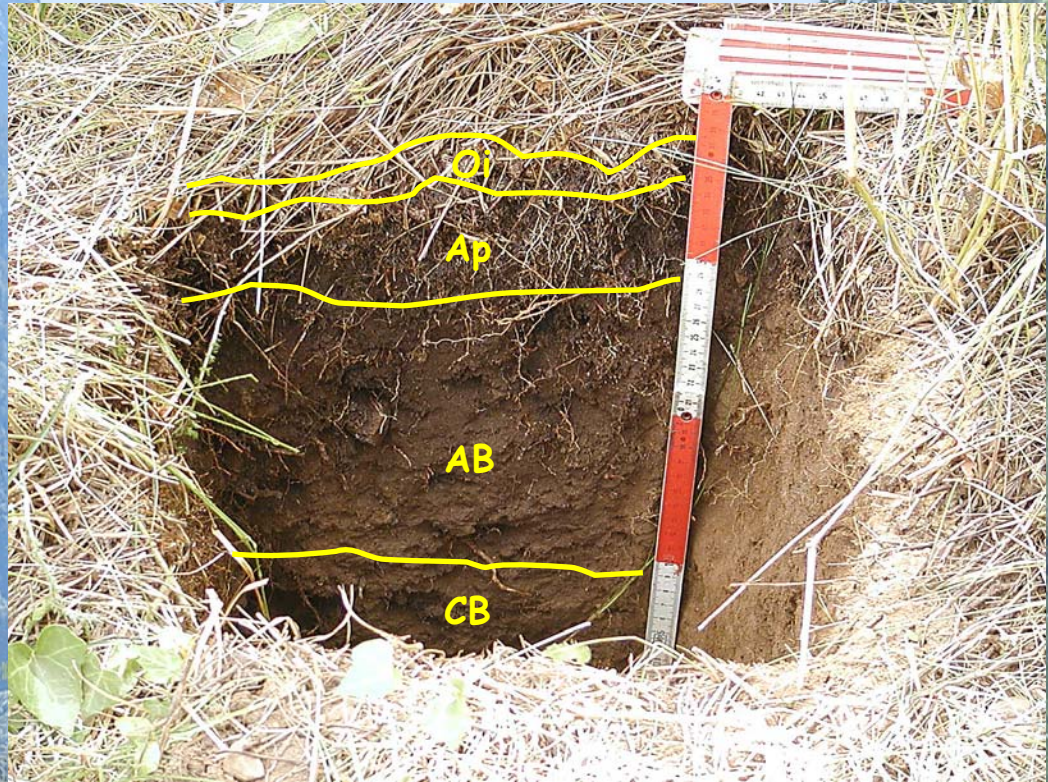
BA = pH 4.5 (H<sub>2</sub>O)

Bw = pH 4.6 (H<sub>2</sub>O)

## Old Anthropogenic Soils → Semi-natural Soils



550 m a.s.l.  
terraces with vineyards



**Haplic Umbrisol (WRB 1998)**  
Ap = pH 5.6 (H<sub>2</sub>O)  
AB = pH 5.6 (H<sub>2</sub>O)

# Soil Distribution with Altitude

natural vegetation

Epileptic Podzols (albic/spodic)  
and Entic Podzols (spodic)

1100-1200 m a.s.l.

natural vegetation

Skeleti-Humic Umbrisols (umbric)

700-750 m a.s.l.

terraces with chestnut woods

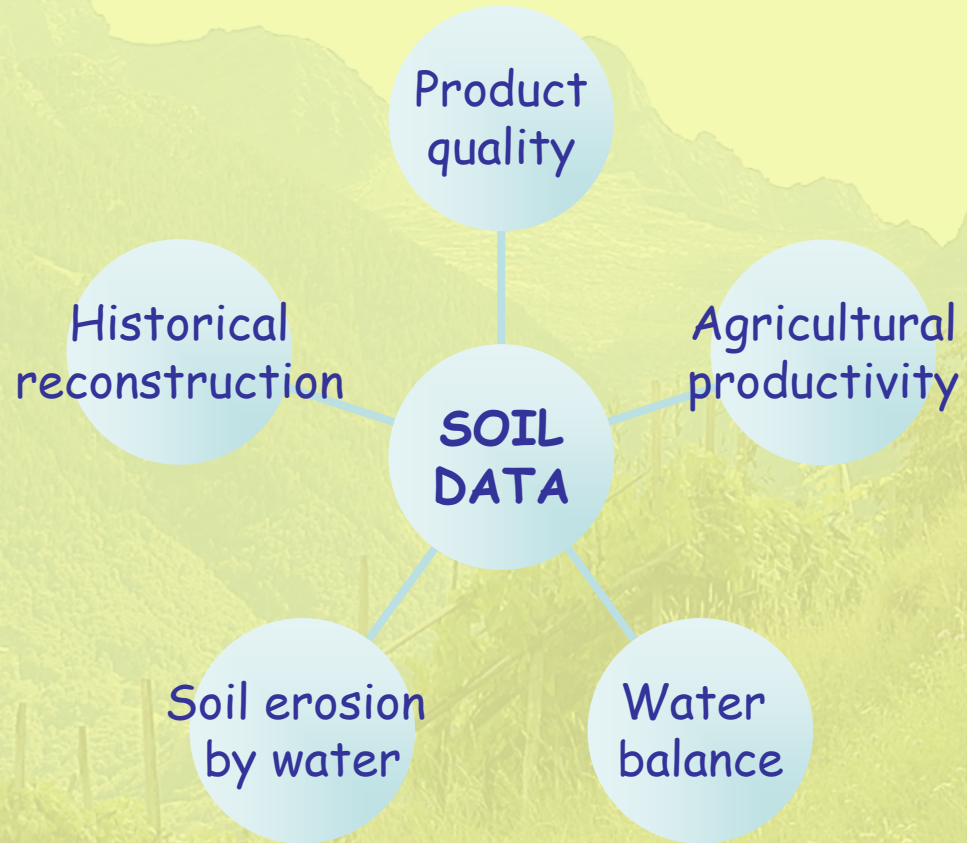
Cambic Umbrisols (umbric/cambic)

650-700 m a.s.l.

terraces with vineyards

Umbrisols (umbric)  
and Cambisols (ochric/cambic)

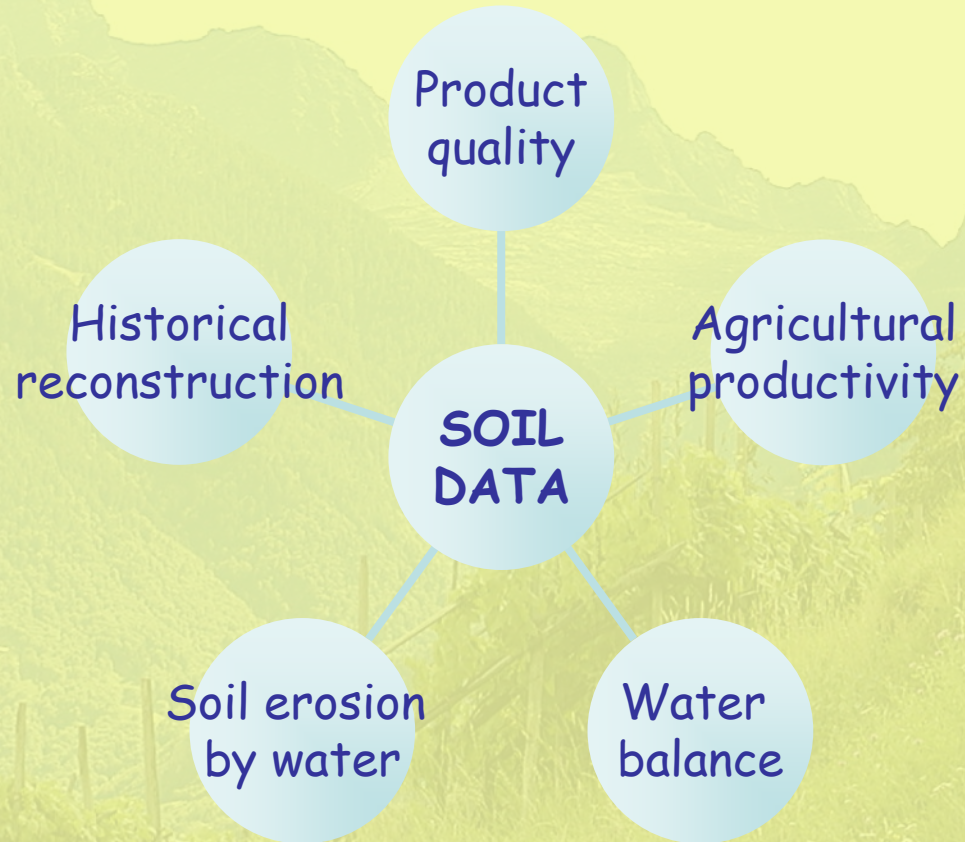
350 m a.s.l.

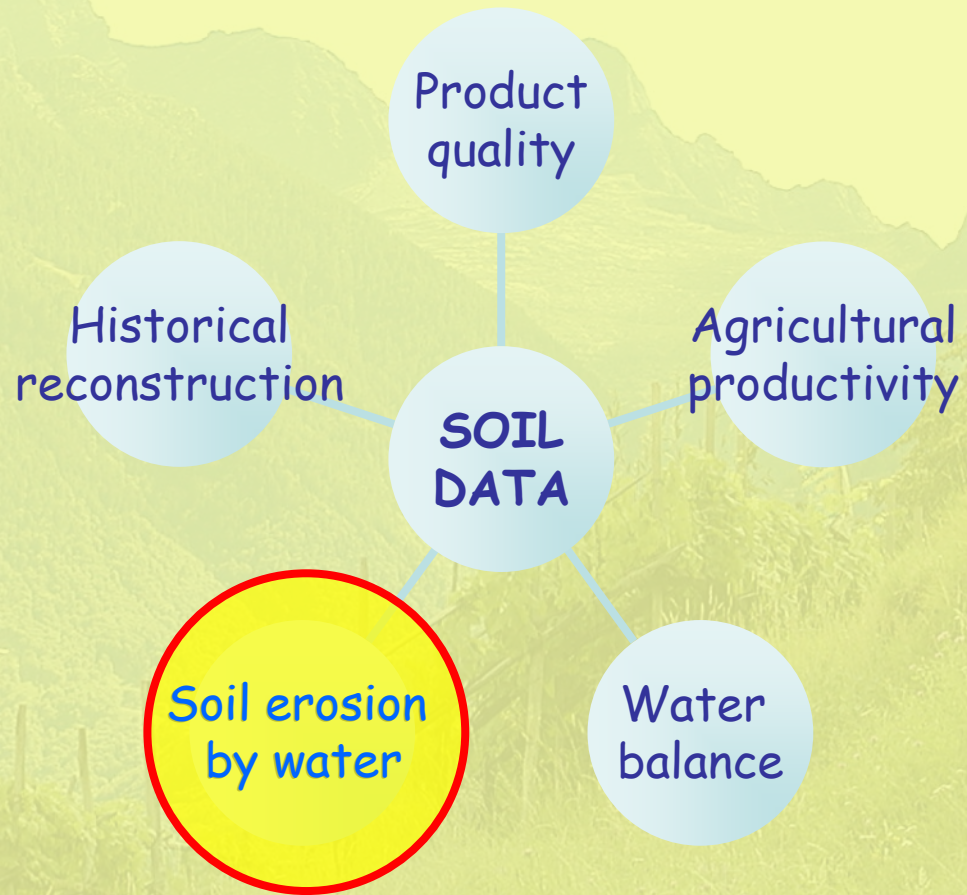




## Importance of Soil Data

<b>Agricultural productivity</b>	<ul style="list-style-type: none"><li>• Soil chemical fertility (pH, organic matter, total carbonates, cation exchange capacity, N, P, K, Ca, Mg, micronutrients)</li><li>• Soil physical fertility (texture, drainage, bulk density, structure, air capacity)</li><li>• Soil biological fertility (microbial biomass, pedodiversity)</li></ul>
<b>Product quality</b>	<ul style="list-style-type: none"><li>• Soil thickness</li><li>• Gravel content</li><li>• Available Water Content (AWC)</li><li>• Soil fertility</li></ul>
<b>Water balance</b>	<ul style="list-style-type: none"><li>• Infiltration from the surface and water movement into the soil</li><li>• Available Water Content (AWC), f(soil thickness, gravel, texture, organic matter, structure)</li><li>• Water table depth</li></ul>
<b>Historical reconstruction</b>	<ul style="list-style-type: none"><li>• Pedological horizons (O, A, Ap, B, C)</li><li>• Organic matter content</li><li>• P content</li><li>• Thickness of the first mineral horizon (A)</li></ul>





# Universal Soil Loss Equation - USLE (United States Department of Agriculture)

$$\text{Soil Erosion} = f(R K L S C P)$$

where:

R = rainfall erosivity factor

K = soil erodibility factor

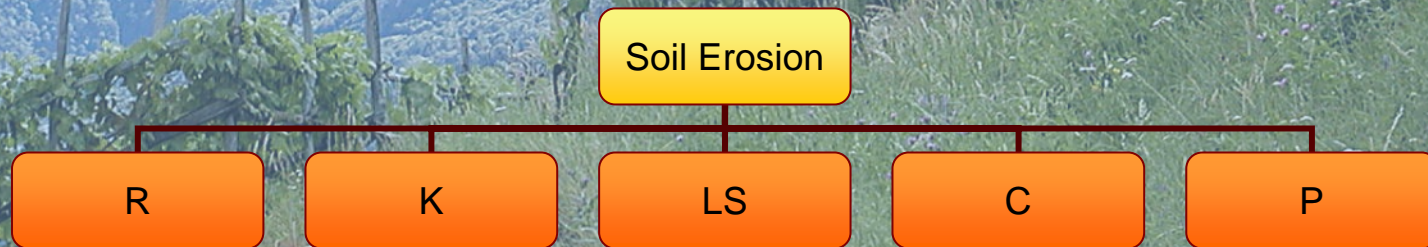
L = slope length factor

S = slope steepness factor

C = crop management factor

P = erosion-control practice factor

(LS = topographic factor)

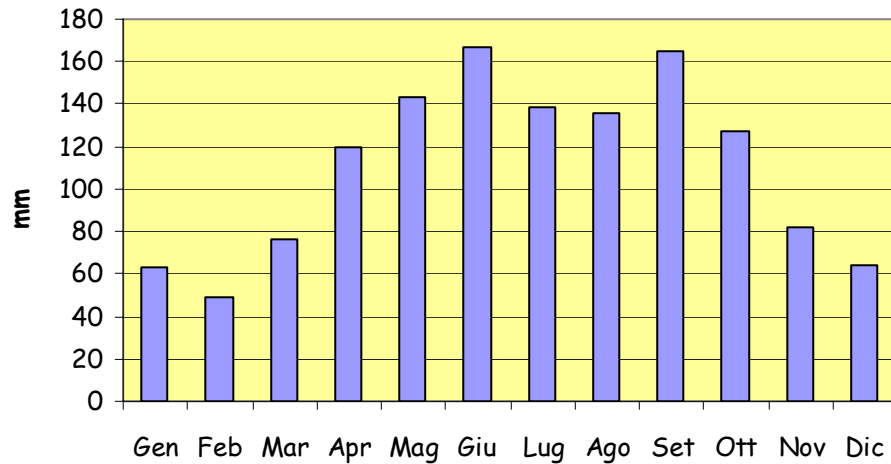


# USLE

## R factor estimation for Pianazzola

R is a function of rainfall distribution and intensity

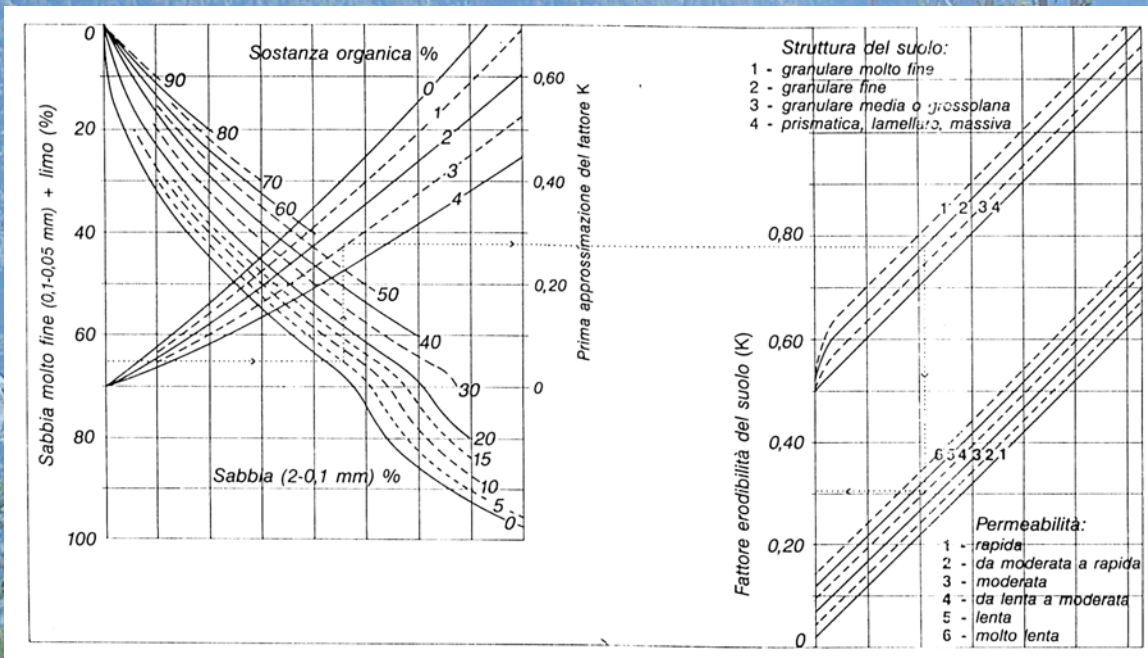
Precipitazioni medie



For Pianazzola, using the FAO-modified Fournier Index (Arnoldus, 1977), **R = 338**

# USLE K factor estimation for Pianazzola

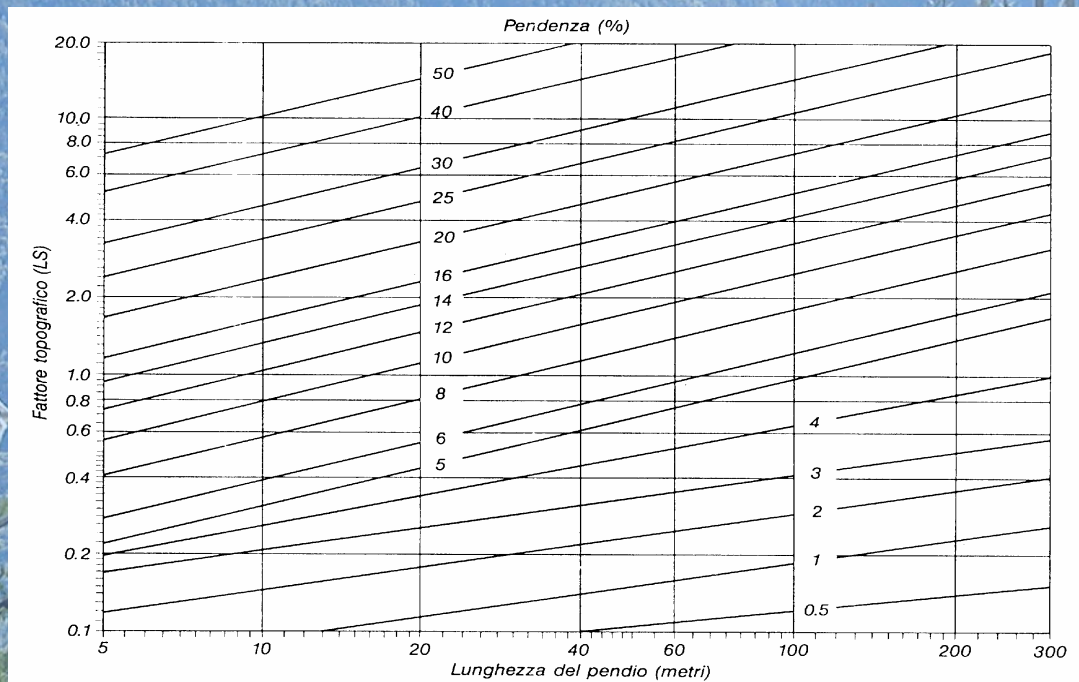
K is a function of soil texture (sand, silt, clay), soil structure, soil organic matter content and soil permeability



For Pianazzola (sandy loam texture, fine granular structure, 4% organic matter, moderate to rapid permeability),  $K = 0.24$

# USLE LS factor estimation for Pianazzola

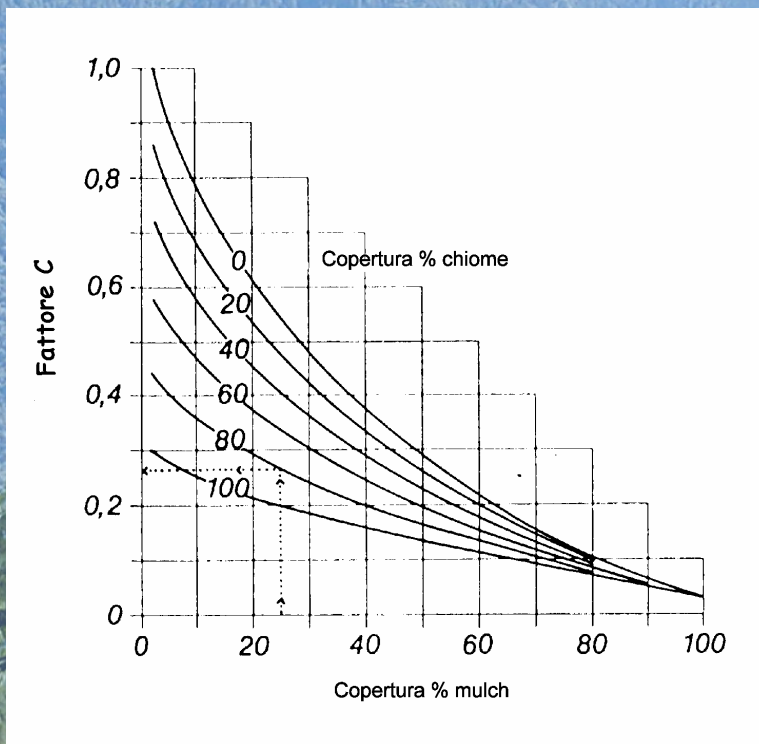
LS is a function of slope length and slope steepness



For Pianazzola **LS** varies from **0.1** (well-maintained terraces) to **12.5** (collapsed terraces)

# USLE C factor estimation for Pianazzola

C is a function of crop management, canopy density, vegetation height, mulch cover



For Pianazzola  $C$  varies from **0.05** (natural vegetation, wood) to **0.32** (vineyard)



# USLE

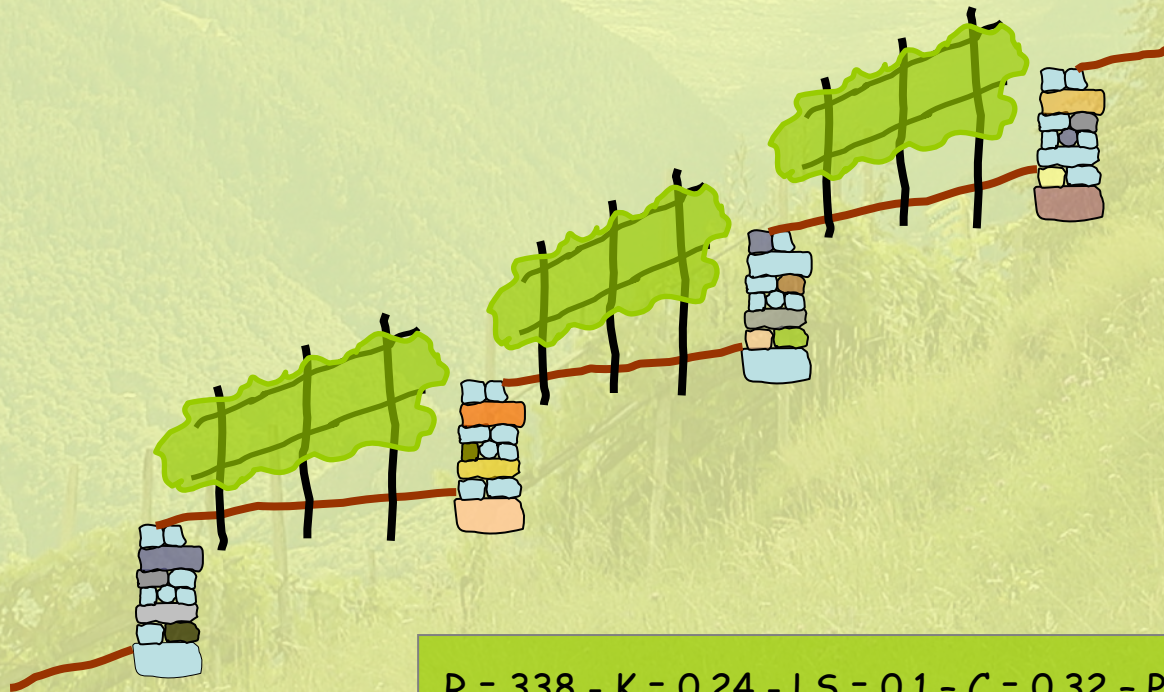
## P factor estimation for Pianazzola

P is a function of erosion-control practices, particularly of man-made terraces characteristics



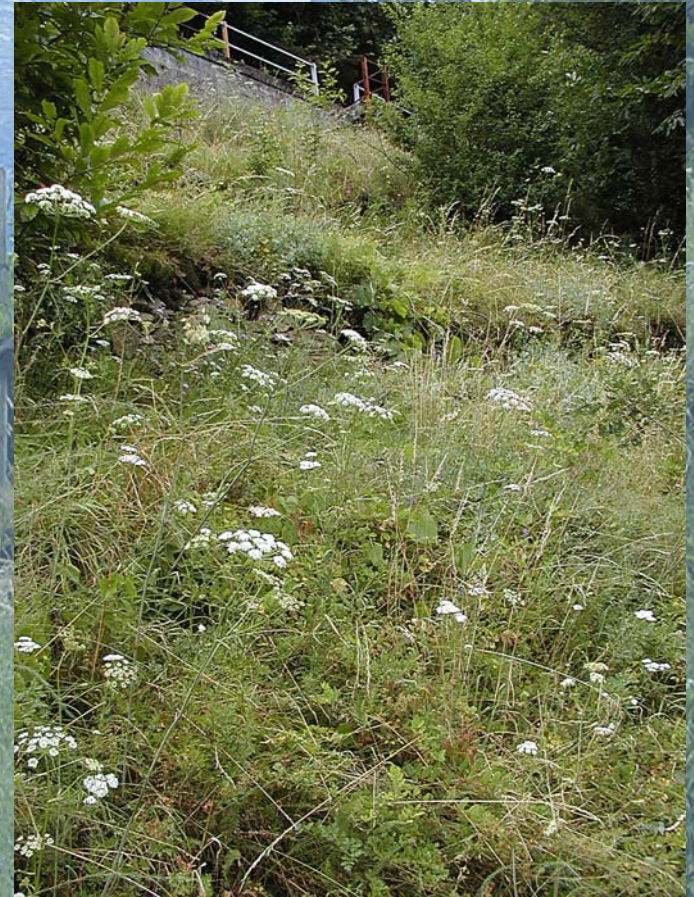
For Pianazzola P varies from **0.35** (well-maintained terraces) to **0.90** (collapsed terraces)

Pianazzola - Case # 1  
Well-maintained terraces with vineyards  
T = 0 years

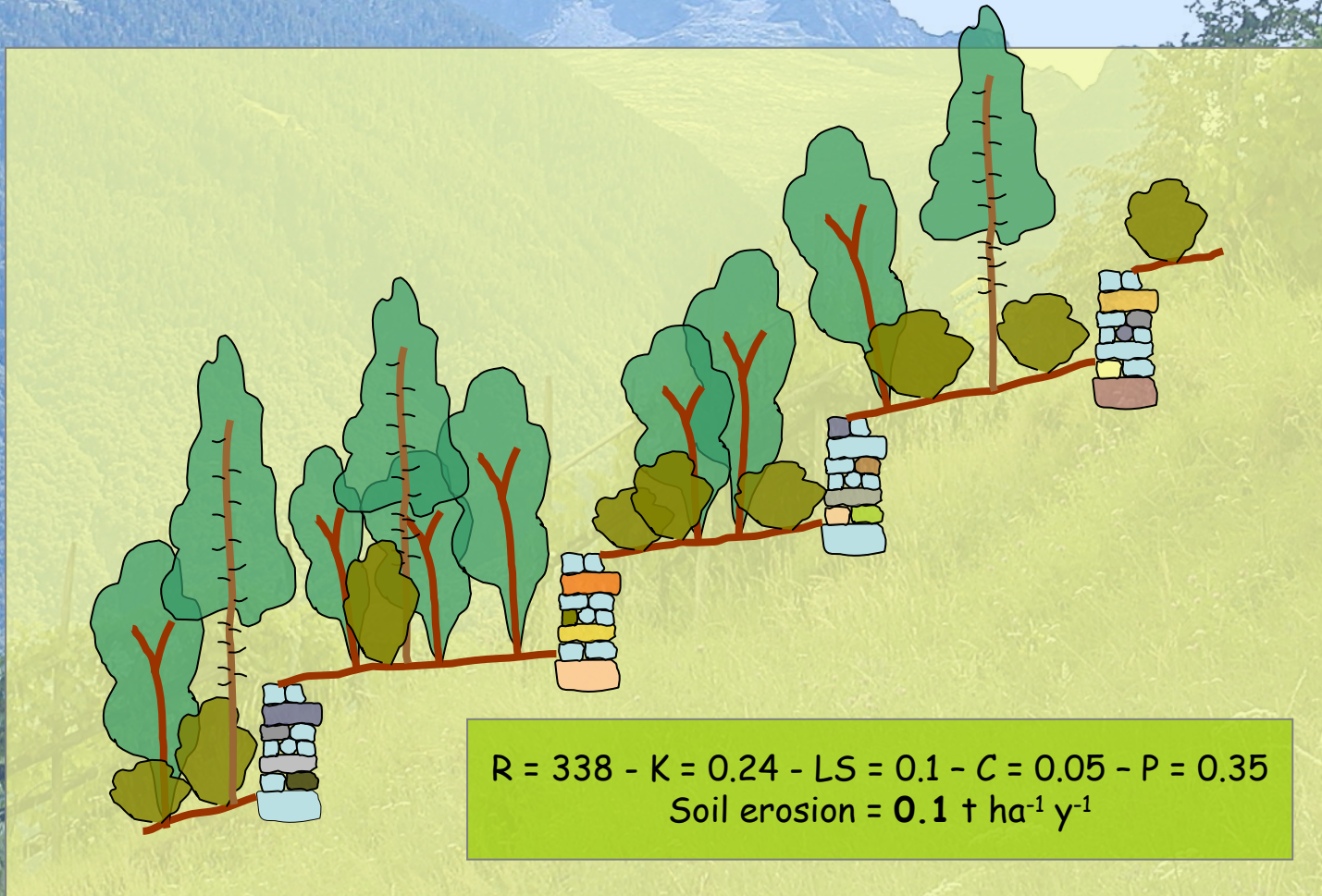


$$R = 338 - K = 0.24 - LS = 0.1 - C = 0.32 - P = 0.35$$
$$\text{Soil erosion} = 0.9 \text{ t ha}^{-1} \text{ y}^{-1}$$

Pianazzola - Case # 2  
Abandoned terraces in good conditions,  
with natural vegetation  
T = 20-30 years



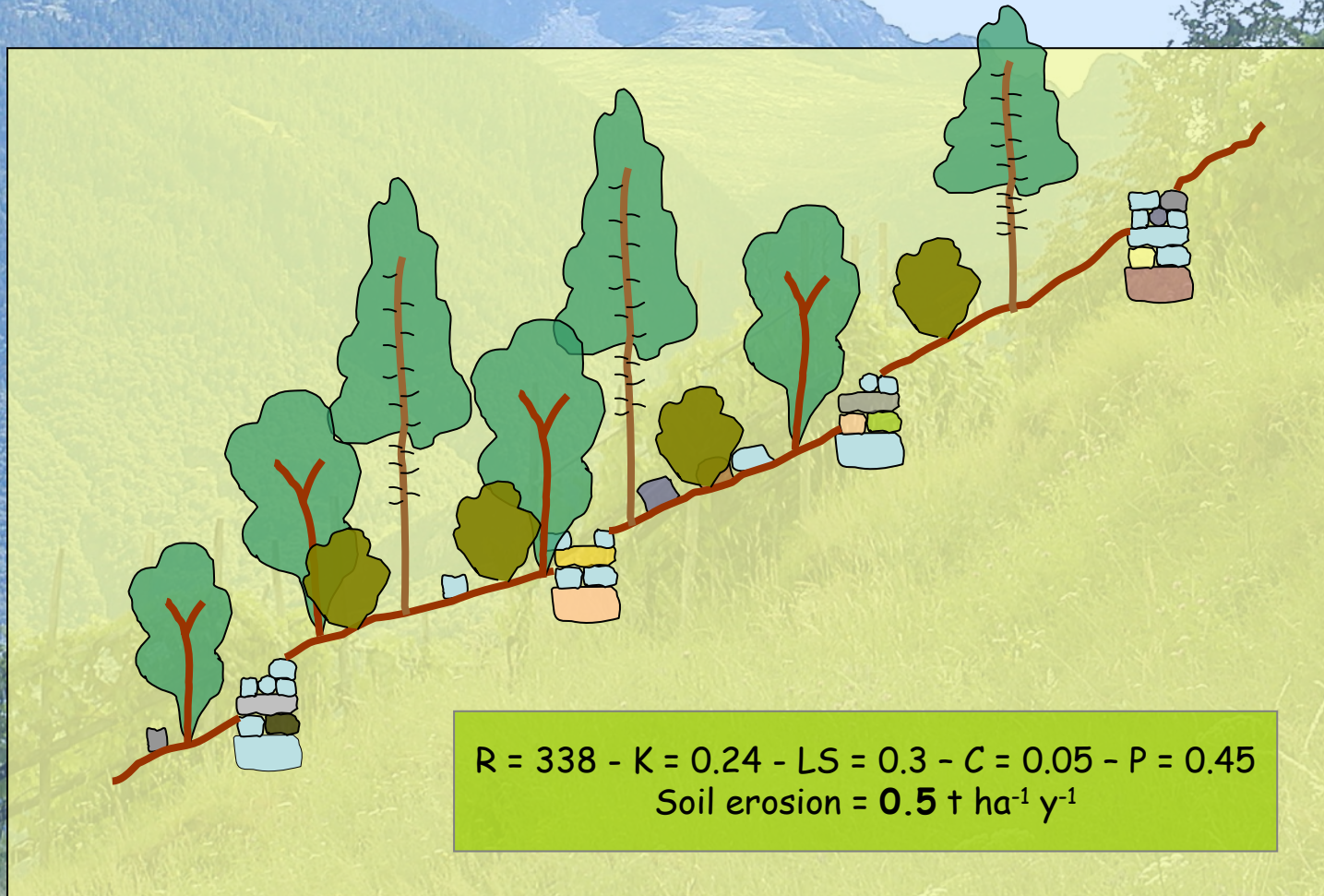
Pianazzola - Case # 2  
Abandoned terraces in good conditions,  
with natural vegetation  
T = 20-30 years



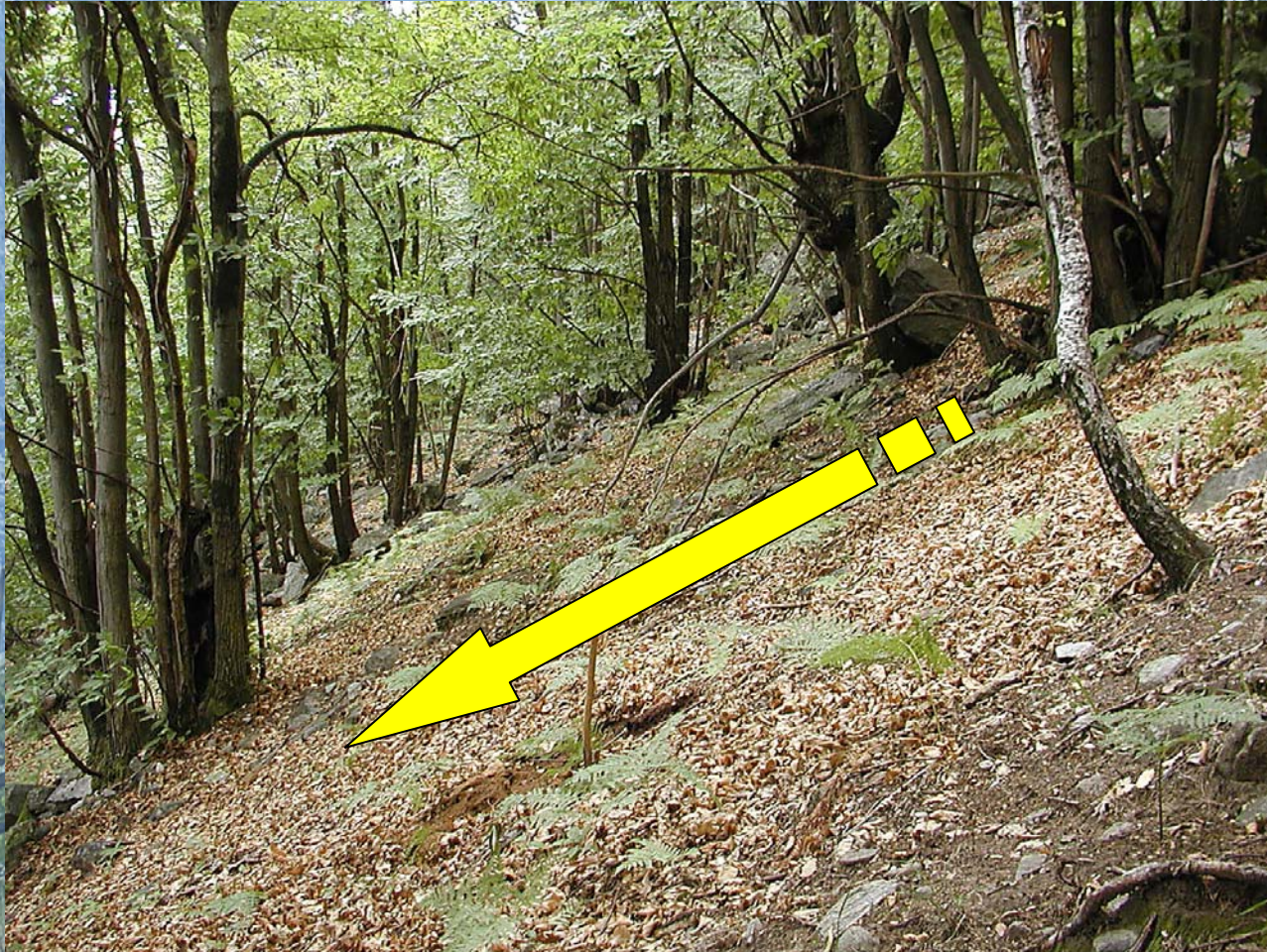
Pianazzola - Case # 3  
Abandoned terraces, partially collapsed,  
with natural vegetation  
T = 70-100 years?



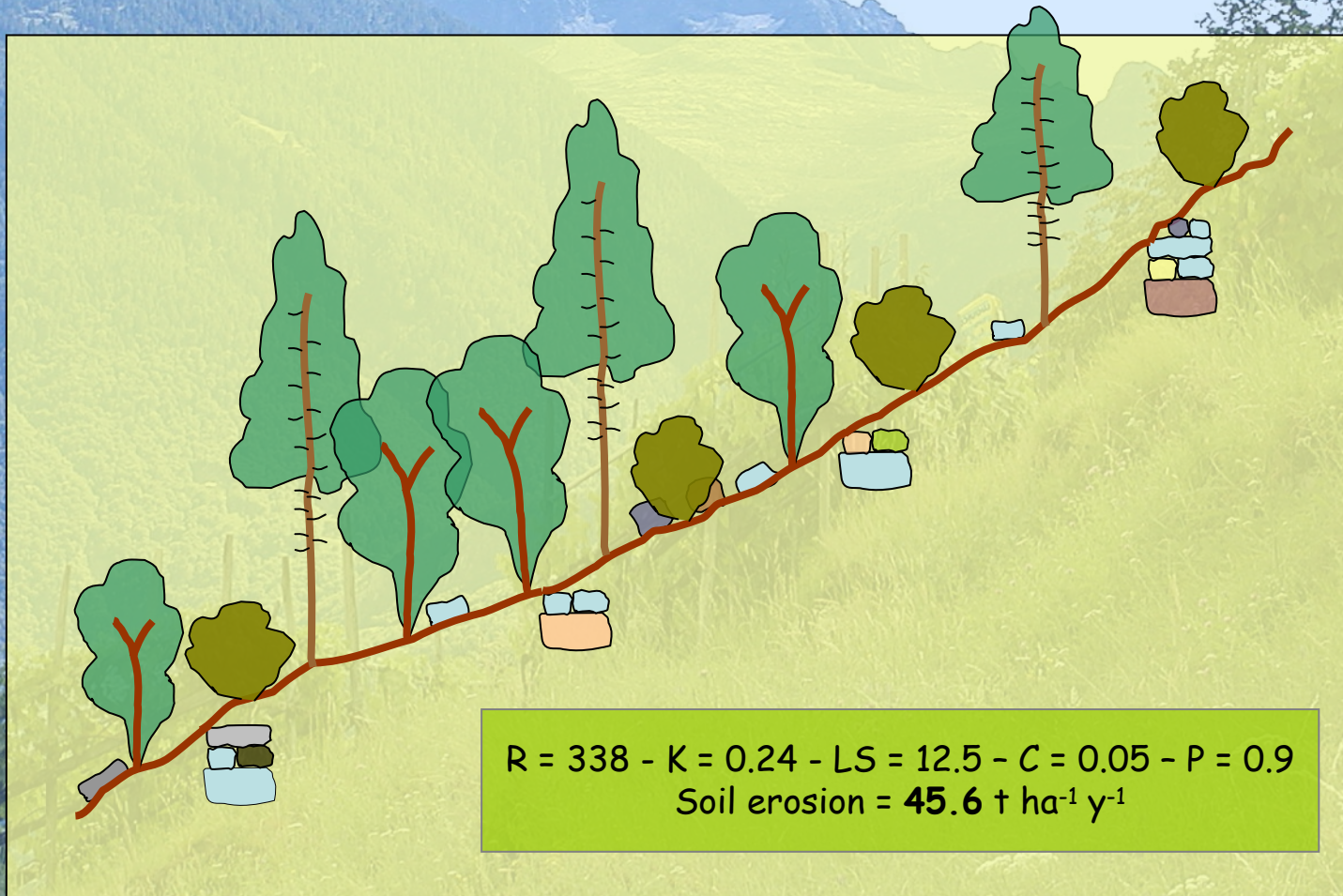
Pianazzola - Case # 3  
Abandoned terraces, partially collapsed,  
with natural vegetation  
 $T = 70-100$  years?



Pianazzola - Case # 4  
Abandoned terraces, completely collapsed,  
with natural vegetation  
 $T > 100$  years?

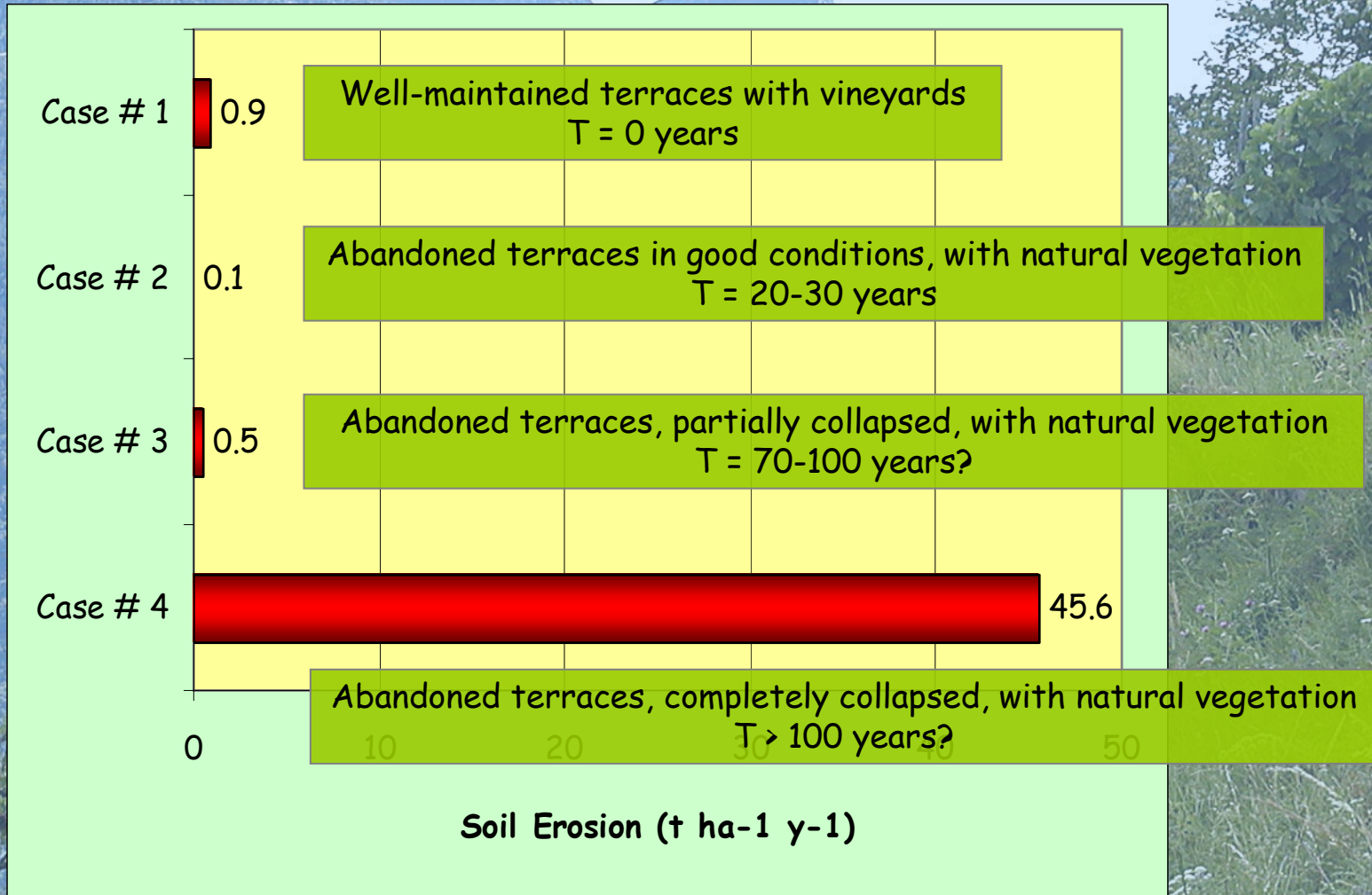


Pianazzola - Case # 4  
Abandoned terraces, completely collapsed,  
with natural vegetation  
 $T > 100$  years?





## Soil Erosion Estimations Comparison





Thank you for your attention!