Ending the Cinderella Status of Terraces and Lynchets in Europe

Daniel Fallu[1], Kevin Walsh[2], Sara Cucchiaro[3], Paolo Tarolli[3], Pengzhi Zhao[4], Kristof van Oost[4], Lisa Snape[5], Andreas Lang[5], Rosa-Maria Albert[6,7], Inger Alsos[1], Clive Waddington[8], Francesco Ficetola[9], and Tony Brown[1,10]

[1]Centre for Ecosystem Genomics, Natural Sciences, Tromsø Museum, UiT: The Arctic University of Norway , [2]Archaeology, University of York, UK [3]Department of Land, Environment, Agriculture and Forestry, University of Padova, Legnaro, Italy , [4]Earth and Life Institute, Georges Lemaître Centre for Earth and Climate Research, Université Catholique de Louvain, Belgium , [5]Department of Geography and Geology, University of Salzburg, Austria , [6]ICREA, Pg. Lluis Companys 23, 08010 Barcelona, Spain , [7]ERAAUB, Department of Prehistory and Archaeology, Universitat de Barcelona, 08001 Barcelona, Spain , [8]Archaeological Research Services Ltd, UK, [9]University of Milan, [10]Geography & Environmental Sciences, University of Southampton, UK,

Cultivation terraces – a worldwide phenomena…

From mountains in Peru..

Ifugao rice terraces..

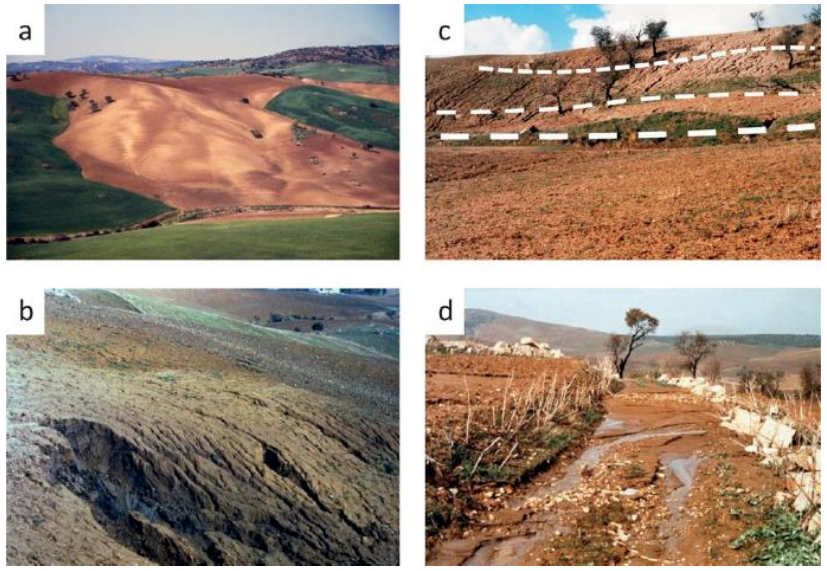
Olives in Spain..

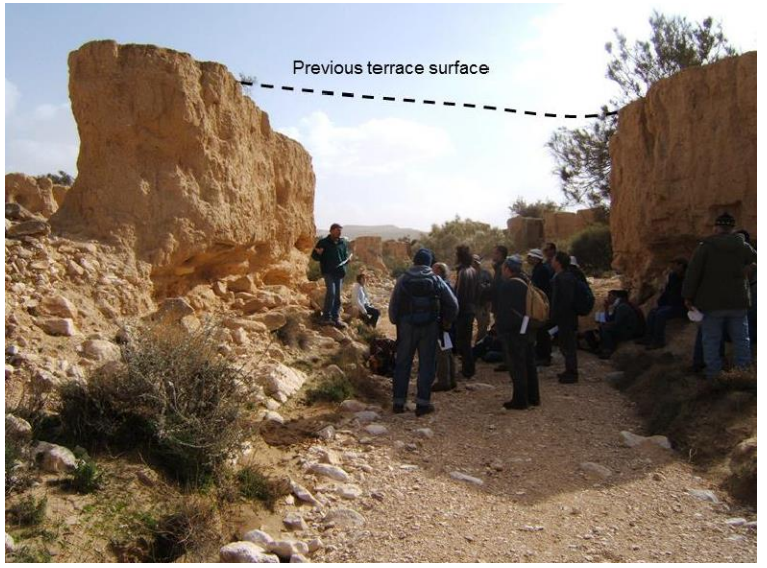
Vineyards in Italy..

Konzo terraces Kenya

'lynchets' in S England....

Now often uncared for, abandoned, or demolished…

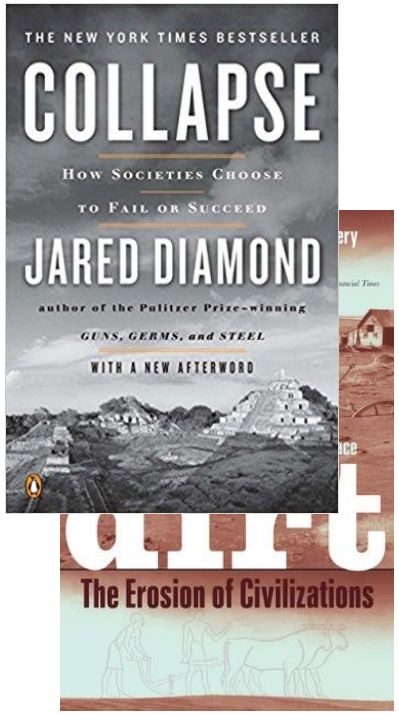


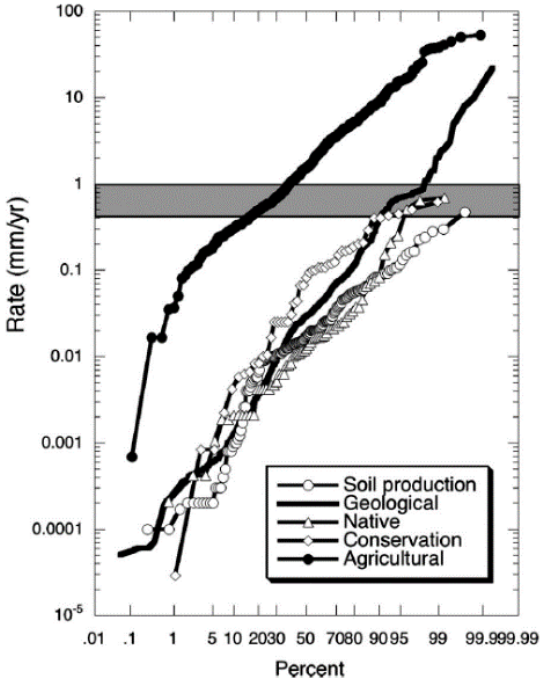


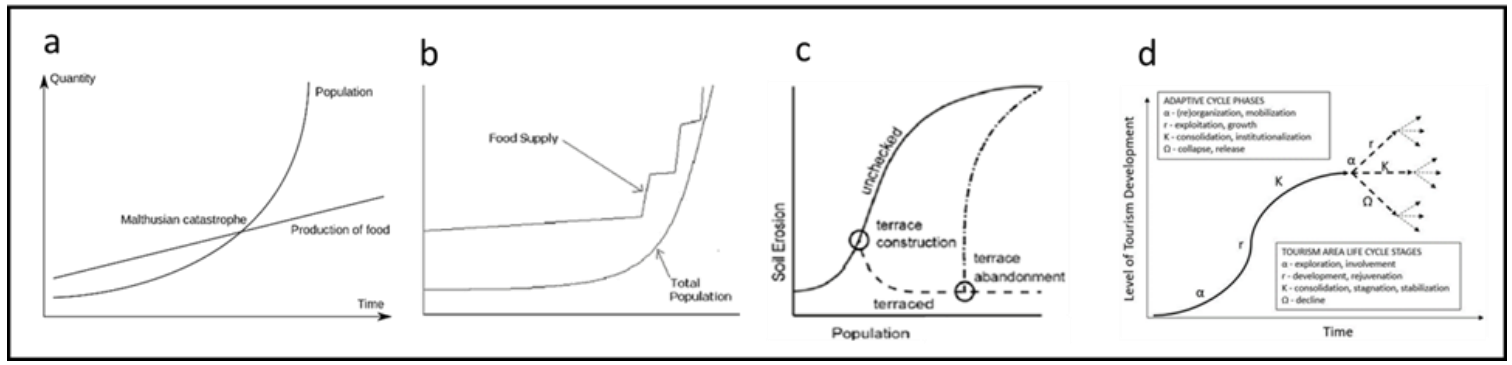
Benefits of Terraces: Ecosystem Services,

- Food security – grain, wine, olives, rice, potato……..
- Sustainable fertility – storage of nutrients
- Water and soil conservation – reduction of runoff & erosion, incl. landsliding
- Biodiversity – ‘weeds & ruderals’, rare communities, arboriculture..
- Scenic value – tourism (e.g. viticulture…)
- Historic value – tourism (e.g. Macchu Piccu, San Fruttuoso)

Benefits of Terraces: Soil erosion and Demography







a) the Malthusian model

b) the Broserup land intensification model

c) terrace, population and erosion model

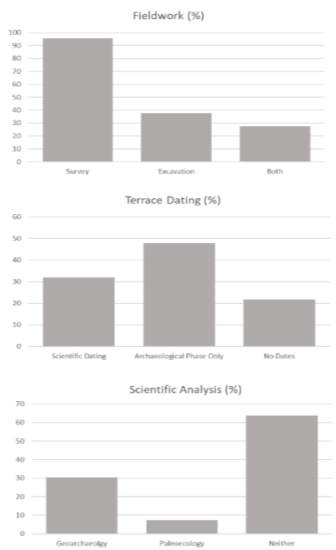
d) adaptive resilience model (Lew 2017)

In *The Conditions of Agricultural Growth* Broserup directly implicated terracing as one of the step changes in land intensification (Broserup 1969 p. 80).

Terraced landscapes are a major landscape type in the **Globally Important Agricultural Heritage Sites (GIAHS) Program of UNESCO**

Of 20 most famous 8 have some archaeology & fewer have reliable dating

	Country	date	Type	Current Condition	Modern Function/service	Archaeology
Douro vineyards	Portugal	200 BP?	vineyard	well maintained	viticulture, tourism	No
Sierra de Tramuntana	Spain	700 BP?	stone walled	part abandoned	orchards, vegetables, olives	Bisson..
Cinque terre	Itlay	1200 BP?	Stone walled	part abandoned	viticulture, olives, tourism	No
Lavaux	Switzerland	900 BP?	stone walled	well maintained	viticulture, tourism	No
Wachau vineyard	Austria	1100 BP?	vineyard	well maintained	viticulture, tourism	No
Battir hill terraces	Palestine	5000 BP	stone	poor	orchards	Some
Ibb terraces	Yemen	5000 BP	dryland	abandoned	degradtion control, coffee	Wilkinson..
Ouadi Qadash	Lebanon	2500 BP	stone walled bench	degraded	grain, erosion control	Some
Bahá'í Faith	Isreal	1200-1000 BP	dryland	well maintained	tourism, runoff retention	Herman...
Al Jabal Al Akhdar Aflaj	Oman	500 BP?	irrigated	poorly maintained	food, security, soil conservation	No
Konso	Ethiopia	4000 BP	stone walled irrigated	well maintained	erosion control, water supply	Sutton, Stump
Sukur	Nigeria	400 BP?	dry stone	well maintained	soil water conservation	No
Cordilleras	Phillippines	2000 BP?	rice	part collapsed	rice, water, tourism	No
Bali Tegallalang	Indonesia	1100 BP?	rice	well maintained	rice, coffee, tourism	No
Sapa	Vietnam	200 BP?	rice	well maintained	runoff, soil, tourism	No
Ziquejie	China	2000 BP?	rice	well maintained	rice, coffee, tourism	No
Hani	China	1300 BP	rice	well maintained	rice, biodiversity, water, soil	Yongxun
Gudeuljangnon	S Korea	400 BP?	stone rice	well maintained	soil, water, biodiversity	No
Noto Peninsula	Japan	600-400 BP	stone walled rice	Part abandoned	water, lanslide, ecosystem, scenic	No
Machu Picchu	Peru	700-600 BP	stone walled potato	abandoned	climate, water	Bingham, Wright..



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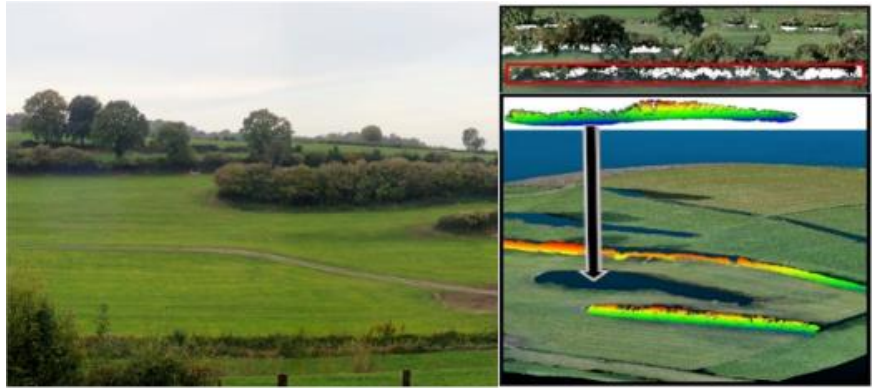
An ongoing analysis of published projects shows that the majority of terrace systems are unexcavated, undated, and have not been subjected to geoarchaeological or paleoecological analysis

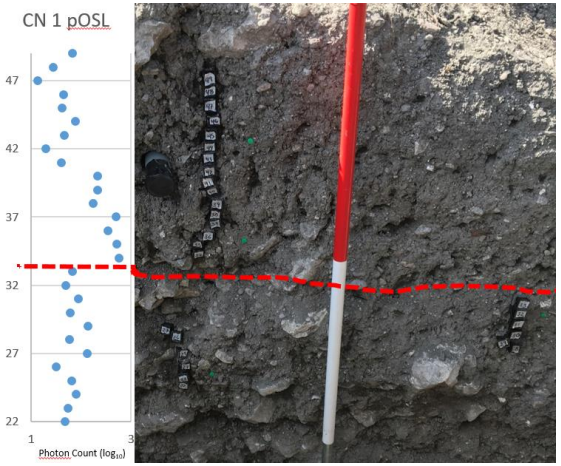
Terrace Archaeology and Culture in Europe: TerrACE

- Mapping and Organization
  - Studies either large scale and low resolution or dependent on «line plots» of terrace walls
  - Fusion of TLS and UAV structure-from-motion allows high resolution capture of vertical and horizontal surfaces



Cucchiaro et al., in prep.

- Dating
  - Can be confused by method of construction and post depositional processes
  - Combination of pOSL, OSL and other analytical methods allow for stratigraphic interpretation to inform dates



- Ecology and Cultivation
  - Limited by the preservation of plant material and distances traveled by pollen
  - Phytoliths and DNA provide a more locally-constrained evidence of ecology and cultivation

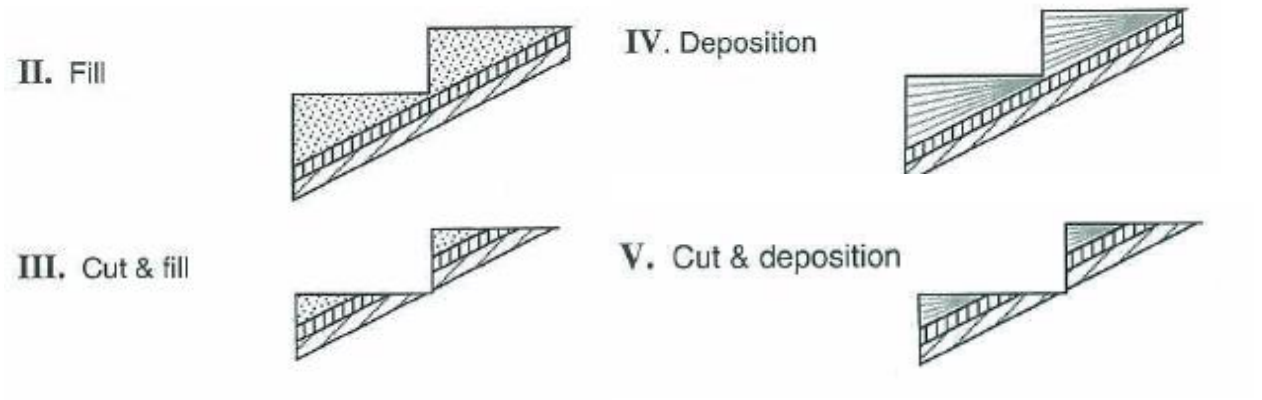
Terrace Classification

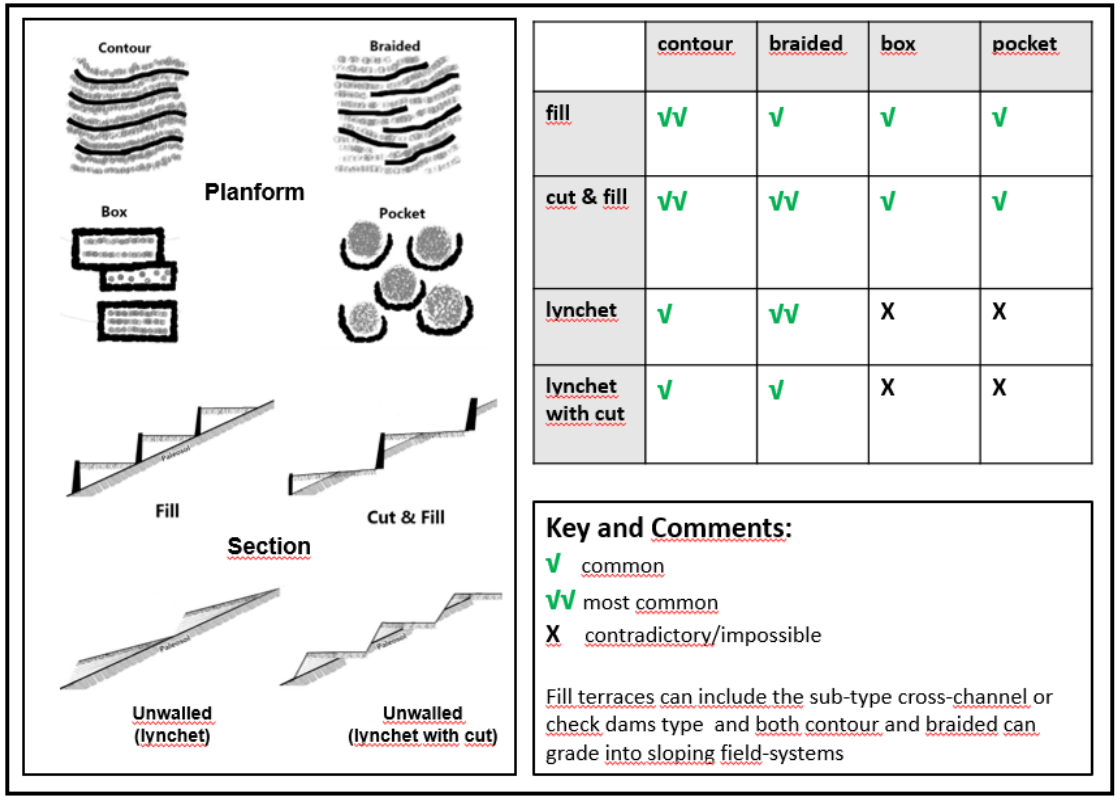
Contour

Fornace Michelon, Soave, N Italy

Braided

Belloca, Soave, N Italy





	contour	braided	box	pocket
fill	√√	√	√	√
cut & fill	√√	√√	√	√
lynchet	√	√√	X	X
lynchet with cut	√	√	X	X

Key and Comments:

√ common

√√ most common

X contradictory/impossible

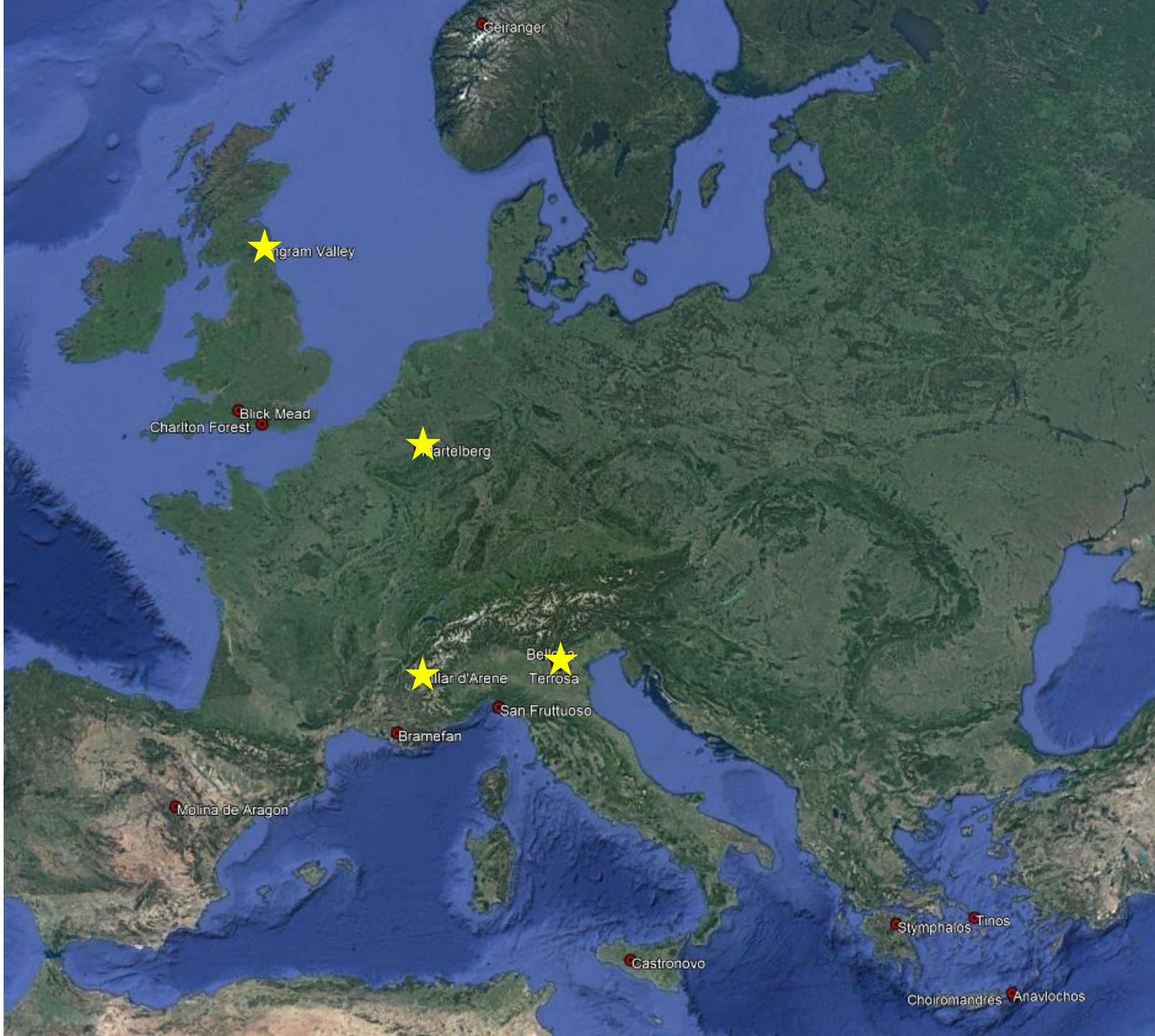
Fill terraces can include the sub-type cross-channel or check dams type and both contour and braided can grade into sloping field-systems

Brown et al., submitted

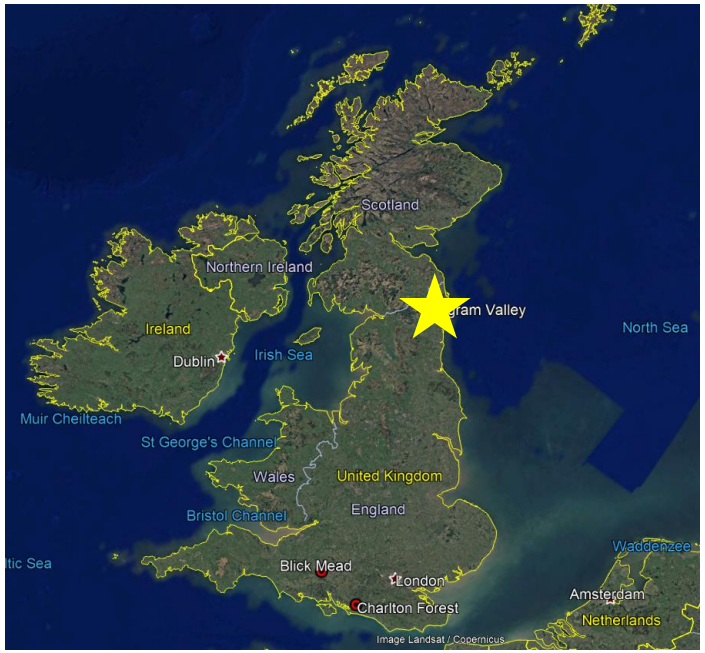
- The most practical classification will use both the planform and the excavated profile
- Contour and braided terraces the most common

TerrACE

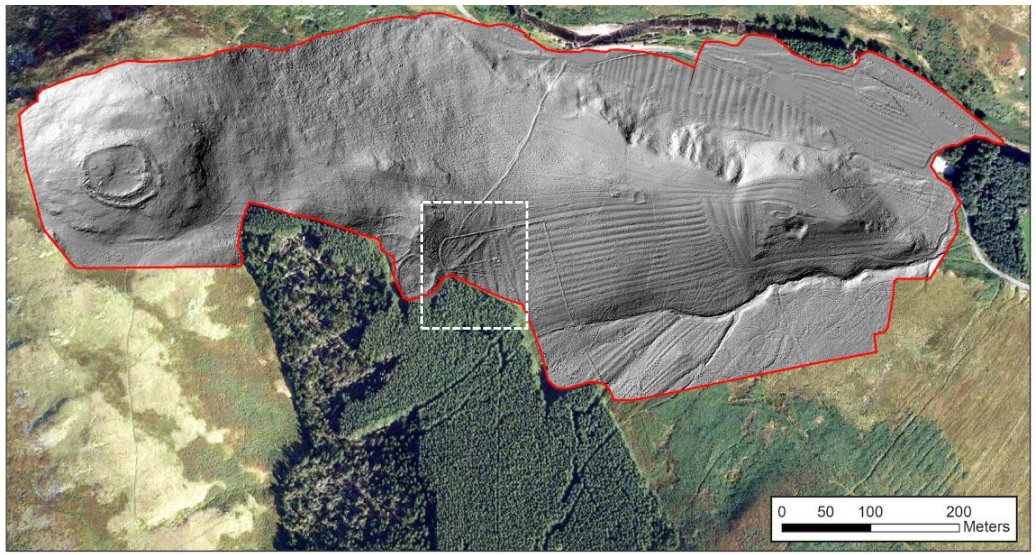
- 15+ sites in a NW-SE transect
- Climates from sub-artic to Xeric Mediterranean
- Variety of geological and climatic settings to demonstrate utility of OSL, Phytolith, and sedaDNA in varying environments



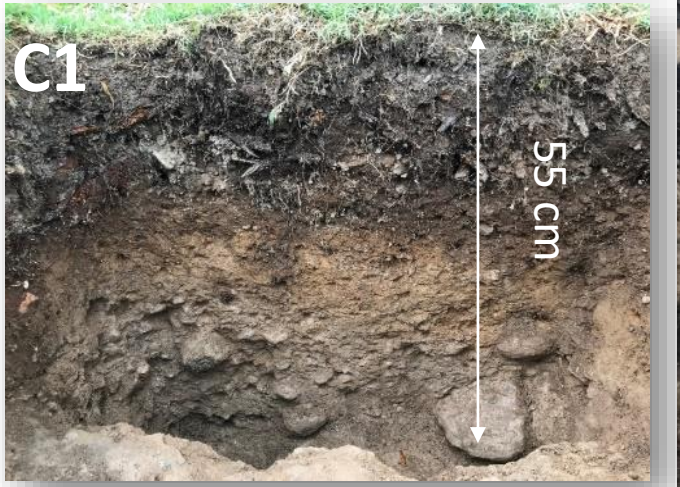
Ingram Valley, United Kingdom

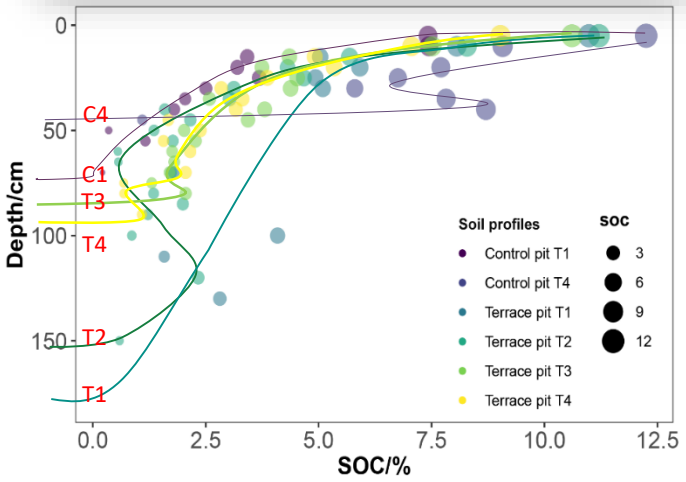


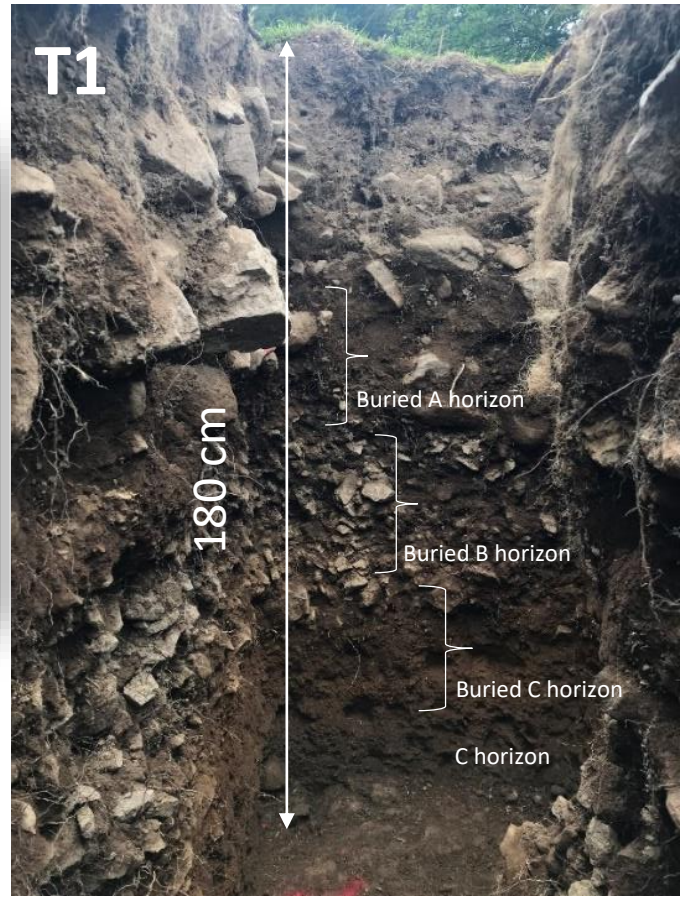
- 5 terraces (7 after SfM analysis)
- Dating unsure, Bronze Age or Early Iron Age
- SOC levels higher in paleosol buried by terrace construction



Cucchiaro et al., 2020

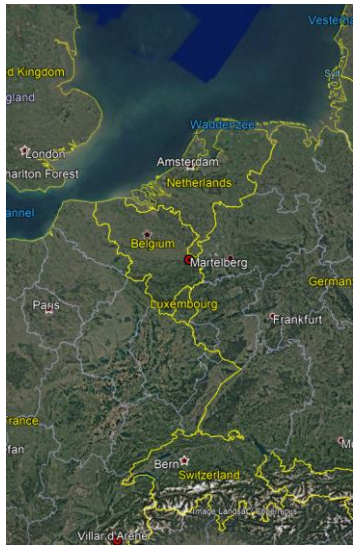


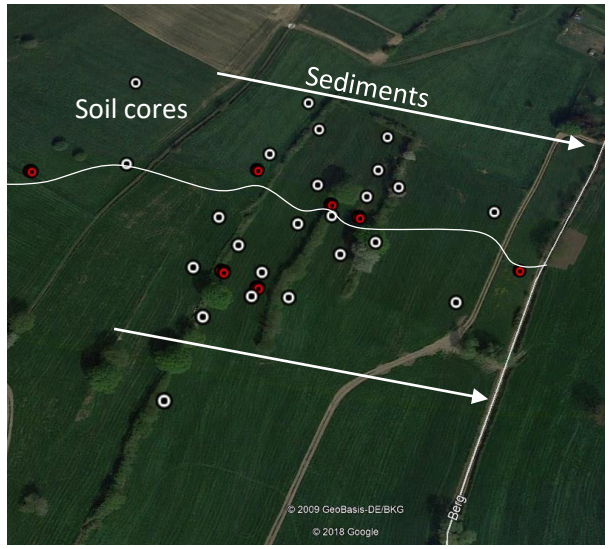


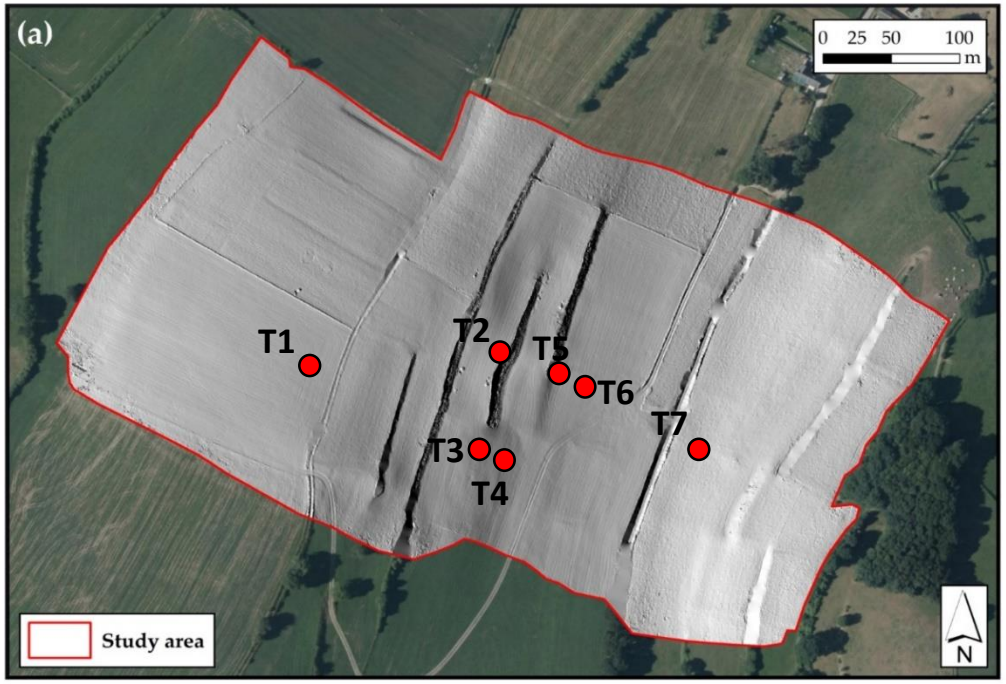


SOC were buried in deep layers due to construction of terrace

Martelberg, Belgium

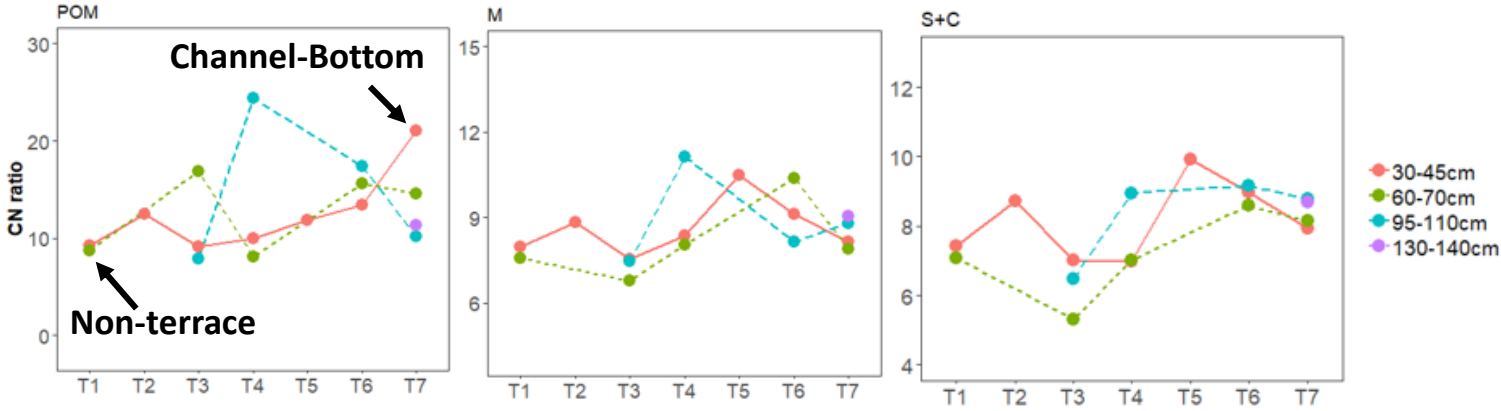






Cucchiaro et al., in prep.

C/N ratios: SOC Stability



Phytoliths

- 4 terraces, 3 excavated.
- Apparent lynchets w/cut, allowing for tall riser scarp
- SOC more stable (high C/N ratio) in terraced slope and valley bottom than on unterraced field.
- Phytoliths and other microremains indicative of grasses, frequent burning, and pasturing/manuring

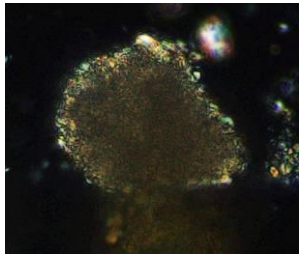
Crenate

Rondel C3 Pooid

Diatom

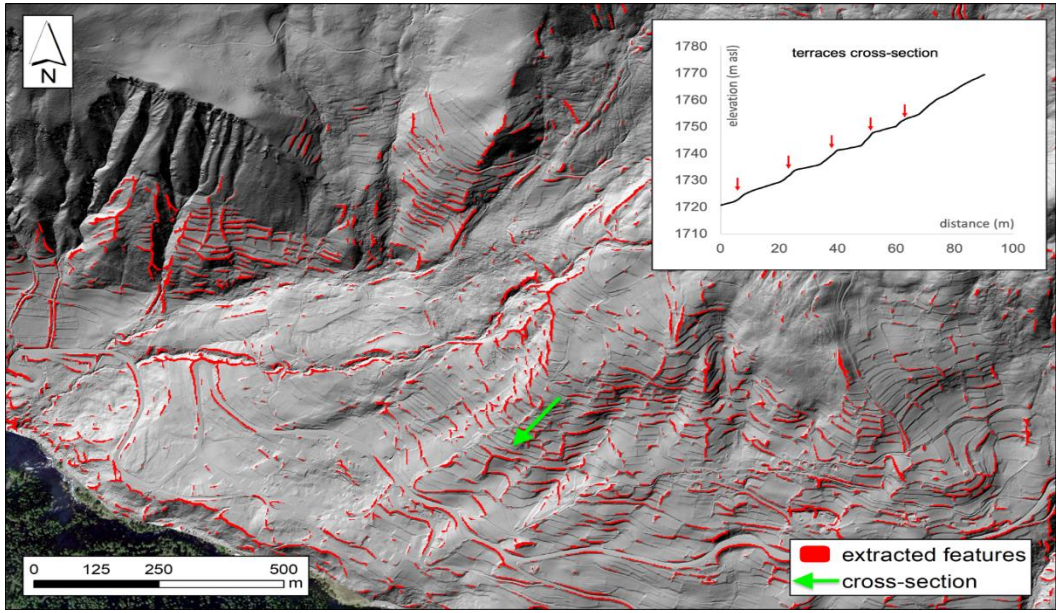
Fecal Spherulite

Sponge spicule



Ash pseudomorph

Villar-d'Arêne, France



Brown et al., submitted

- LiDAR-derived DEM based on data captured in 2012
- Landscape cultivated at least since the Roman Period, if not the Bronze Age
- Terraces date at possibly to the foundation of the modern village in the 12th or 13th century.

Conclusions

- Terraces are an important component of past and present landscapes, serving as a record for the past of agriculture as well as a guard against further landscape change.
- Until recently, studies have relied on archaeological material or architectural phasing for dates, and scientifically dated studies have been infrequent.
- The full range of terraced landscapes must be studied by a combination of modern spatial analysis, scientific dating, and state-of-the-art paleoecological methods in order to fully characterize their construction and use histories, as well as to assess there impact on soils in the past and present.
- Early results from the United Kingdom, Belgium, and Italy show storage of SOC in paleosols buried by terrace construction, potential greater stability.

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