The erosion of agricultural society: Toward an integrated approach for a sustainable connection of soil, water and health

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Environment, Sustainable Agriculture and Forest Management
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Agriculture has to deal with one of the major challenges of the future: to produce more food to feed a growing population from the same amount of, or even less, land, and, at the same time, safeguard natural resources adopting more sustainable production practices (*Alexandratos, 1999; Tilman et al., 2002, 2011; Ruttan, 2002; von Braun, 2007*).

Prosdocimi / Masin / Tarolli – Dep. TESAF & DAFNAE – University of Padova (Italy)

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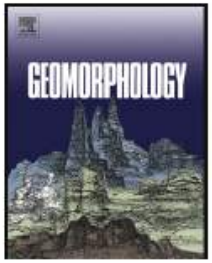
Any effect on Earth surface processes?

Geomorphology 255 (2016) 140–161

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph



Invited Review Article

Human topographic signatures and derived geomorphic processes across landscapes

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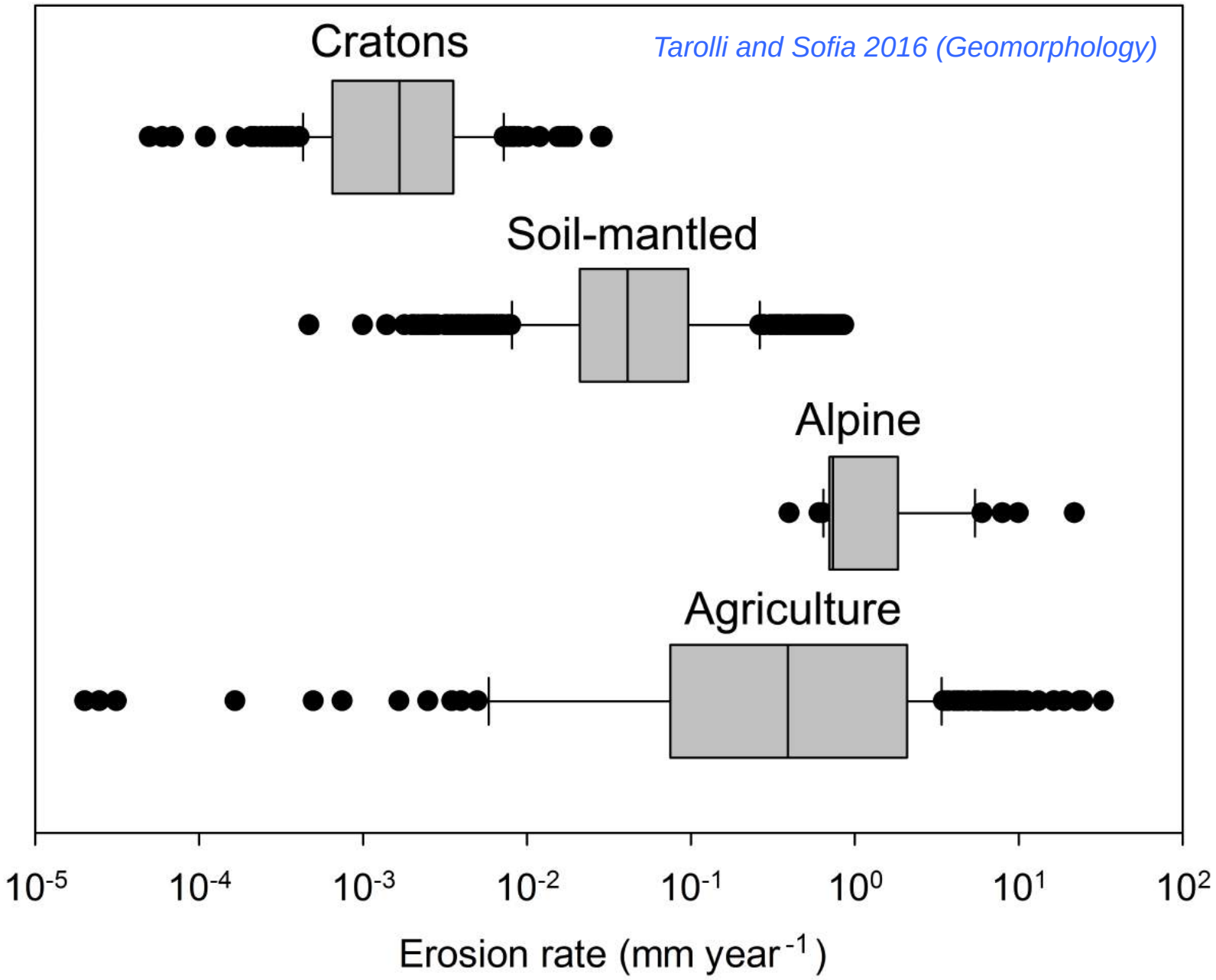
Cratons
Tarolli and Sofia 2016 (Geomorphology)
Soil-mantled
Alpine
Agriculture
10-5
10-4
10-3
10-2
10-1
100
101
102
Erosion rate (mm year-1)

Cerdan et al. 2010 (Geomorphology)

Land use	Other regions				Mediterranean			
	Database entries*	Plot-months	Mean (t ha^{-1} year^{-1})	Std. Dev.	Entries*	Plot-months	Mean (t ha^{-1} year^{-1})	Std. Dev.
Bare	62	7599	17.12	30.23	20	2868	9.05	35.23
Arable	73	6635	6.33	13.46	30	5363	0.84	1.66
Forest	2	60	0.003	0.0018	4	552	0.18	0.18
Grassland	7	1535	0.29	1.15	11	1700	0.32	1.09
Shrub	3	90	0.13	0.19	28	3193	0.54	1.74
Vineyard	4	144	23.64	26.0	6	1210	8.62	27.4
Orchard	2	408	20.6	19.4	2	321	1.67	5.21

Catena 141 (2016) 1–21

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Soil water erosion on Mediterranean vineyards: A review

Massimo Prosdocimi [a,*], Artemi Cerdà [b], Paolo Tarolli [a]

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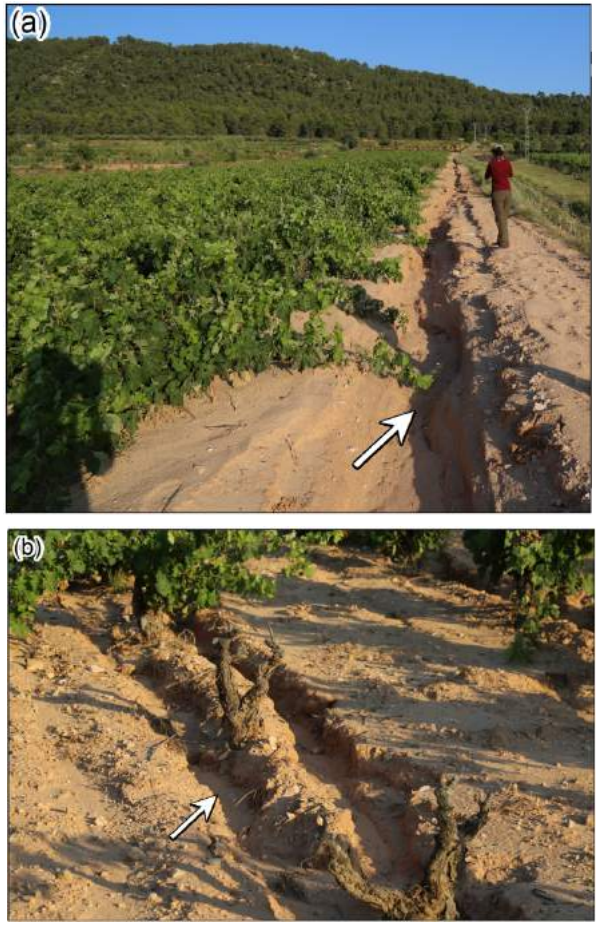
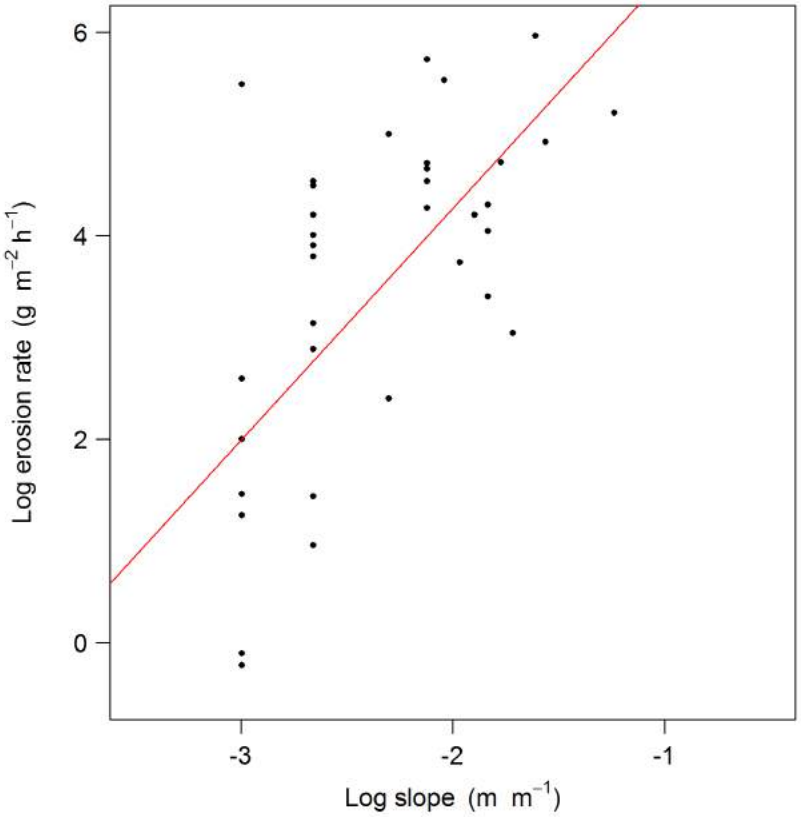
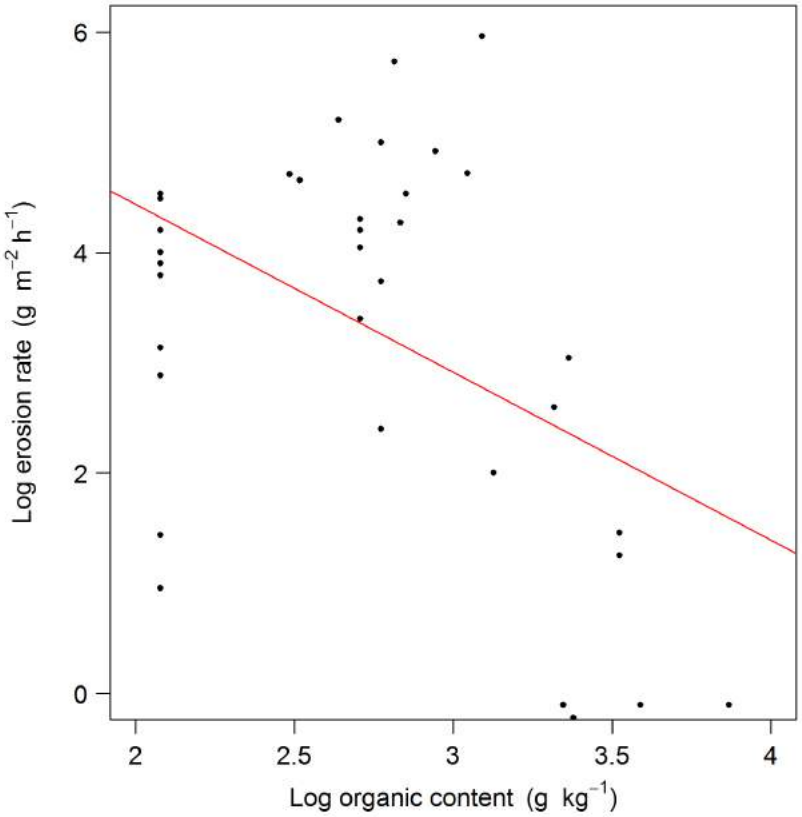
[b] Soil Erosion and Degradation Research Group, Department of Geography, University of Valencia, Blasco Ibáñez, 28, 46010 Valencia, Spain



Prosdocimi et al. 2016 (Catena)
Prosdocimi et al. 2016 (Science of The Total Environment)





Prosdocimi et al. 2016 (Catena)

Tarolli et al. under review (Anthropocene)

Prosdocimi / Masin / Tarolli – Dep. TESAF & DAFNAE – University of Padova (Italy)

It's not just the eroded soil (or landslides) that is damaging, pesticides and fertilizers carried in rain and irrigation runoff can pollute surface water.

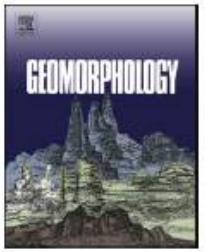
HOW CAN WE ANALYZE AND MONITOR THESE PROCESSES?

Geomorphology 216 (2014) 295–312

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph



Invited review article

High-resolution topography for understanding Earth surface processes: Opportunities and challenges

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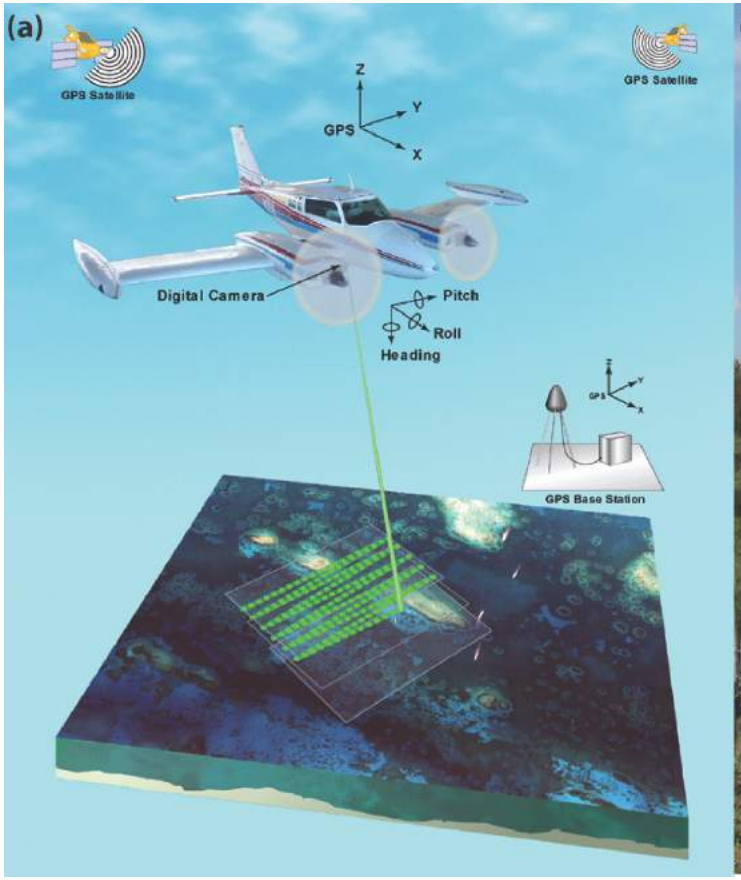
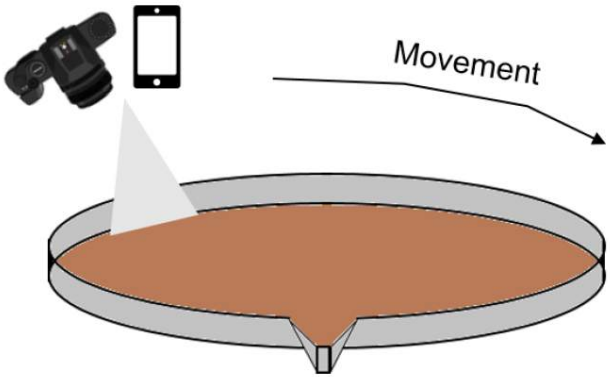
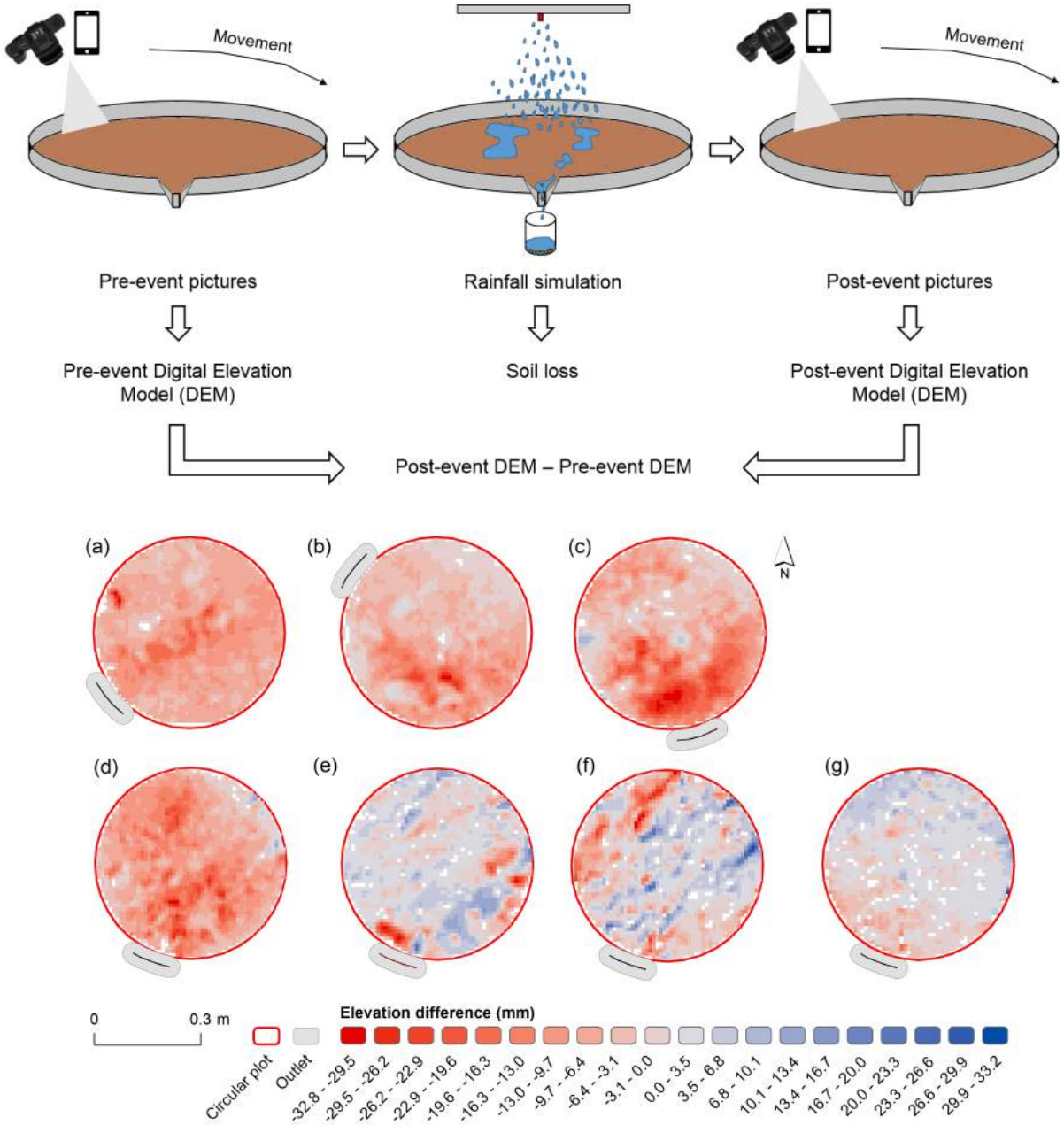
Lidar technology



Structure-from-Motion (SfM)



Prosdocimi et al. 2016 (Science of The Total Environment)



Prosdocimi et al. 2016 (Science of The Total Environment)

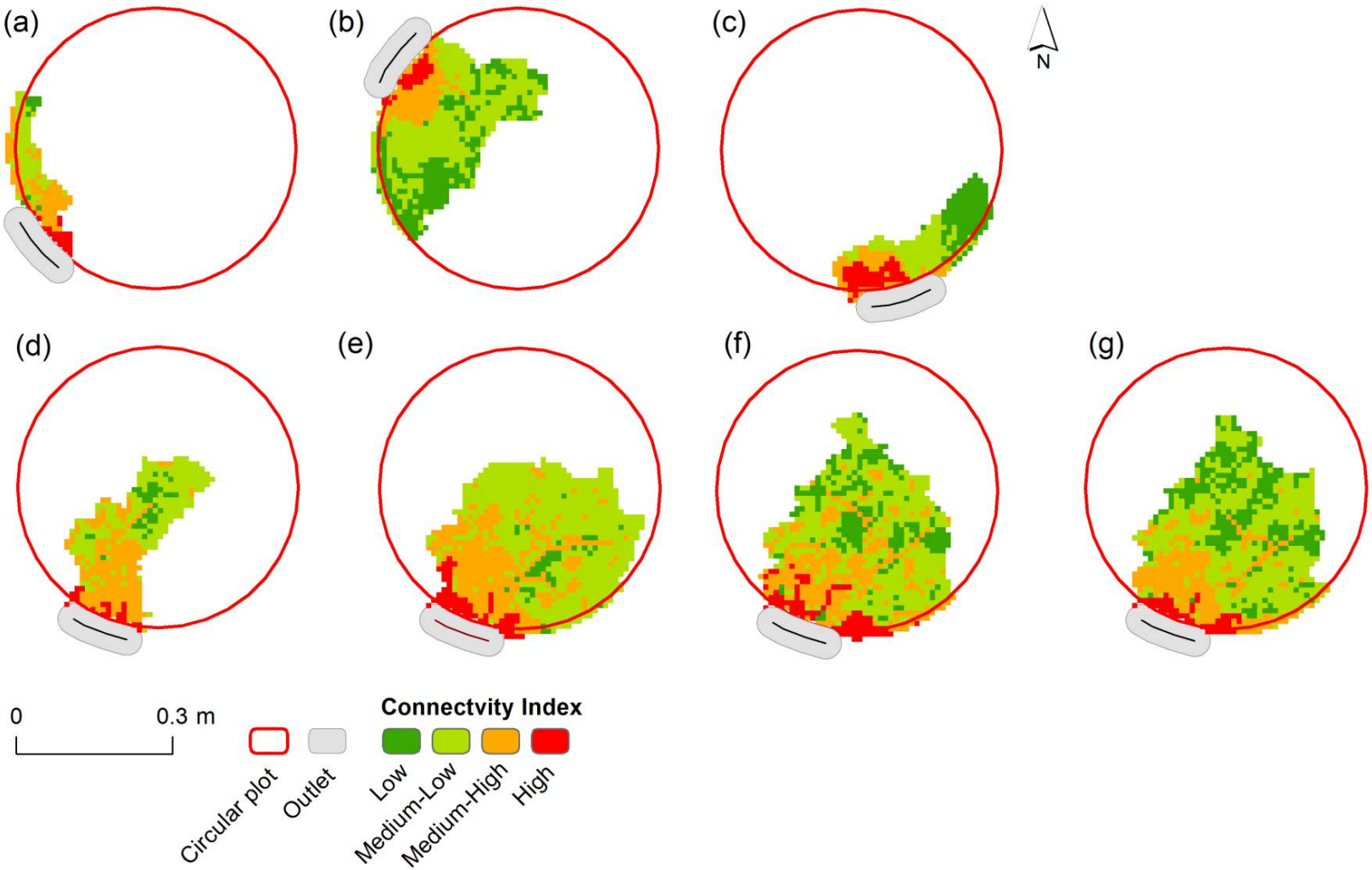
CONNECTIVITY INDEX

It is a topographic index intended to represent the potential sediment connectivity between different parts of the catchment and aims, in particular, at evaluating the potential connection between hillslopes and features which act as targets or storage areas for transported sediment.

$$IC = \log_{10}\left(\frac{D_{up}}{D_{dn}}\right)$$

***D*$_{up}$** and ***D*$_{dn}$** are the upslope and downslope components of connectivity

Cavalli et al. 2013 (Geomorphology)



Prosdocimi et al. 2016 (Science of The Total Environment)

RELATIVE PATH IMPACT INDEX

$$RPII = \ln\left(\frac{A_r - A_{sm}}{A_{sm}}\right)$$

① A_r is the contributing area evaluated in the presence of agricultural roads and terraces on hillslopes

② A_{sm} is the contributing area in the absence of morphological alterations on hillslopes

③ The logaritmic form is given to emphasize and map only such areas where an increase of the drainage area is observed due to road/terraces alteration

④ The greater is the index and the greater is the alteration due to the anthropic pressure. As a consequence, greater is the probability of superficial instability as well.

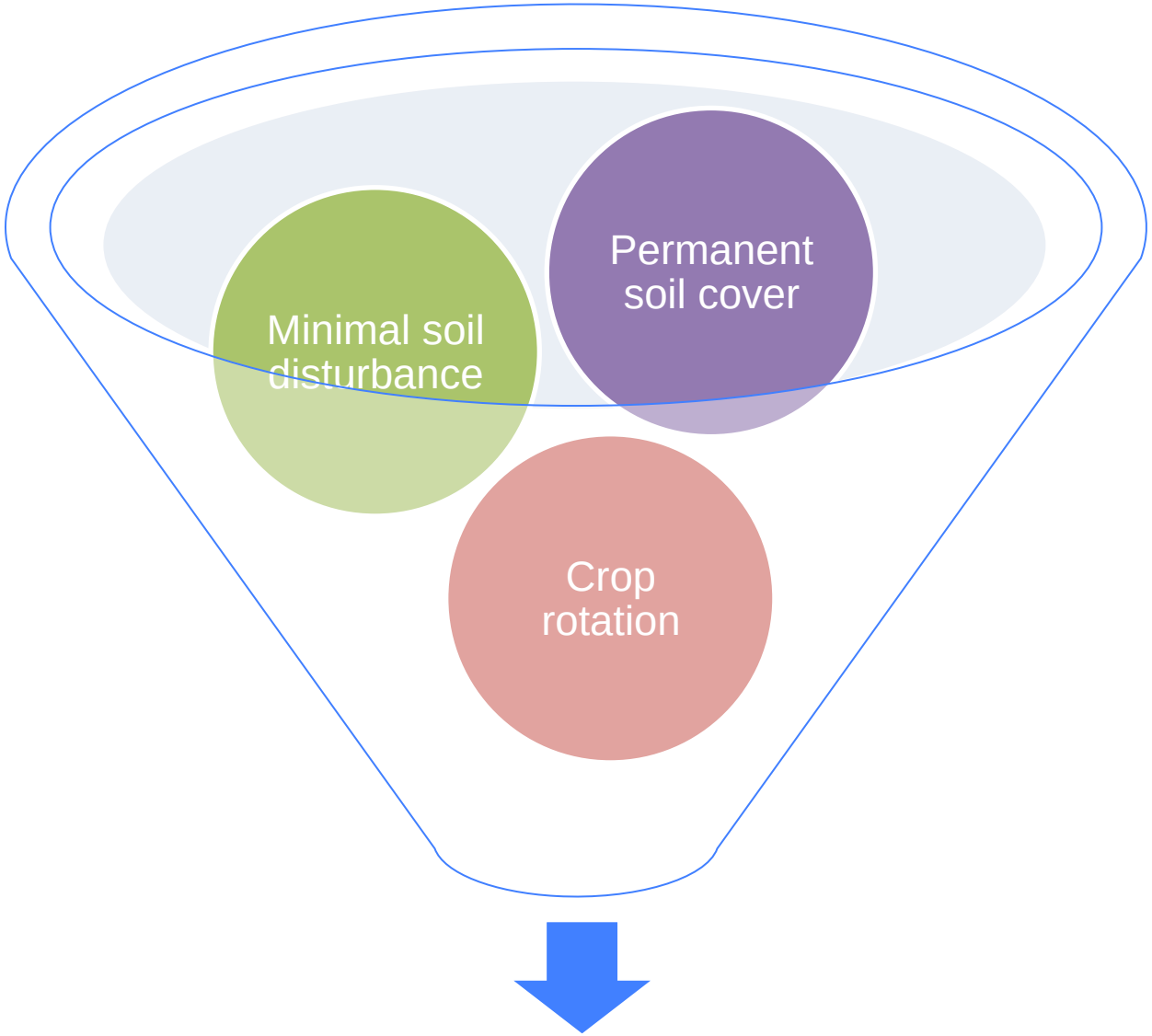
Tarolli et al. 2013 (European Journal of Remote Sensing)
Tarolli et al. 2015 (Land Degradation & Development)

Tarolli et al. under review (Anthropocene)

RUNOFF MONITORING AND WATER SAMPLES COLLECTION

Collector systems located in the ditch designed to measure runoff volumes and collect water samples.

ANY SOLUTIONS TO SOIL WATER EROSION ?



Conservation agricolture (*FAO, 2011*)

+ runoff
+ erosion
+ erbicides / pesticides
  connected to drainage systems

Masin et al. in preparation

- runoff
- erosion
- erbicides / pesticides
  connected to drainage systems

Earth-Science Reviews 161 (2016) 191–203

Contents lists available at ScienceDirect

Earth-Science Reviews

journal homepage: www.elsevier.com/locate/earscirev

Mulching practices for reducing soil water erosion: A review

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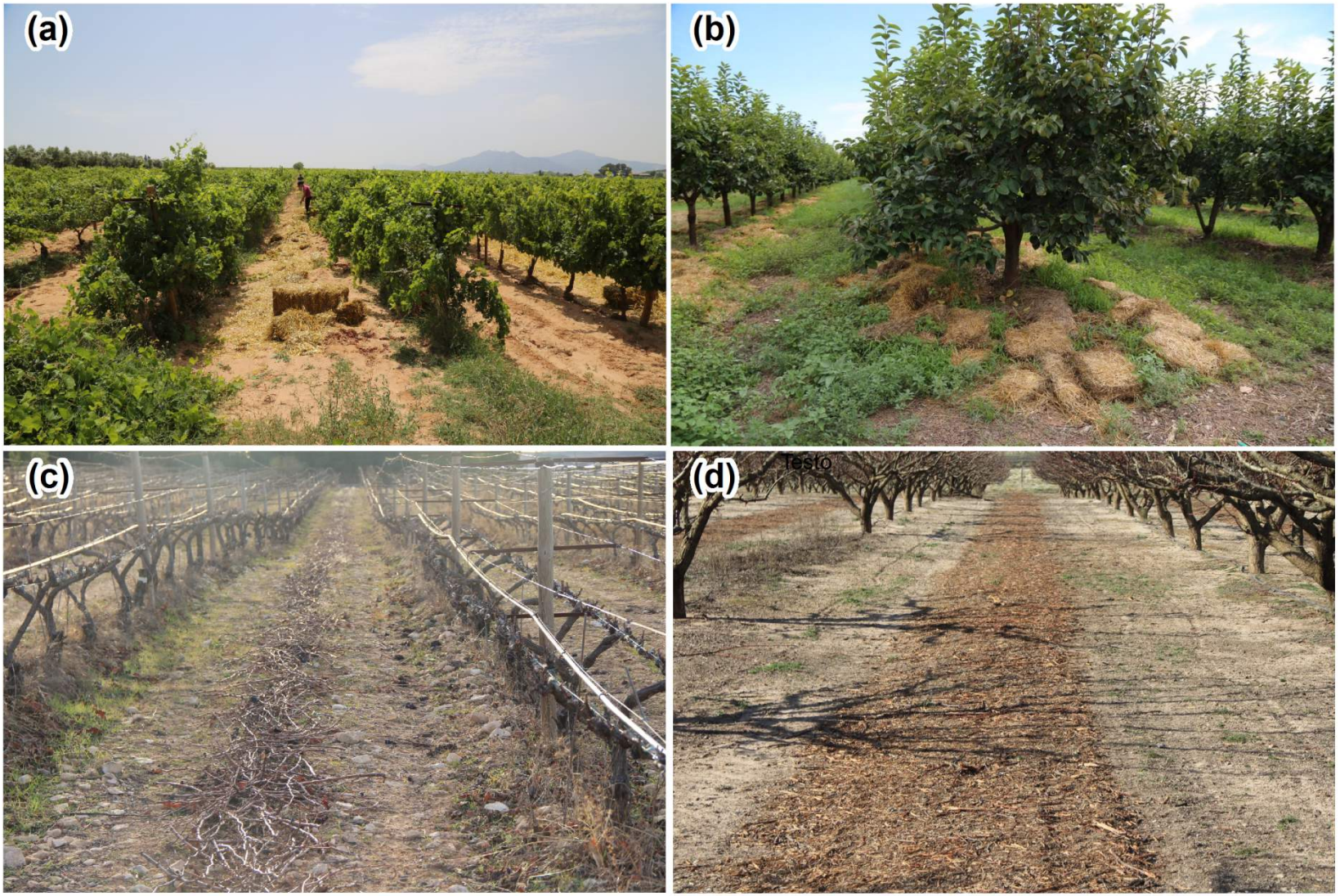
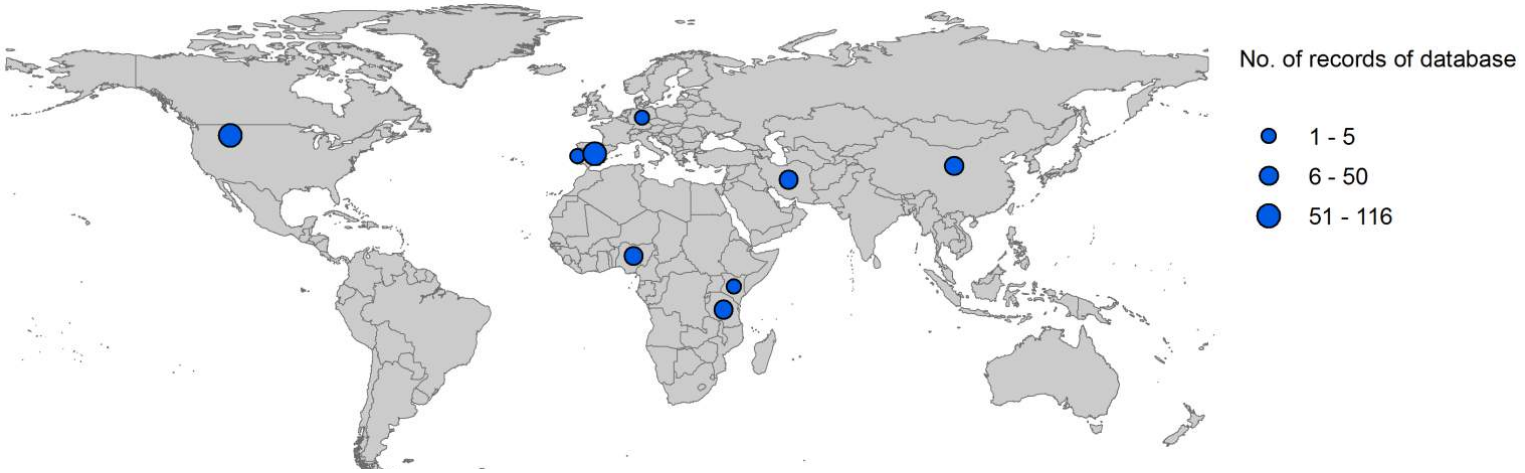
Soil water erosion
Agricultural lands
Fire-affected areas

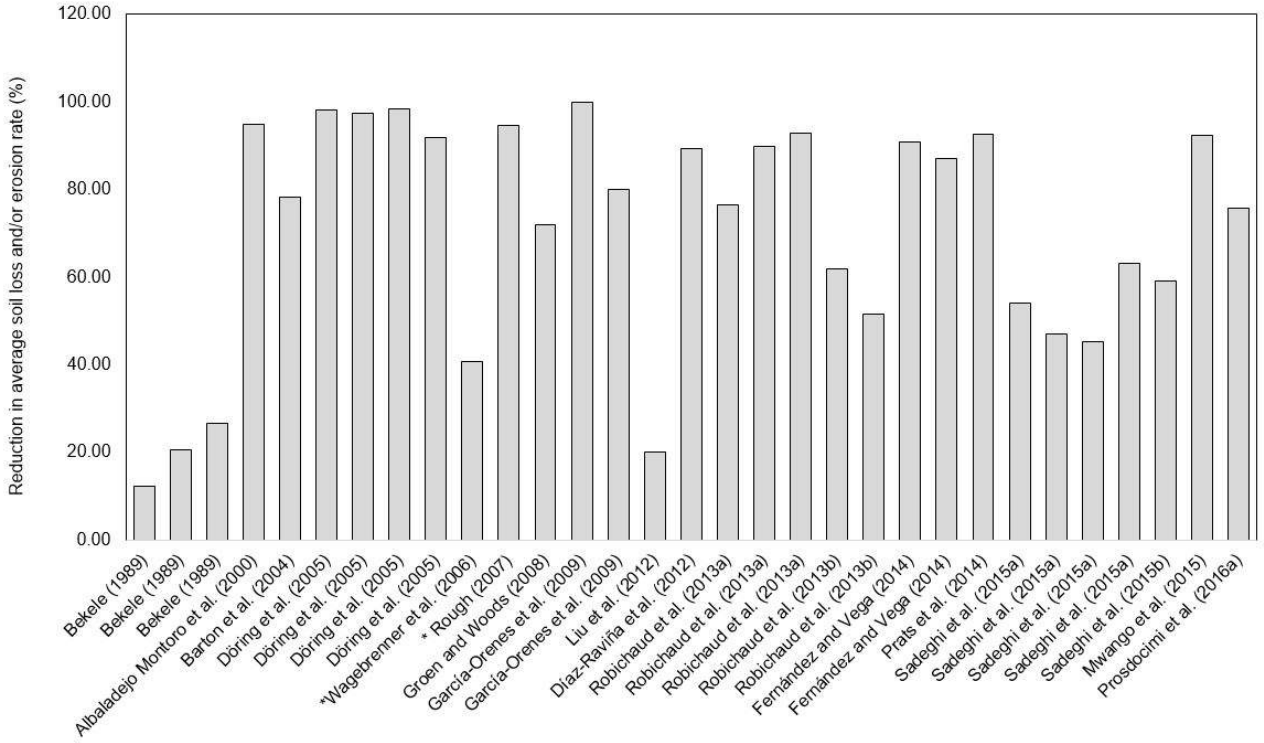
ABSTRACT

Among the soil conservation practices that are used, mulching has been successfully applied to reduce soil and water losses in different contexts, such as agricultural lands, fire-affected areas, rangelands and anthropic sites. In these contexts, soil erosion by water is a serious problem, especially in semi-arid and semi-humid areas of the world. Although the beneficial effects of mulching are known, further research is needed to quantify them, especially in areas where soil erosion by water represents a severe threat. In the literature, there are still some uncertainties about how to maximize the effectiveness of mulching to reduce the soil and water loss rates. Given the seriousness of soil erosion by water and the uncertainties that are still associated with the correct use of mulching, this study review aims to (i) develop a documented and global database on the use of mulching with vegetative residues; (ii) quantify the effects of mulching on soil and water losses based on different measurement methods and, consequently, different spatial scales; (iii) evaluate the effects of different types of mulches on soil and water losses based on different measurement methods; and (iv) provide suggestions for more sustainable soil management. The data published in the literature have been collected. The results showed the beneficial effects of mulching in combating soil erosion by water in all of the environments considered here, with reduction rates in the average sediment concentration, soil loss and runoff volume that, in some cases, exceeded 90%. However, the economic feasibility of mulching application was not readily available in the literature. Therefore, more research should be performed to help both farmers and land managers by providing them with evidence-based means for implementing more sustainable soil management practices.



Prosdocimi et al. 2016 (Earth-Science Reviews)





Prosdocimi et al. 2016 (Earth-Science Reviews)

Science of the Total Environment 547 (2016) 323–330

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

The immediate effectiveness of barley straw mulch in reducing soil erodibility and surface runoff generation in Mediterranean vineyards

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[b] MED_Soil Research Group, Dept. of Crystallography, Mineralogy and Agricultural Chemistry, University of Seville, C/Profesor García González #1, 41012, Spain
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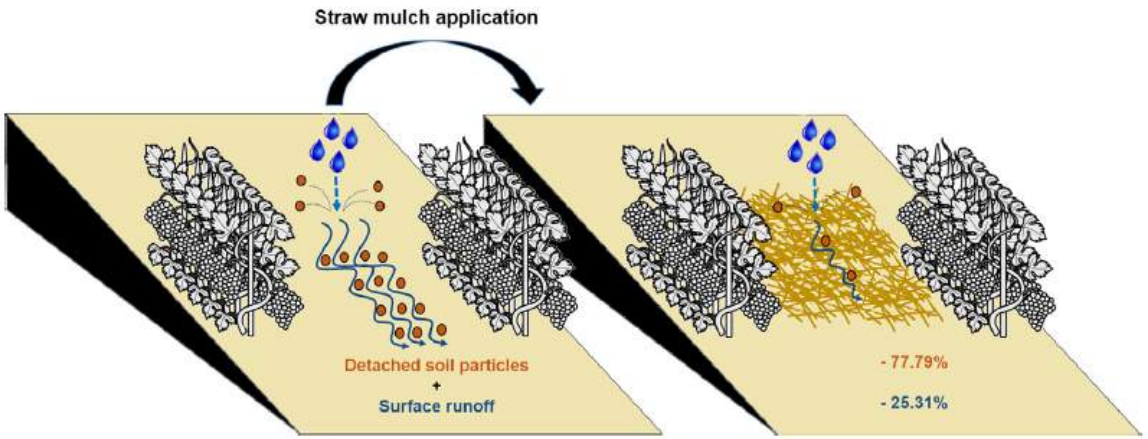
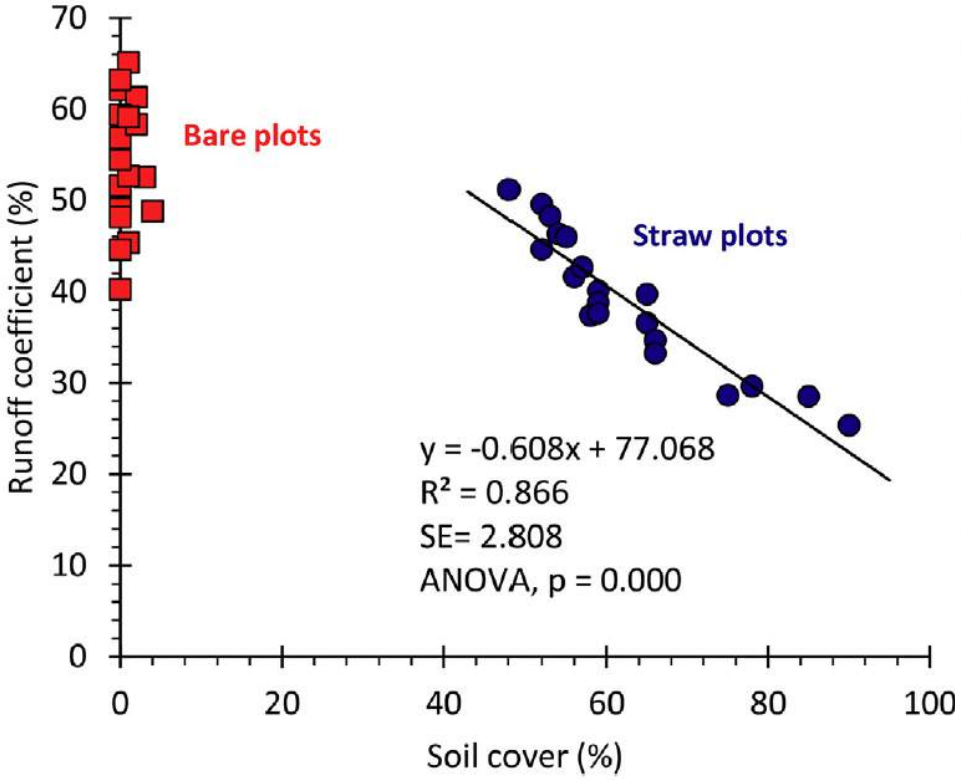
[e] Soil Erosion and Degradation Research Group, Department of Geography, University of Valencia, Blasco Ibáñez, 28, 46010 Valencia, Spain

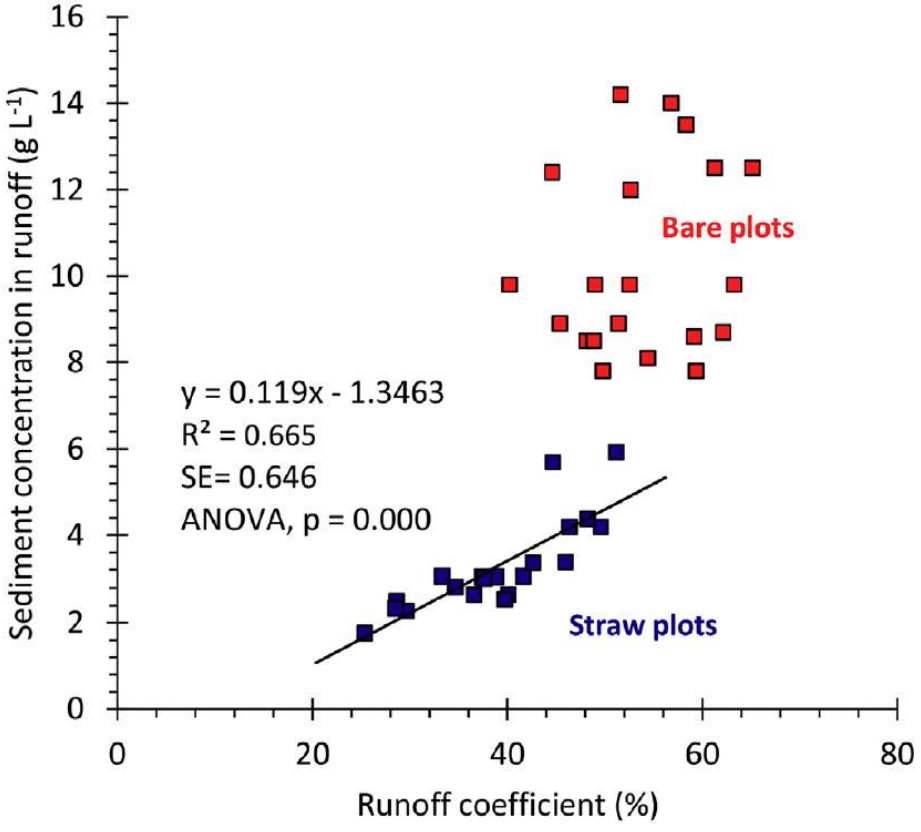
HIGHLIGHTS

- Mulching rate of 75 g m^{-2} has beneficial effects on soil and water losses.
- Straw mulch reduces the median water loss from 52.59 to 39.27%.
- Straw mulch reduces the median erosion rate from 2.81 to 0.63 Mg ha^{-1} h^{-1}.
- Straw mulch is a sustainable management strategy in Mediterranean vineyards.

GRAPHICAL ABSTRACT

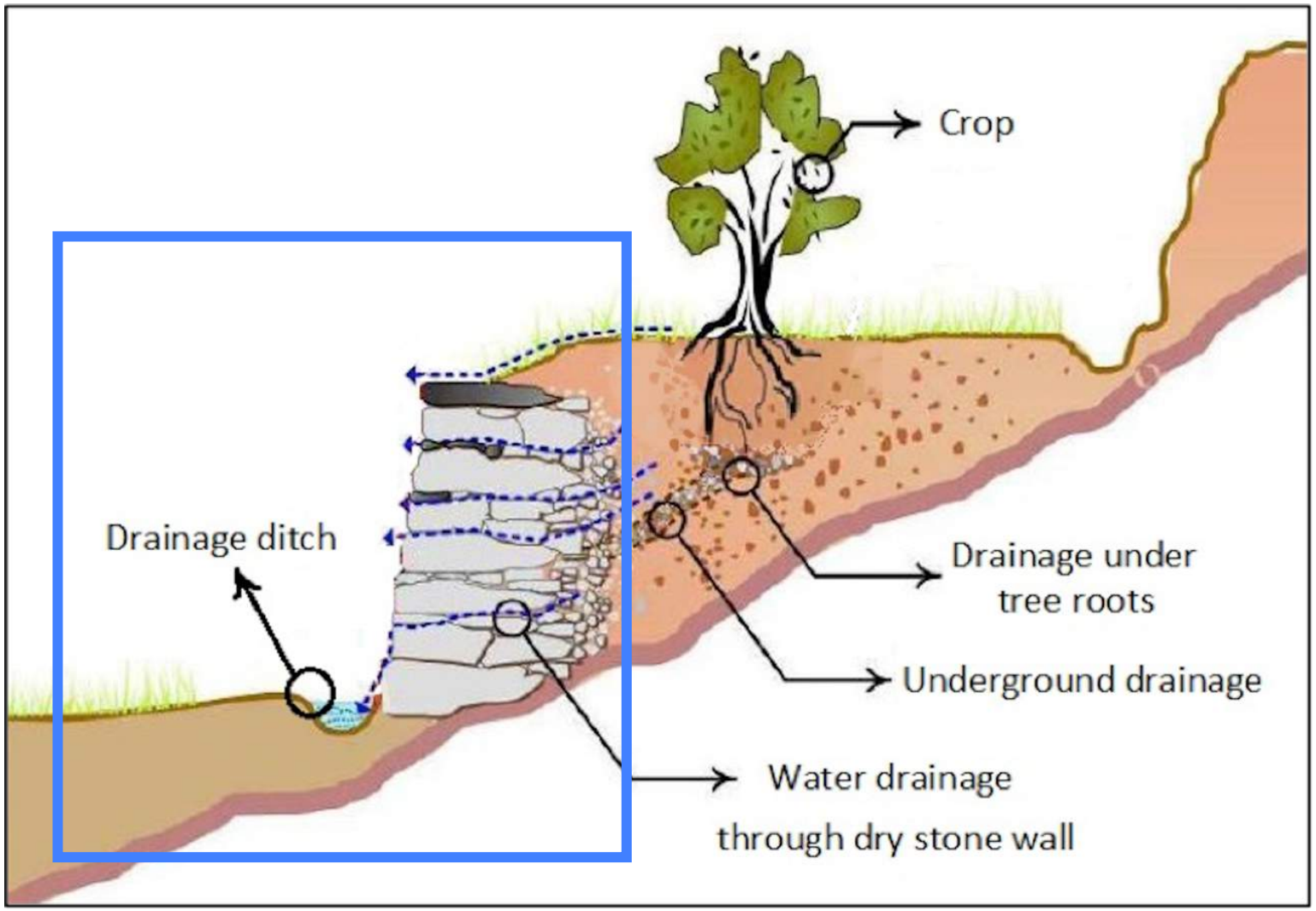






Prosdocimi et al. 2016 (Science of The Total Environment)

Improve / maintain drainage system in agricultural terraced lanscapes



FINAL REMARKS

- High-resolution topographic data obtained from remote-sensing technologies, especially those cheaper and faster, may provide new insights into the knowledge of erosion processes that affect vineyards. The results can help to schedule appropriate soil and water management techniques for a sustainable viticulture.

- Proper measures must be taken to protect the soil, and more resources should be addressed to keep monitoring soil erosion by field measurements over longer periods.

- We believe that much more attention should be paid to the viticulture sector to reduce its impact on soil erosion issue.

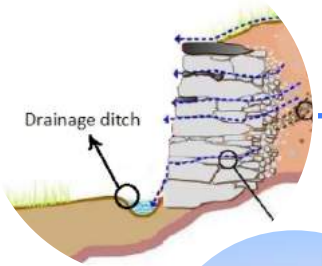
FINAL REMARKS

- Terraced landscapes need to be maintained, well managed, and protected. These actions can help to overcome the critical issues related to erosion risk and landslides.

- Mulching practice confirmed to be effective for reducing soil and water losses in different environments across the world. However, there are still some open questions about the most appropriate types of mulches, application rate and cover and economic feasibility.

- The presented methodologies and results may be of assistance to both farmers and land managers by providing them with evidence-based means for implementing more sustainable soil management practices.

eng. solutions



cover crops conservation tillage

mulching

remote-sensing GIS

people

Thank you for your attention