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From grapes to getaways: Unraveling the residential tourism impact on land use change and soil erosion processes in Menfi district

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ABSTRACT

The Mediterranean basin has experienced widespread changes in land use and, along with this, changes in geomorphological and hydrological processes and erosion risks. The Menfi area (Italy) has been no exception, and residential tourism has played an unexplored role. Using satellite images in 2007 and 2022, the main changes in land use were determined comparatively, and the variation in soil erosion levels was calculated using the RUSLE equation. The contribution of residential tourism to these processes was also analyzed. The results show a substantial decrease in the area occupied by vineyards and a increase in the site devoted to residential tourism (second homes) with olive orchards. Erosion values have also decreased. The results allow us to conclude that the decrease in the area with vineyards results in a reduction in soil erosion. The main drivers of the change in land use are socioeconomic factors, including the aging of farmers, the shift of subsequent generations to alternative activities, and the overall decrease in agricultural income. In addition, the expansion of tourist infrastructure was accentuated in the new land with olive orchard groves in south-faced, medium-altitude, and lower slope areas, which together provide landscape value and contribute to the reduction of soil erosion.

1. Introduction

Human activities exert mounting environmental pressure on soil, encompassing agricultural-forestry practices, mining operations, industrial activities, urban development, and tourism pursuits.

Among these human activities, residential tourism (second homes), defined as tourism that does not appear, often represents the driving force of the local economy, and the opportunity for investments and support populations from the economic point of view and, in many cases can be considered the main driving forces in land use change of large territory. Its quantification can provide local policymakers with a strategic tool for planning infrastructural and economic investments, improving the efficiency of services and tourist flows. This type of tourism development is generating repercussions on the environment, and there is little knowledge about the impact on ecosystem services, especially soil erosion. Consequently, the degradation of soil, predominantly attributable to erosion, emerges as a significant ecological concern (Olarieta et al., 2008; Zika and Erb, 2009) and Mediterranean areas are no exception. Soil erosion is exacerbated by rapid changes in land use, high rainfall intensity, low organic matter, and agricultural activities on steep slopes (García-Ruiz, 2010; Novara et al., 2011).

For a wide range of spatial scales, soil types, climates, and vegetation, the relationship between vegetation cover and water erosion fits a negative exponential curve (Gyssels et al., 2005). The presence of vegetation also helps to increase the amount of organic matter in the soil, which further strengthens soil aggregates and makes them more resistant to erosion. It also protects the soil from the impact of raindrops, increases infiltration capacity, and slows runoff.

Land use change has historically been considered a localized environmental problem but has progressively gained a position of global importance (Foley et al., 2005). In natural areas, changes are commonly associated with productive agricultural, forestry, or livestock use. In the case of rural areas, changes are related to productive changes (type of productive approach) or changes in activities (urbanization or tourism). Regardless of the specific course of action pursued, there exists a looming risk of compromising natural resources unless appropriate measures are undertaken to ensure their sustainable utilization and conservation (Casas, Albarracin, 2015). Thus, changing from one type of use to another (*e.g.*, from agriculture to urban tourism) or changes in crops (from perennial to annual) and technical management (from

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traditional to conservationist management) could transform the composition of local ecosystem services. When these changes diminish ecosystem services related to erosion control, soil degradation processes advance.

The Mediterranean region is a land of contrasts, where urban centers and agricultural fields coexist nearby. However, these two land uses are increasingly coming into conflict, as urban expansion encroaches on arable land. This is a trend that is likely to continue in the years to come, as the Mediterranean region continues to grow and develop. Urban expansion on arable land is a common trend in much of the Mediterranean (Marraccini et al., 2015; Russo et al., 2017) that has led to hydrological and geomorphological changes near Mediterranean coasts (García-Ruiz, 2010; Villa et al., 2018). A thorough investigation of land cover transitions is available in Roy et al. (2014). The authors highlight those vineyards decreased by about 35% between 1950 and 2011, mainly due to urbanization. However, it should be noted that not all vineyards became impervious surfaces. In one Italian Mediterranean region, Sicily, according to the latest agricultural censuses, it has gone from 168,000 ha of vineyards in 1990 to 98,000 in 2020. Several factors contribute to these phenomena, including inadequate economic compensation for grape production, the increase in the average age of winegrowers, insufficient financial incentives for young winegrowers, the sale of replanting rights outside the region, the bankruptcy or closure of established wineries, the lack of interest in the conservation and improvement of the rural and viticultural landscape as well as the wineries' environment. Despite this negative trend, the Protected Geographical Indication slows down further changes in land use, and adherence to protocols or voluntary certifications related to sustainability and organic farming contributes to reducing the risk of soil erosion in vineyards.

Vines and olive trees are the native species of the Mediterranean agricultural landscape, determining a "cultural" landscape. Both species contribute to the development process of the Mediterranean, and the branding and promotion of a particular place as a tourist destination (Bitsani et al., 2019). In this sense, and the framework of the multifunctionality of agriculture, tourism development has advanced on agricultural land, and it is expected to observe vineyards and olive orchards that partially or totally change their production objective for the offer of tourist experiences or for the establishment of second homes. It should be noted that the landscapes used to define, to a large extent, the type and final intensity of land use. Thus, an almost total change of use is common in places with favorable climatic conditions and easy access to machinery. At the same time, less accessible areas are more likely to be abandoned when they are not cultivated (Schirpke et al., 2019). An equivalent phenomenon affects agricultural regions overlooking the Mediterranean Sea, such as the Rimini coast in Italy (Villa et al., 2018), Malaga and Costa del Sol (Andalusia), and Costa Daurada (Catalonia) in Spain (Serra et al., 2014) and the Côte d′Azur and Marseille areas in France.

In the south of Sicily, transitions are taking place that are visible to the naked eye but have not been quantified, such as that from vineyards to olive orchards, where tourist development is appreciable. In this regard, since the early 2000s, there has been a shift in the Menfi region, where the "tourist olive orchards" have emerged as a substitute for the old vineyards or as a new form of land use. This practice consists of growing olive trees primarily for their aesthetic appeal and residential properties with or without swimming pools. Consequently, this change in land use leads to alterations in the ecosystem services provided, especially in terms of erosion control. Given the circumstances, it is crucial to know how the change in land use has been, how the advance of tourism has been with the land occupied by vineyards and olive trees, and to know what the result of these processes in terms of soil erosion is.

This paper aims to understand the variation in erosion risk between 2007 and 2022 associated with land use changes in the Menfi district, explicitly focusing on landform, altitude, and slope, and their relationship with residential tourism development, while quantifying overall erosion changes for each land use.

2. Materials and methods

2.1. Study area

The Menfi district is located on the southwest coast of Sicily; it experiences a Mediterranean-type climate, characterized by an average temperature of 27 °C in July and August, with occasional highs reaching 43 °C. According to the Köppen climatic classification, it belongs to zone B, with a total of 825 days in this category. The Belice and Carboj rivers, along with several streams, cross the territory and provide water for the population and agricultural production. The soils of the area belong mainly to Luvisols, and Cambisols SRGs, including minor areas with Vertisols, according to WRB classification. Altitude ranges from zero to 620 m a.s.l. Agriculture is the primary economic sector in Menfi, where vine cultivation occupies 50% of the area. Traditional crops such as olives, artichokes, melons, and potatoes are also grown. Modern agricultural practices are applied in 925 farms, covering approximately 8600 ha, supported by irrigation practices. This agricultural activity forms the basis for a network of small businesses engaged in irrigated produce and the processing and marketing of farm products. The wine industry is crucial to the local economy, processing and selling some 60,000 tons of grapes per year. The leading wine cooperative, "Cantine Settesoli" (6000 ha and 2000 associated farmers), exports its products worldwide, while La Goccia d′Oro (1100 members) produces extra virgin olive oil.

The town of Menfi is located between the Doric temples of Selinunte and the archaeological excavations of Eraclea Minoa. Menfi has a long history of settlement, including the ancient city of Inico and Saracen settlements. Historical interest in the area, together with its coastal resorts and child-friendly beaches, has made Menfi an increasingly popular tourist destination. However, the issue of seasonality persists as an unresolved challenge, with tourist flows across the island being concentrated during specific periods of the year (Cuccia and Rizzo, 2011). On the other side, analyzing the economic effects associated with environmental quality certification, such as the Blue Flag award, Menfi stands out as one of the 458 beaches in Italy that received this prestigious recognition in 2023. This certification plays a significant role in attracting tourists to the area, as highlighted by Capacci et al. (2015).

2.2. Data preparation and processing

A geodatabase, with two land cover maps for 2007 and 2022, was created after a photo interpretation and digitization of the images acquired at the cadastral parcel level. About 5000 cadastral parcels were digitalized in the total Menfi municipal area (about 1100 ha). The interpretation resulted in six different land covers as follows: (1) Abandon land, (2) Wood, (3) Olive orchard, (4) Arable land, (5) Built-up area, (6) Vineyard. Arable land refers to rainfed durum wheat and on flatlands (< 5% slope) annual rotation only durum wheat-tomato or durum wheat-artichoke.

In particular, data was stored in a raster format (geotiff) and projected in a unique geographical system (ETRS89 Lambert Azimuthal Equal Area). Raster map-algebra techniques were used to overlap all raster data (Licker et al., 2010) and to calculate the investigated outputs.

2.3. Erosion estimation using RUSLE

The RUSLE estimates average annual soil erosion rates and determines spatial patterns of soil loss (Eastman, 2012). The model was run on IDRISI TerrSet 2020 software (Clark Labs, MA U.S.A.) using a 5 m DEM for 2007 and 2022 to estimate soil erosion based on land cover maps produced (Fig. 1).

RUSLE parameters for erosion estimation are described below (Renard et al., 1997):

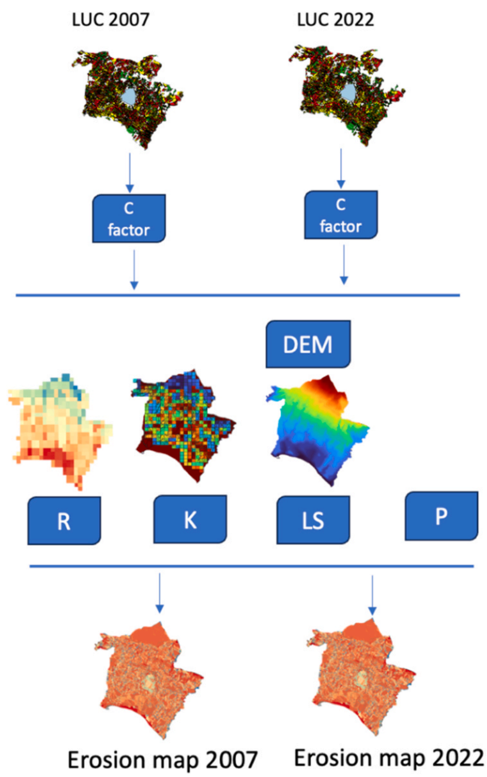

Fig. 1. Synthesis of the methodological process for obtaining erosion values in Menfi for the years 2007 and 2022.

$$A = R \times K \times LS \times C \times P \quad (1)$$

A = average annual soil loss (t ha^{-1} yr^{-1})
R = rainfall-runoff erosivity factor (MJ mm ha^{-1} h^{-1} yr^{-1})
K = soil erodibility factor
LS = slope length and steepness factor
C = cover management factor
P = support practice factor.
Rainfall erosivity (R)

Rainfall erosivity is the kinetic energy of a raindrop's impact and the rate of associated runoff. Among the factors used within RUSLE and its earlier version, the Universal Soil Loss Equation (USLE), rainfall erosivity is of high importance as precipitation is the driving force of erosion and has a direct impact on the detachment of soil particles, the breakdown of aggregates and the transport of eroded particles via runoff. The R-factor accumulates the rainfall erosivity of individual rainstorm events and averages this value over multiple years. Rainfall erosivity data was derived from Panagos et al. (2015a)).

Soil erodibility (K).

Application of the RUSLE model also required the K factor estimation, which represents the influence of different soil properties on the slope susceptibility to erosion (Renard et al., 1997). K factor also defines the "mean annual soil loss per unit of rainfall erosivity for a standard condition of bare soil, recently tilled up down slope with no conservation practice" (Morgan, 2005). In the RUSLE, Renard et al. (1997) proposed an equation that relates textural and organic matter characteristics, soil structure, and profile-permeability with the K factor or soil erodibility factor. Recently, the new soil erodibility map for Europe generated by Panagos et al. (2014) using the Land Use/Cover Area frame Survey (LUCAS) soil European dataset allowed a rough evaluation of the K factor in the absence of the required soil textural information for the K factor RUSLE estimation (https://esdac.jrc.ec.europa.eu/themes/soil-erodibility-europe).

Slope length and steepness factor (LS).

The LS factor was extended to topographically complex units using a method that incorporates contributing area and flow accumulation (Desmet and Govers, 1996) derived from DEM and GIS approaches. In our case, a high-resolution DEM was used to assess the LS factor of each plot. LS factor was calculated according to Renard et al. (1997).

Cover management (C).

The C factor, which represents the influence of vegetation on soil erosion, ranges from 0 to 1. Lower values indicate higher vegetation cover and reduced soil erosion, while higher values indicate lower cover and increased erosion. Estimating the C-factor in the RUSLE model requires knowledge of several subfactors, such as past management practices, vegetation height, surface cover, and roughness. Locally, the vegetation cover accompanying crops is usually removed mechanically or chemically before the dry and hot summer season. Yet, variations in cultivation techniques are recognized that would correspond to different values for Factor C. A list of values for Factor C according to crop type was obtained by reviewing updated literature and consulting specialists and local academics who have worked on similar crops (Table 1).

Conservation practice (P).

In our case, supporting practices (P) were standardized for all land use types, setting the P factor value at a value equal to unity (Adornado et al., 2009). This is mainly due to the absence of any support practices in the specific area, which leads us to conclude that assigning a value of 1 to the factor would have no significant impact on the Wischmeier equation, as suggested by Panagos et al. (2015c).

3. Results

3.1. Land use change

3.1.1. Description of changes in land use in terms of surface area

An assessment was conducted to determine the area occupation of different land use types in Menfi, such as "Abandoned land" (from here on, Abandoned), "Wood", "Olive orchard", "Arable land", and "Vineyard" for the years 2007 and 2022.

Fig. 2 presents an image of Menfi with the areas occupied by each of the land use types in the years 2007 and 2022. Table 2 shows the absolute and percentage variation of the land as mentioned above. The land use analysis in Menfi reveals that in 2007, the predominant cultivation land uses were "Vineyard" (occupying 30.78% of the surface area), "Arable land" (25.38%), "Abandoned" (17.38%), and "Olive orchard" (14.28%). However, by 2022, the ranking had shifted, with "Arable land" taking the lead (occupying 28.70%), followed by "Vineyard" (26.11%), "Olive orchard" (16.59%), and "Abandoned" (16.21%). It can also be observed that ""Arable land"" and ""Olive orchard"" are the uses that have increased their surface areas the most (3.32% and 2.30%, respectively) and that "Vineyard" and "Abandoned" are the uses that have decreased their surface areas (−4.67 and −1.17%, respectively).

An analysis of the percentage variation by type of land use indicates

Table 1
Setting of values for C-factor according to the type of land uses in Menfi 2007–2022.

Land use	Bibliographic values	References	Proposed value
Vineyard	0.3434; 0.3574; 0.3; 0.18; 0.4	Panagos et al. (2015b);Roy et al. (2014);Biddoccu et al. (2020); Baiamonte et al. (2019)	0.3
Olive	0.2273; 0.2163; 0.1–0.3	Panagos et al. (2015b)	0.22
Arable land	0.2323; (0.07–0.35)	Panagos et al. (2015b)	0.23
Abandon	0.01–0.1	Panagos et al. (2015b)	0.06
Mixed forest	0.001–0.003	Panagos et al. (2015b)	0.002

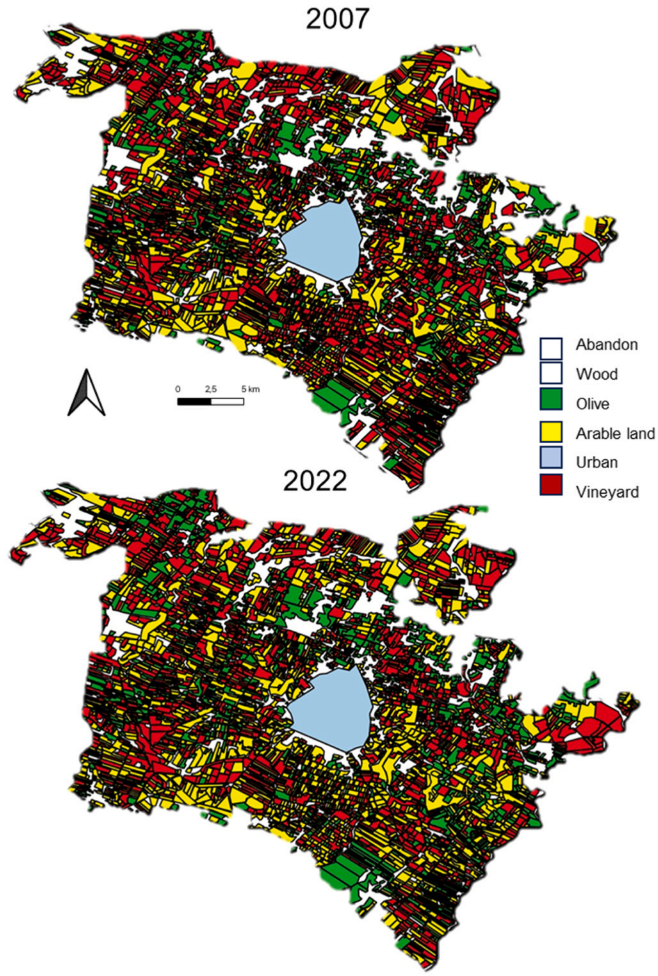

Fig. 2. Land use change maps from 2007 to 2022 in Menfi area.

Table 2
Land use change from 2007 to 2022 in Menfi area.

	Area (ha)			Area (%)		
	2007	2022	delta	2007	2022	delta
Abandoned	1710	1595	-115	17.4	16.2	-1.2
Forest	909	909	0	9.2	9.2	0.0
Olive	1405	1632	227	14.3	16.6	2.3
Arable land	2498	2825	327	25.4	28.7	3.3
Urban	289	311	21	2.9	3.2	0.2
Vineyard	3029	2569	-460	30.8	26.1	-4.7

that the land use “Vineyard” lost 15.18% of the land it had in 2007 and that “Abandoned” land decreased by 6.74%. In the opposite direction, the land use type “Olive tree” increased by 16.14% and “Arable land” by 13.34%.

Fig. 3 and Table 3 show the proportion of area that continues to be occupied with the same type of land use, as well as the origin of the incorporated area and the destination of the ceded area. It also shows the proportional values in a matrix. The “Vineyard” and the “Arable land” use retained 62.44% and 69.87% of the area they occupied in 2007, respectively. These values indicate that the area occupied by these two types of land use has undergone the most remarkable dynamic change. On the other hand, the “Abandoned” and the “Olive orchard” uses retained, respectively, 92.29% and 97.44% of the area they occupied in 2007.

In the Menfi area, the “Arable land” type of use increased its relative area by 3.32% in 2022. This is mainly explained by having retained 69.87% of the 2007 area and by the positive balance (7.90%) between the area incorporated (38.02%) and the area changed to other uses (30.13%), as shown in the following detail. The use of “Arable land” incorporated, in relative terms to the Menfi area, 32.92% of the area used for “Vineyard”, 3.39% for “Abandoned” and 1.71% for “Olive orchard”. In turn, it ceded land to the uses “Vineyard” (25.15%), “Olive orchard” (4.73%), “Urban” (0.11%), and “Abandoned” (0.23%).

The “Vineyard” category experienced, in relative terms to the study area, a decrease of 4.67% from 2007 to 2022. This decrease can be attributed mainly to retaining only 62.44% of the 2007 area and exhibiting a negative balance of 9.22% between the area incorporated (28.12%) and the area turn down (37.34%). Further analysis reveals that the “Vineyard” category included land from “Arable land” (25.11%), “Abandoned” (2.03%), and “Olive orchard” (0.46%). Conversely, it transferred land to “Arable land” (32.93%), “Olive orchard” (4.46%), and “Abandoned” (0.20%) uses.

The “Olive orchard” land use category experienced a relative increase in surface area of 2.30% in 2022. This increase can be primarily explained by the retention of 97.44% of the original area and a positive balance of 7.20% between newly incorporated areas (9.80%) and areas ceded (2.56%). A detailed breakdown reveals that the “Olive orchard” use included land from “Arable land” (4.73%), “Vineyard” (4.46%), and “Abandoned” (0.64%). Conversely, it relinquished land to “Arable land” (1.70%), “Vineyard” (0.46%), and “Abandoned” (0.34%).

The land use category “Abandoned” experienced a relative decrease in area of 1.17% in 2022. This decrease can be primarily attributed to retaining 92.22% of the original area and exhibiting a negative balance of 6.94% between newly incorporated areas (0.77%) and areas relinquished (7.71%). A breakdown reveals that areas previously categorized as “Olive orchard” (0.34%), “Arable land” (0.22%), and “Vineyard” (0.20%) became part of the “Abandoned” category. On the other hand, 3.39% went to “Arable land” use, 2.25% to “Vineyard” use, 1.16% to “Urban” use, and 0.64% to “Olive grove” use.

The land use category labeled as “Urban” increased its occupied area by 0.21%. This increase can be explained by incorporating 1.16% of the land previously categorized as “Abandoned” as well as minimal land values from the “Olive orchard”, “Vineyard”, and “Arable land” uses. The “Wood” category maintained its original area from 2007 because it experienced negligible incorporation or transfer of land to other uses.

In summary, the analysis of the data shows that between 2007 and 2022 there has been a change in land use where the vineyard and arable land are the main actors in the dynamics of change, since between these two types of use, there was a high percentage of exchange. The distinction between the two is that vineyards have decreased in area and arable land has increased, becoming the main crop. Olive trees also grew, mainly on land previously occupied by vineyards. Finally, there has been a drop in the area of abandoned land, which has been occupied by arable land and, to a lesser extent, by vineyards.

3.1.2. Land use allocation in terms of altitude and slope

The following is an analysis of the geographic changes (altitude and slope) in the occupied areas according to the type of land use for the years 2007 and 2022 in Menfi. Fig. 4 shows, for the years mentioned, the range and dispersion of altitudes (m a.s.l.) in the areas occupied by each type of land use.

In the “Abandoned” (a), “Wood” (b), and “Urban” (u) land use types, no changes are observed in the interval and dispersion of altitudes for the respective occupied area.

Fig. 4 shows that the type of land use “Vineyard” (v) presents in 2022 concerning 2007 a median and an interval of greater value; in addition, the outliers are limited. The interquartile range (Q2 and Q3) maintains its dimension but is slightly displaced towards higher altitude values and presents a negative asymmetry (the values are more concentrated in quartile 3 than in quartile 2), *i.e.,* the median is higher than the mean. The land use type “Olive orchard” presents in 2022 with respect to 2007 a median of lower value, an interval of equal value, and the discordant

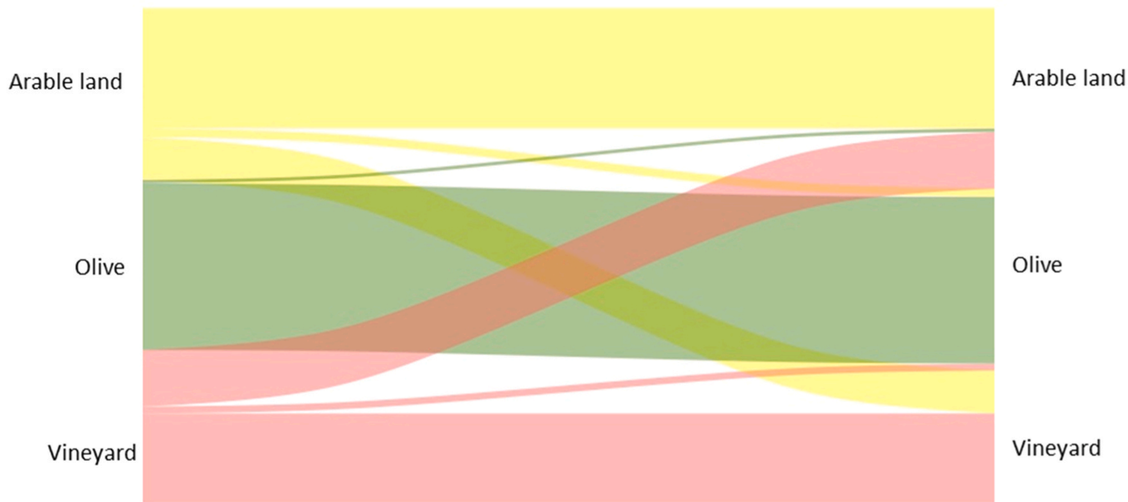

Fig. 3. Proportion of land permanents, as well as that which was relinquished or incorporated in the transition 2007 and 2022.

Table 3
Land use transitions from 2007 to 2022 in the Menfi area. Diagonal bold numbers indicate land use persistences.

		2022							
		Abandoned	Forest	Olive	Arable land	Urban	Vineyard	**Losses**	**Balance**
2007	Abandoned	**0.92**	0.00	0.01	0.03	0.01	0.03	0.08	-0.07
	Forest	0.00	**1.00**	0.00	0.00	0.00	0.00	0.00	0.00
	Olive	0.00	0.00	**0.97**	0.02	0.00	0.00	0.03	0.07
	Arable land	0.00	0.00	0.05	**0.70**	0.00	0.25	0.30	0.08
	Urban	0.00	0.00	0.00	0.00	**1.00**	0.00	0.00	0.01
	Vineyard	0.00	0.00	0.04	0.33	0.00	**0.62**	0.38	-0.09
	Gain	0.01	0.00	0.10	0.38	0.01	0.28		

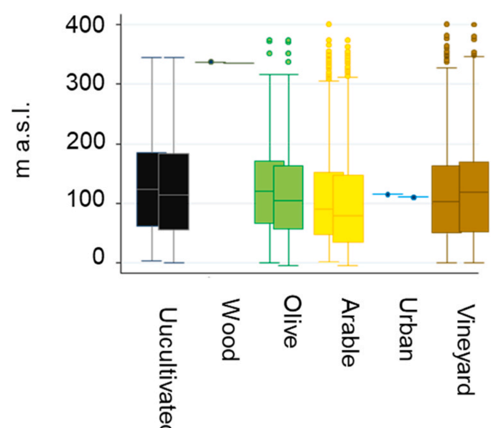

Fig. 4. Box and whiskers diagrams and dispersion of altitudes on the ordinates (m a.s.l.) according to the type of land use for the years 2007 (left) and 2022 (right). [Polygons with identical land use were computed as input data].

values are in greater quantity.

The interquartile range (Q2 and Q3) maintains its dimension but is slightly displaced towards lower altitude values and presents greater symmetry, that is, the median is close to the mean. The land use type “Arable land” (s) has a lower median value in 2022 compared to 2007;, the interval is slightly smaller and the discordant values are more grouped. The interquartile range is slightly higher in dimension and the second quartile starts from values of lower altitude, in addition, they maintain the positive asymmetry, that is, the median is lower than the mean.

Part of the area with the “Vineyard” type of use has slightly shifted towards higher altitude zones from 2007 to 2022 (data in SI). Thus, in 2007, 50% of the area was located up to 113 m a.s.l., and in 2022 it will be up to 123 m a.s.l. The opposite is true for the “Arable land” type of use (s), as more area is located at lower altitudes. Thus, in 2007, 50% of the area was located below 110 m a.s.l. in 2022 it was below 99 m a.s.l. The type of land use “Olive orchard” has a different behavior from the previous uses analyzed, since the significant changes are located below 40% of the surface area at a higher altitude (105 m a.s.l.) and in 2022 it is located below 95 m a.s.l. In general, there has been a noticeable trend in land use patterns. Vineyards, for instance, are increasingly found at higher altitudes, while arable land and olive tree cultivation have shifted towards lower altitude areas (data in SI).

The vineyard’s movement towards higher altitudes can be attributed to the desire to mitigate the impact of high summer temperatures, ultimately enhancing the quality of grapes for winemaking. Lastly, the shift in olive orchard cultivation is primarily driven by the aesthetic appeal of this species in tourist developments, particularly in areas near urban centers and the sea (at lower altitudes) or offering sea views (at medium altitudes and South quadrant exposure), which were previously occupied by vineyards.

From 2007 to 2022, 60% of the area allocated to the “Vineyard” type of use has shifted slightly towards areas with lower slopes (<3%). In 2007, 60% of the “Arable land” area was located on slopes of less than 3.30% and in 2022 it is located on slopes of less than 3.70%. Finally, the “Olive orchard” land use did not change between 2007 and 2022.

3.2. Tourism associated with vineyards and olive orchards

3.2.1. Tourism associated with the “Olive orchard” type of use in terms of surface (area) and spatial characteristics

A visual analysis performed on a satellite image from 2007 indicates that no area of the “Olive orchard” use type was clearly associated with a new or restored residence or a residence with a swimming pool, allow us to consider it as a residential tourism pressure indicator. In the year 2022 and as mentioned above, 263 new hectares with olive trees were found. Applying the same visual analysis as in 2007, it was found that 75.3% of the new hectares had only olive trees and 24.7% were associated with tourism infrastructure (new residence, 47.0 ha, or new residence and swimming pool, 18.0 ha).

Table 4 shows that tourism developments associated with olive growing are mainly located in places with southern and southwestern solar exposure, at medium or low altitudes and on slopes below the average values for olive trees in the region.

Olive groves, whether designated for tourism or not, are managed identically. In the case of those earmarked for tourism, only a small portion of the land is occupied by swimming pools. The annual management practices, including pruning and harvesting, follow uniform procedures across all olive groves. Given that these activities are primarily outsourced, disparities in management do not manifest.

3.2.2. Tourism associated with the “Vineyard” type of use in terms of surface area and spatial characteristics

Visual analysis of a satellite image of Menfi in 2007 indicates that there were no new or restored residences or residences with swimming pools that could be associated with tourism developments. The same analysis applied to a 2022 image gave identical results. That is, no new or restored residences or residences with swimming pools were found that would indicate tourism associated with “Vineyard” use. It should be noted that wineries providing tourism services were not counted.

It was previously described that the “Vineyard” land use type retained 1981 ha (62.40%) of the total hectares in 2007 and incorporated 667 new hectares, reaching a total of 2564 ha. Table 5 shows that the new vineyard presents in general terms similar characteristics of slope and solar exposure to the rest of the vineyards. The difference is that the new vineyards occupy, in terms of average value, areas with a significantly higher altitude.

3.3. Soil erosion

3.3.1. General erosion by type of land use

The results of changes in erosion as a function of changes in land use between 2007 and 2022 are presented in Fig. 5. Total erosion decreased from 2007 to 2022 by an absolute value of 2626 t, equivalent to 2.58%. However, the average values per hectare (from 8.16 t ha^{-1} $year^{-1}$ in 2007–8.17 t ha^{-1} $year^{-1}$ in 2022) are similar and far from the tolerable values proposed by Bazzoffi (2009) of 3 t ha^{-1} $year^{-1}$. In particular, the “Wood”, and “Abandoned” uses did not present variations. In the “Vineyard” use, erosion decreased by 7.05% and in the “Olive orchard” and “Arable land” uses, erosion increased by 2.32% and 4.82% respectively. The decrease in erosion in the “Vineyard” use is associated with the decrease in its surface area (4.70%) and in the opposite direction occurs with the “Olive orchard” and “Arable land” uses, but to a lesser extent (2.30% and 3.20%, respectively).

4. Discussion

We invested considerable effort in scrutinizing the institutional framework of the area, particularly concerning land use regulations that might govern or restrict specific land use changes in designated areas or transitions between distinct land use categories. However, it has become evident that such specific regulations, simply, do not currently exist. To date, the sole forbidden activity has been the potential sale of the vineyard replanting share, as stipulated by the legislation enacted in 2020. Consequently, during the period in question, there existed no explicit legal framework governing the utilization of the designated land.

The analysis of the results presented shows that between 2007 and 2022 there have been variations, always less than 5%, in the amount of area allocated to each type of land use. In the process of land use change, the uses “Vineyard” and “Arable land” are the main actors in the dynamics of change, since between these two types of use there was a high percentage of exchange (greater than 25%). The distinction between them lies in the fact that the “Vineyard” use decreased its surface area and the “Arable land” use increased it, becoming the main use. A secondary actor has been the “Olive” type of use, which also increased its surface area and did so mainly on land previously occupied by the “Vineyard” use. Finally, there was a drop in the area of “"Abandoned”, which was occupied by “Arable land” and, to a lesser extent, “Vineyards”.

The change observed in land use patterns in Menfi between 2007 and 2022 aligns, to a large extent, with the trends identified by Roy et al. (2014), as the use “"Vineyard”" has decreased in area and the use “Arable land” has grown. A unique case is described by Sparks et al. (2022) for the Douro region, where arable land has been increasing since 2009 and permanent agriculture has also increased since 1993—changes showing increased agricultural intensification along with a contrasting trend of polarization of abandonment. Like the Menfi region, the Portuguese Douro region presents a rich variety of landscapes characterized by their unique attributes. In the western part, where human influence is more prominent, the valleys are mainly characterized by a combination of vineyards, olive groves and orchards. It should be noted that, in the case of the Douro region, the “Olive orchard” class has been driven by plans to achieve economic viability. However, an opposite trend occurred, and olive trees have become increasingly marginal and subsidiary compared to the prominence of vineyards (Medeiros et al., 2022). This situation does not correspond to the changes in Menfi, where not only was more than 90% of the cultivated area preserved, but also increased it by 2.60% in terms relative to the area. The future of rural landscapes and ecosystem services in the Mediterranean region is uncertain, but understanding the impact of historical land use on biodiversity in olive orchards can help us to make better decisions about how to manage these landscapes in the future. A study in southern France examined land use patterns over two centuries and their relationship to botanical data, management practices, and environmental conditions (Cohen et al., 2023). The results revealed that past land use plays an essential role in determining plant community parameters and species composition.

Table 4
Analysis of the location of new “Olive orchard” as a function of altitude, slope and sun exposure compared to the entire olive grove area.

	Sun exposure (degree)			Slope (%)			Altitude (m a.s.l.)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
New Olive	96	312	204	0	10.7	2.2	70	337	104
New Olive + house	115	306	209	0	7.8	1.8	2	245	91
New Olive + house +swimming pool	184	264	215	0	5.9	1.8	14	175	67
Total Olive	88	360	210	0	17.5	2.1	0	374	121

Table 5
Analysis of new "Vineyard" in terms of altitude, slope and sun exposure in comparison to all vineyard areas.

	Sun exposure (degree)			Slope (%)			Altitude (m a.s.l.)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
New Vineyard	68	260	206	0	13	2.0	9	360	104
Total Vineyard	31	360	209	0	15	1.9	4	400	122

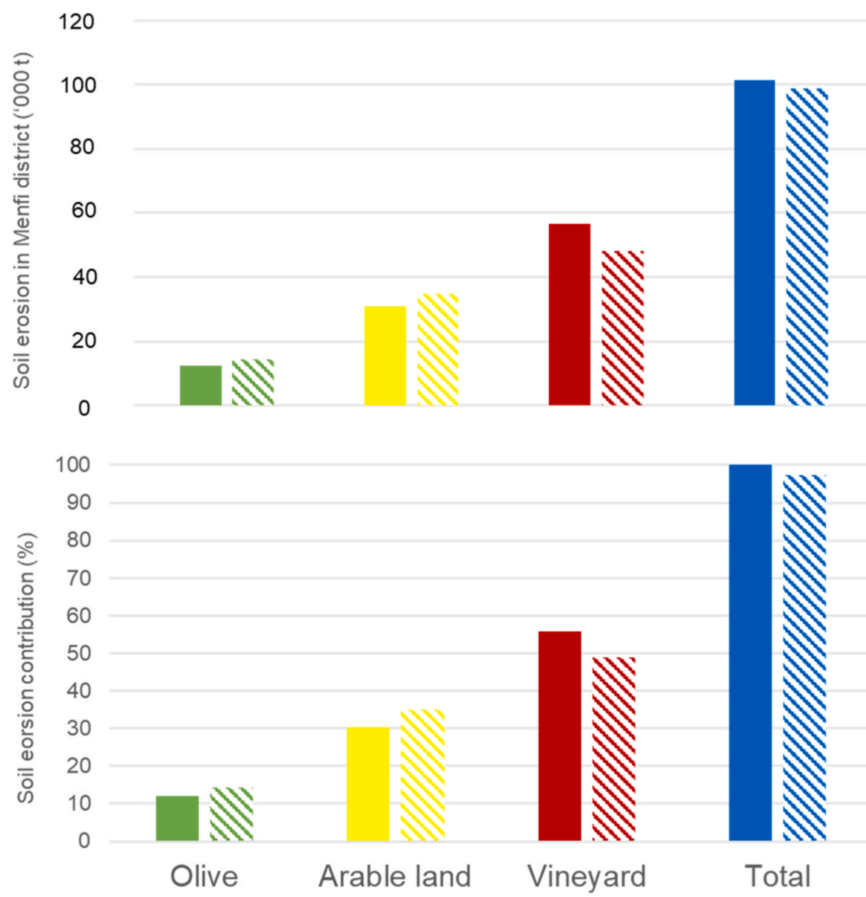

Fig. 5. Total erosion and percent contribution of different land use for Menfi district in the years 2007 (solid) and 2022 (stripes).

Olive trees with a history of natural vegetation and recent rehabilitation by farmers showed the highest species richness, whereas long-cultivated, abandoned and burned olive trees exhibited lower levels of biodiversity (Jiménez et al., 2023).

In the Mediterranean region, there is a growing trend of tourism associated with culinary experiences, especially focused on wine and olive oil (Jimenez et al., 2022, Martínez-Arnáiz et al., 2022). Similarly, it happens in agricultural areas overlooking the Mediterranean Sea, such as the Rimini coast in Italy (Villa et al., 2018), Malaga, Costa del Sol (Andalusia) and Costa Daurada (Catalonia) in Spain (Serra et al., 2014) and the Côte d'Azur and Marseille areas in France. This trend has implications for the management of farms dedicated to production and has a substantial impact on the catering and accommodation offered. In the case of Menfi, the descriptive analysis carried out allows us to interpret that tourism has been a driving force to be considered, since slightly more than 24% of the new olive orchards have infrastructures associated with residential tourism. The opposite is true for vineyards, where no associations with tourism were found in 2007 or 2022. Thus, the "Olive orchard" type of use, which, nowadays, responds mainly to aesthetic purposes and contributes to the visual and landscape attractiveness of the region, resulted as the consequence of the residential tourism rise.

Fleischer (2012) found that a sea view from a hotel room can add significant value to the room, but a sea view from the balcony side does not add as much value. This is likely because guests are more likely to spend time in the room itself and, therefore, appreciate a sea view from the window. This is reflected in the results of our work since the new olive trees associated with tourism are located in areas with southwest exposure and with medium altitude and slope, all aspects that favor the sea view.

In Menfi, the change in land use characterized by a decrease in vineyards and an increase in arable land and olive orchards has resulted in a slight decrease in soil erosion. According to Bazzoffi (2009), soil erosion values of 3 t ha^{-1} year^{-1} are tolerable, but the values obtained for the Menfi area are higher and make it vulnerable to soil erosion. This situation indicates the need to work on incentives for cover crops or other agro-environmental practices that allow to approach tolerable values and improve soil conservation (Ebabu et al., 2022; Gristina et al., 2022; Casas and Albarracin, 2015). Updating to date the calculations of Gaitán-Cremaschi et al. (2017), reduced erosion can save the farm no less than 20 EUR ha^{-1} year^{-1}.

The decrease in soil erosion, even in low amounts, means a positive impact, which extrapolated, also means an impact on the Sustainable

Development Goals (SDGs), and in particular on SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Earth).

5. Conclusions

In Sicily, as in the Mediterranean region, the process of decline in the area occupied by vines (vineyards) continues (*source* FAOSTAT). The change of land use in Menfi analyzed in this article constitutes new evidence of this process since the land that was used for vineyards has changed mainly to arable land. This indicates a continuity in the decline of land devoted to vine cultivation. The factors behind these trends are socioeconomic, including the aging of farmers, the shift of subsequent generations to alternative activities, and the overall decrease in agricultural income. The typic Mediterranean species, olive, has increased its surface area in the Menfi area, incorporating new areas previously occupied by vineyards at medium and low elevations above sea level. The situation described above raises questions and compromises since it is not known what the social and ecological impact of the new spatial configuration will be and whether the institutional framework will be able to respond quickly so that the changes that have occurred find rapid resilience.

The expansion of the "Olive orchard" type of use, where a quarter of the new additions are associated with residential tourism, requires particular attention since it allows us to postulate that we are in the presence of a nascent force of land use change that will consolidate and advance in areas with landscape qualities favorable to tourism. The tourism industry has the responsibility to safeguard the living conditions of the host community during tourism development, considering both benefits and costs. In turn, long-term effects should be carefully evaluated to ensure sustainable returns and avoid community dependence on tourism. In addition, tourists should be encouraged to appreciate and value the environmental heritage for the benefit of future generations.

Finally, as a result of land use change, the ecosystem service soil erosion control increased its effect. Because total erosion in the Menfi area decreased by ~3%, but is still above tolerable levels and needs to be addressed with some urgency. The main cause of the reduction in erosion lies in the decrease in the area of "Vineyard" use, which in turn is the type of use most susceptible to erosion. Even so, the situation indicates the need to plan sustainable soil management approach to improve erosion control and improve soil conservation.

The prime factors leading to the growth and progress of this type of tourism appear to be the high-grade seawater, presence of natural and scenic attractions, quality of services catered to tourists, initiatives associated with food and wine tourism, historical importance of the site, quality of social and institutional life, ability to welcome tourists and stability and control of living costs but also the specific beauty of the actual landscape composition.

The landscape is a major selling point for this territory. It is characterized by the sea and, above all, by the vineyards. However, the tourism of second homes is unknowingly reducing the area of the vineyards. While this trend has an accidentaly beneficial effect on the environment, it is also changing the landscape. The landscape is becoming different from the reason why the territory is now increasingly appreciated. Suppose we do not maintain the vineyards and introduce management practices that reduce erosion but instead let aesthetic olive orchards replace them with swimming pools. In that case, we risk reaching a point of no return where the general appreciation of the landscape decreases. The aesthetic value of the landscape is currently high due to the unique beauty of the vineyards that reach the sea. However, if these vineyards were to be converted to another use, the aesthetic value of the landscape could decline.

The results of this research should be considered in the context of the following limitations. First, the paper represents a static picture of two periods (range of 18 years) for which the dynamics of the LUC are uncertain for the future trend. Second, the dynamics examined will have to be discussed in terms of physical driving forces and in terms of logistical (distance to roads and cities) and social (age of farmers, per capita income, market structure, etc.). Thirdly, based on the above, careful modeling should be carried out shortly to propose a helpful management tool for farmers, policymakers, and stakeholders. Finally, to ensure the stability of the results over the whole area and over a long period, it is advisable to carry out a comparative study on several sites.

CRediT authorship contribution statement

Tonolli Alejandro: Writing – review & editing, Writing – original draft, Visualization, Investigation, Formal analysis, Data curation, Conceptualization. **Pisciotta Antonino:** Formal analysis. **Scalenghe Riccardo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Conceptualization. **Gristina Luciano:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

All authors disclose no financial and personal relationships with other people or organizations that could inappropriately influence (bias) our work.

Data Availability

Data will be made available on request.

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Impact statement

The research might contribute to the economy by guiding policymakers, land managers, and the tourism industry in making informed choices, leading to sustainable growth and minimizing environmental risks. It influences public policy by highlighting the need for effective measures to protect the environment and manage tourism activities. Furthermore, the findings promote soil conservation and erosion control, contributing to environmental health and long-term sustainability.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2023.107013.

References

Adornado, H.A., Yoshida, M., Apolinares, H.A., 2009. Erosion vulnerability assessment in REINA, Quezon Province, Philippines with raster-based tool built within GIS environment. Agric. Inf. Res. 18, 24–31 doi:10.3173/air.18.24.

Baiamonte, G., Minacapilli, M., Novara, A., Gristina, L., 2019. Time scale effects and interactions of rainfall erosivity and cover management factors on vineyard soil loss erosion in the semi-arid area of Southern Sicily. Water 11, 978–1002, 10.3390/w11050978.

Bazzoffi, P., 2009. Soil erosion tolerance and water runoff control: Minimum environmental standards. Reg. Environ. Change 9, 169–179 doi:10.1007/s10113-008-0046-8.

Biddoccu, M., Guzmán, G., Capello, G., Thielke, T., Strauss, P., Winter, S., Zaller, J., Nicolai, A., Cluzeau, D., Popescu, D., Bunea, C., Hoble, A., Cavallo, E., Gómez, J., 2020. Evaluation of soil erosion risk and identification of soil cover and management factor (C) for Revised Universal Soil Loss Equation in European vineyards with

different soil management. Int. Soil Water Conserv. Res. 8, 337–353. https://doi.org/10.1016/j.iswcr.2020.07.003.
Bitsani, E., Agriopoulou, S., Athanasopoulou, C. 2019. The cultural, nutritional and socioeconomic value of Greek Messinian olive oil. In A. Kavoura et al. (Eds.), Strategic Innovative Marketing and Tourism, Proceedings in Business and Economics. Springer. doi:10.1007/978–3-030–12453-3_35.
Capacci, S., Scorcu, A.E., Vici, L., 2015. Seaside tourism and eco-labels: The economic impact of Blue Flags. Tour. Manag. 47, 88–96 doi:10.1016/j.tourman.2014.09.003.
Casas, R., Albarracin, G. 2015. El Deterioro del Suelo y del Ambiente en la Argentina – Tomo 2. Fundación para la Educación, la Ciencia y la Cultura, FECIC. Buenos Aires, Argentina. p. 178–179, 347–353.
Cohen, M., Godron, M., Cretin-Pablo, R., Pujos, R., 2023. Plant biodiversity in Mediterranean orchards is related to historical land use: Perspectives for biodiversity-friendly olive grove production. Reg. Environ. Change 23 (2), 70 doi:10.1007/s10113-023-02067-6.
Cuccia, T., Rizzo, I., 2011. Tourism seasonality in cultural destinations: Empirical evidence from Sicily. Tour. Manag. 32, 589 doi:10.1016/j.tourman.2010.05.008.
Desmet, P.J., Govers, G., 1996. A GIS procedure for automatically calculating the USLE LS factor on topographically complex landscape units. J. Soil Water Conserv. 51, 427–433.
Eastman, J.R. 2012 IDRISI Selva Tutorial. IDRISI Production, Clark Labs-Clark University, Worcester, 45.
Ebabu, K., Tsunekawa, A., Haregeweyn, N., Tsubo, M., Adgo, E., Fenta, A.A., Meshesha, D.T., Berihun, M.L., Sultan, D., Vanmaercke, M., Panagos, P., Borrelli, P., Langendoen, E.J., Poesen, J., 2022. Global analysis of cover management and support practice factors that control soil erosion and conservation. Int. Soil Water Conserv. Res. 10 (2), 161–176 doi:10.1016/j.iswcr.2021.12.002.
Fleischer, A., 2012. A room with a view—A valuation of the Mediterranean Sea view. Tour. Manag. 33, 598–602 doi:10.1016/j.tourman.2011.06.016.
Foley, J.A., Defries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.T., Gibbs, H.K., Helkowsky, J.H., Holloway, T., Howard, E.A., Kucharic, C.J., Monfreda, C., Patz, J.A., Prentice, I.C., Ramankutty, N., Snyder, P.K., 2005. Global consequences of land use. Science 309, 570, 10.1126/science.1111772.
Gaitán-Cremaschi, D., Palomo, I., Baraibar Molina, S., De Groot, R., Gómez-Baggethun, E., 2017. Applicability of economic instruments for protecting ecosystem services from cultural agrarian landscapes in Doñana, SW Spain. Land Use Policy 61, 185–195, 10.1016/j.landusepol.2016.11.011.
García-Ruiz, J.M., 2010. The effects of land uses on soil erosion in Spain: A review. Catena 81 (1), 1–11 doi:10.1016/j.catena.2010.01.001.
Gristina, L., Novara, A., Minacapilli, M., 2022. Rethinking vineyard ground management to counter soil tillage erosion. Soil Tillage Res. 217, 105275 doi:10.1016/j.still.2021.105275.
Gyssels, G., Poesen, J., Bochet, E., Li, Y., 2005. Impact of plant roots on the resistance of soils to erosion by water: A review. Prog. Phys. Geogr. 29 (2), 189–217 doi:10.1191/0309133305pp443ra.
Jimenez, J.A.C., de la Torre, M.G.M.V., Millán, M.G.D., 2022. Factors that characterize oleotourists in the province of Córdoba. PLoS ONE, e0276631 doi:10.1371/journal.pone.0276631.
Jiménez, M.N., Castro-Rodríguez, J., Navarro, F.B., 2023. The effects of farming system and soil management on floristic diversity in sloping olive groves. Renew. Agric. Food Syst. 38, e15 doi:10.1017/S1742170523000091.
Licker, R., Johnston, M., Foley, J.A., Barford, C., Kucharik, C.J., Monfreda, C., Ramankutty, N., 2010. Mind the gap: How do climate and agricultural management explain the "yield gap" of croplands around the world? Glob. Ecol. Biogeogr. 19, 769–782, 10.1111/j.1466-8238.2010.00563.x.
Marraccini, E., Debolini, M., Moulery, M., Abrantes, P., Bouchier, A., Chéry, J.-P., Napoleone, C., 2015. Common features and different trajectories of land cover changes in six Western Mediterranean urban regions. Appl. Geogr. 62, 347–356 doi:10.1016/j.apgeog.2015.05.004.
Martínez-Arnáiz, M., Baraja-Rodríguez, E., Herrero-Luque, D., 2022. Multifunctional territorialized agri-food systems, geographical quality marks, and agricultural landscapes: The case of vineyards. Land 11, 457 doi:10.3390/land11040457.
Medeiros, A., Fernandes, C., Gonçalves, J.F., Farinha-Marques, P., 2022. A diagnostic framework for assessing land-use change impacts on landscape pattern and character – A case-study from the Douro region, Portugal. Landsc. Urban Plan. 228, 104580 doi:10.1016/j.landurbplan.2022.104580.
Morgan, R.P.C. 2005. Soil Erosion and Conservation. In Environmental Modelling: Finding Simplicity in Complexity, 2nd ed. Blackwell Publishing. doi:10.1002/9781118351475.ch22.
Novara, A., Gristina, L., Saladino, S.S., Santoro, A., Cerdà, A., 2011. Soil erosion assessment on tillage and alternative soil managements in a Sicilian vineyard. Soil Tillage Res. 117 doi:10.1016/j.still.2011.09.007.
Olarieta, J.R., Rodriguez-Valle, F.L., Tello, E., 2008. Preserving and destroying soils, transforming landscapes: Soil and land-use changes in the Vallès County (Catalunya, Spain) 1853–2004. Land Use Policy 25, 474–484 doi:10.1016/j.landusepol.2007.10.005.
Panagos, P., Meusburger, K., Ballabio, C., Borrelli, P., Alewell, C., 2014. Soil erodibility in Europe: A high-resolution dataset based on LUCAS. Sci. Total Environ. 479–480, 189–200 doi:10.1016/j.scitotenv.2014.02.010.
Panagos, P., Ballabio, C., Borrelli, P., Meusburger, K., Klik, A., Rousseva, S., Tadic, M.P., Michaelides, S., Hrabalíková, M., Olsen, P., Aalto, J., Lakatos, M., Rymszewicz, A., Dumitrescu, A., Beguería, S., Alewell, C., 2015a. Rainfall erosivity in Europe. Sci. Total Environ. 511, 801–814. https://doi.org/10.1016/j.scitotenv.2015.01.008.
Panagos, P., Borrelli, P., Meusburger, K., Alewell, C., Lugato, E., Montanarella, L., 2015b. Estimating the soil erosion cover-management factor at the European scale. Land Use Policy 48, 38–50 doi:10.1016/j.landusepol.2015.05.021.
Panagos, P., Borrelli, P., Meusburger, K., van der Zanden, E.H., Poesen, J., Alewell, C., 2015c. Modelling the effect of support practices (P-factor) on the reduction of soil erosion by water at European scale. Environ. Sci. Policy 51, 23–34 doi:10.1016/j.envsci.2015.03.012.
Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K., Yoder, D.C., 1997. Predicting soil erosion by water: A guide to conservation planning with the revised universal soil loss equation (RUSLE). USDA Agric. Handb. Number 703.
Roy, H., Fox, D., Emsellem, K., 2014. Impacts of vineyard area dynamics on soil erosion in a Mediterranean catchment (1950–2011). J. Land Use Sci. 13 (1–2), 118–129 doi:10.1080/1747423X.2017.1385654.
Russo, P., Tomaselli, G., Pappalardo, G., 2017. Marginal periurban agricultural areas: A support method for landscape planning. Land Use Policy 41, 97–109 doi:10.1016/j.landusepol.2014.04.017.
Schirpke, U., Altzinger, A., Leitinger, G., Tasser, E., 2019. Change from agricultural to touristic use: Effects on the aesthetic value of landscapes over the last 150 years. Landsc. Urban Plan. 187, 23–35 doi:10.1016/j.landurbplan.2019.03.004.
Serra, P., Vera, A., Tulla, A.F., Salvati, L., 2014. Beyond urban–ruralurban–rural dichotomy: Exploring socioeconomic and land-use processes of change in Spain (1991–2011). Appl. Geogr. 55, 71–81 doi:10.1016/j.apgeog.2014.09.005.
Sparks, A.M., Bouhamed, I., Boschetti, L., Gitas, I.Z., Kalaitzidis, C., 2022. Mapping arable land and permanent agriculture extent and change in Southern Greece using the European Union LUCAS survey and a 35-year Landsat time series analysis. Remote Sens. 14 (14), 3369 doi:10.3390/rs14143369.
Villa, P., Malucelli, F., Scalenghe, R., 2018. Multitemporal mapping of peri-urban carbon stocks and soil sealing from satellite data. Sci. Total Environ. 612, 590–604 doi:10.1016/j.scitotenv.2017.08.250.
Zika, M., Erb, K.H., 2009. The global loss of net primary production resulting from human-induced soil degradation in drylands. Ecol. Econ. 69, 310–318, 10.1016/j.ecolecon.2009.06.014.