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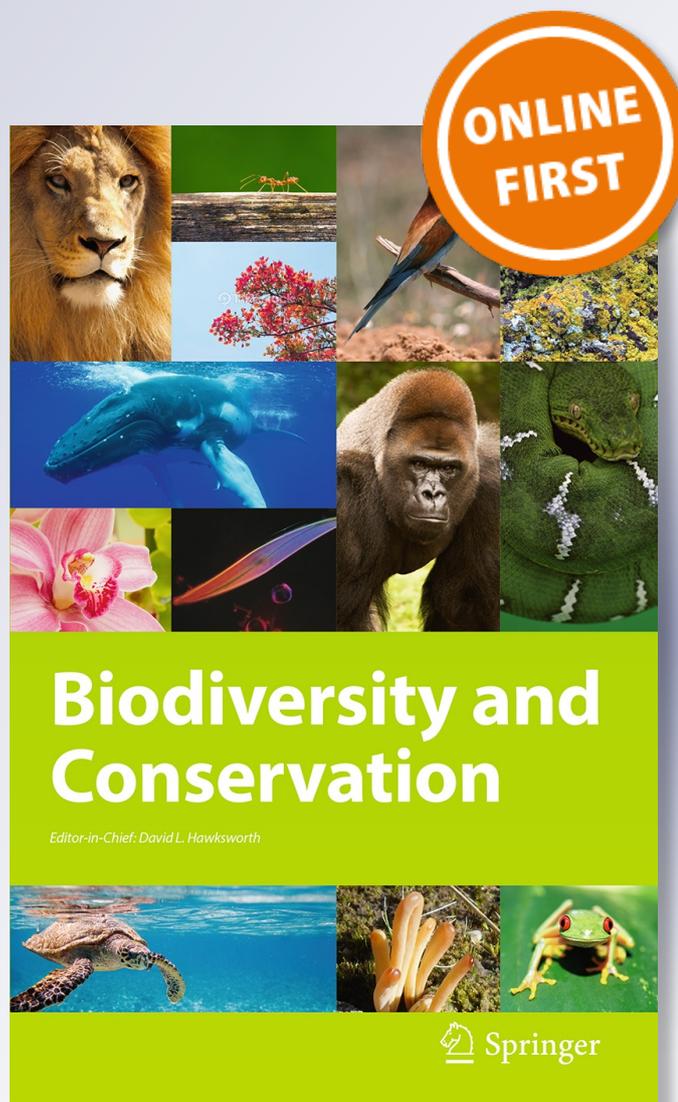
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Biocultural diversity and landscape patterns in three historical rural areas of Morocco, Cuba and Italy

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Abstract As indicated by the UNESCO-sCBD Florence Declaration on biocultural diversity the current state of biological and cultural diversity results from the combination of historical and on-going processes. The Declaration indicates the landscape level, particularly the rural landscape, as an appropriate dimension for understanding and applying this concept. The spatial component of biological diversity is of crucial importance for biodiversity, but is also one of the most interesting scientific perspective to understand biocultural diversity and the relationships with human influence. Historical landscapes still applying traditional agricultural practices are very good examples of how man has been able to adapt to difficult and often extreme, environmental conditions, preserving biodiversity. Species and their habitats have adapted to landscapes, changing their features, therefore a biocultural approach is probably best suited to understand and manage most of the biodiversity existing in landscape characterized by a long history of human influence. Some important international programs, such as UNESCO World Heritage List (WHL) for Cultural Landscapes and FAO Globally Important Agricultural Heritage Systems (GIAHS) are protecting rural landscapes. However, there is the need to introduce the biocultural diversity associated to the landscape mosaic in their conservation strategies. In order to study and compare biocultural diversity at landscape level, three case studies were selected in three different continents: Northern Africa (Morocco), Caribbean (Cuba) and Southern Europe (Italy). The landscape structure has been studied also to understand possible common features among areas located in very different social and environmental conditions, but all of them resulting from centuries of human influence. Despite these differences, the three areas have in common a high complexity and fragmentation of the mosaic that the study intended to highlight as an important aspect of biocultural diversity. In a comparative perspective, the three areas all display a prevalence of farmland over

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woodland and a relatively small average area of farmed plots: 0.48 ha in Viñales, 0.29 ha in the Itria valley, and 0.09 ha in Telouet, with an average patch size of 0.42 ha and an average agricultural patch size of 0.28 ha. The Moroccan site has by far the finest-grained landscape mesh, due to the characteristics of its irrigated fields and historical farming practices. According to this study, complex landscape mosaics represent a common feature of many traditional landscapes around the world, where socioeconomic needs rather than the environmental features, seem to be the driving factors.

Keywords Biocultural diversity · Landscape mosaics · Historical landscapes · Traditional knowledge

Introduction

Decades of historical, ecological and ethnobiological research on traditional knowledge of plants and animals, habitats, and ecological functions and relations, has provided evidence of the low environmental impact, and indeed sustainability of many traditional forms of natural resource use (Maffi 2007). The research evidence also points to a variety of ways in which humans have maintained, enhanced, and even created biodiversity through culturally diverse practices of management of “wild” resources and the raising of domesticated species. However, challenges to the notion that “pristine” environments, unaffected by humans, could be restored to their “original” state by protecting them from human activity, has not really influenced conservation strategies.

A deeper understanding of these processes requires consideration of the relationships between historical processes, biodiversity and the landscape (Cevasco and Moreno 2012). A historical perspective can identify environmental systems and processes that shape each rural landscape as true functional nodes in a more general historical process of “environmental biodiversification” (Ingold 2003). What is less well-known, however, is that by reconstructing the historical role of agricultural, silvicultural and husbandry practices in local processes of biodiversification, we can better define the features of animal and species in combination with the biodiversity at landscape level. During the evolution of agriculture and forestry in several parts of the world, these processes of biodiversification occurred in the context of well-defined reorganizations of geographical spaces. Once recognized, any such space could already be defined as a “biocultural landscape”, resulting from manipulations that often precede the actual “agrarization” of economies.

In reconstructing the history of the management of genetic heritage, less attention has been devoted to the specific local environmental conditions in which biodiversification processes occurred (Piotti et al. 2013; Honnay et al. 2006). This neglect is largely due to a widespread geographical notion of “landscape” based on the opposition of the “agricultural” to the “natural” (Agnoletti 2014). Analyzing the relationship between the production systems and rural landscapes at an appropriate scale, these systems appear to have been characterized by historical processes of “continuous domestication”, as opposed to the idea of existing “uncultivated” or “natural” spaces. Although present and past observers regarded them as “natural”, these spaces are actually no less domesticated, although to different degrees, than those used for crop production. In the case of “continued domestication”, we are confronted with landscapes characterized by historical

sequences and stratifications. In these landscapes, the impact of “domestication” on biodiversity has had a major influence on the present mosaic of plant and animal populations, habitats and soil conditions, i.e., all the elements that constitute the environmental resources of rural areas which a variety of past agricultural systems shaped over the centuries.

Historical rural landscapes (Agnoletti 2013; Watkins 1990), especially highly heterogeneous ones, are often related to traditional practices and represents important examples for understanding biocultural diversity. They usually maintain complex land-use mosaics, such as those existing in Europe in the 19th century before the agricultural industrialization resulted in more homogeneous land covers characterized by intensive monocultures and afforestation of abandoned lands from the 1960s onward (Agnoletti 2013; Marull et al. 2014). This is true also for forest landscapes in other temperate and most subtropical and tropical regions worldwide, which are often affected by centuries of human influence and traditional forest knowledge (Parrotta and Tropper 2012).

Historical landscapes are very good examples of how people have been able to adapt to difficult and often extreme, environmental conditions, often creating and preserving biodiversity in the process. This is also the reason why UNESCO and FAO are promoting increased protection of rural landscapes involving integration of complex sets of values, where biocultural diversity is a common feature.

In the three case studies landscape structure was examined and compared. The goal of the work was to identify and better understand common features among areas located in very different social and environmental conditions, but all resulting from centuries of human influence.

Methods

To develop the comparative study, three areas were selected in three different continents: Northern Africa (Morocco), Caribbean (Cuba) and Southern Europe (Italy). All the areas can be considered historical rural landscapes with high landscape complexity due to the persistence of traditional farming practices. They have been continuously inhabited for many centuries and a complex set of traditional techniques has been developed to adapt to these different environments and modify natural conditions in order to obtain the maximize production of goods and services to people. The three areas were also selected because they are UNESCO World Heritage sites, or because they include UNESCO properties, although classified in different categories, including historical land uses and a rich set of agro-pastoral traditional activities (UNESCO 2009). It was therefore worth of attention to verify whether their biocultural features and the landscape mosaics were considered in the nomination as also whether a biocultural perspective can be applied to territories resulting from the combination of historical, environmental and socioeconomic factors.

GIS software was used to create land use maps through photointerpretation of Google Earth images (for study areas in Cuba and Morocco) or high-resolution orthophotos of 2012 (in Italy). Landscape evaluation indexes were applied to study the structure of the landscape mosaic and to compare the results between sites. All the three sites were visited to verify the results of the photointerpretation, although not all the land uses surveyed could be identified during the field work. There were also some difficulties in recovering detailed historical information for two of these sites, Telouet valley and Viñales, although

the UNESCO nomination dossier and the field visit confirmed the presence of traditional forms of agriculture, associated with historical buildings representing the cultural identity of the areas.

The analysis applied to the sites took into consideration the number of land uses, the total number of patches, number of agricultural patches, average patch surface area, average agricultural patch surface area and the edge density. The edge density index, measures the complexity of a land mosaic and the characteristics of boundaries between the patches that compose it (Eiden et al. 2000); it is calculated as the sum of the Edge Densities of all land-use classes divided by the number of land-use classes. This index shows both the number of the patches and their average surface area, and also the regularity or complexity of their shapes, since the more irregular the patch edges are, the higher the edge density index. The overall extensions of the areas being compared are different. In each case, we chose specific portions of the landscape mosaic to highlight certain features we regarded as characteristic. The area analyzed in Viñales has a total surface area of over 2400 ha, the Itria valley is about 839 ha, while Telouet is 450 ha. These differences are related to the need to select a homogeneous portion of the rural territory, avoiding urban areas and infrastructures as in the case of the Itria valley site. In the case of Telouet, the morphology of the territory, with the development of agriculture in narrow stripes of land along small rivers, suggested limiting the linear extension of the area selected for study in favor of a shape better suited to study the landscape mosaic.

The Viñales valley (Cuba)

The Viñales valley lies in the Province of Pinar del Rio, in the northeast part of the island of Cuba. It is an agricultural area included in UNESCO World Heritage List in 1998 as a cultural landscape (UNESCO 1999). The area is distinguished by a commixture of natural elements (particularly small limestone hills with very steep slopes called *mogotes*) and human activities, principally consisting of the growing of tobacco, forage, and mixed crops. Its peculiar environmental features, along with its agricultural activities and historical dynamics, make this a very special place also from an aesthetic standpoint as well. The valley can be regarded as a traditional agrarian landscape that is representative of the Caribbean zone and of Cuban rural culture.

The Viñales area was inhabited by indigenous populations many centuries before the arrival of the Spanish *conquistadores*. After the Colonization, the very fertile soil and favorable climate encouraged the development of animal husbandry and the growing of forage and food crops, employing slaves brought over from Africa. The village of Viñales was founded in 1875 along the road leading from the town of Pinar del Rio, the provincial capital, to Puerto Esperanza, the largest port in the area. The resident population—about 8000 people—works in tobacco growing and other farming activities. The ploughed and cultivated level part is dotted with limestone outcrops, the *mogotes*, rising as high as 300 meters. The plain is entirely given over to traditional agriculture (Landeiro Reyes 2005). Recent experiments have shown that mechanized farming methods were negatively impacting the final quality of the tobacco. This is why traditional methods, such as animal traction, are still used today. The whole valley is distinguished by its own original culture, a blend of inputs from indigenous populations, the Spanish *conquistadores* and African slaves (Larramendi et al. 2005). About 92 % of the area included in the UNESCO World

Heritage List is privately owned, with the 30 % of this owned by individual farmers and the rest by the National Association of Small Farmers. The valley is presently under protection under clauses in the Constitution of the Republic of Cuba of 1976 and the Declaration of 27 March 1979 which designate it as National Heritage. The area included in the UNESCO World Heritage List is considered a “living landscape” with a high degree of “authenticity”, which has proved capable of retaining its peculiar character in spite of socioeconomic dynamics and high tourist flows. The UNESCO WHL application does not include a detailed land use of the area, which is essential to assess the landscape mosaic and hence the requirements of the management plan.

The Telouet valley (Morocco)

Morocco offers some extraordinary examples of historical rural landscapes characterized by centenarian agricultural practices that local populations continue to use. These practices, besides ensuring the population's livelihood, have allowed farming of very arid areas, transforming the desert into a true garden. Traditional agriculture is still widespread with many rural landscapes combining distinctive environmental characteristics with historical features and traditional agricultural activities. These are fascinating places where farmers practice a low-energy-input sustainable agriculture, carefully managing their crops and water, and graced by settlements of high architectural-historical value.

The village of Telouet and its valley are located about 130 km south-east of Marrakech in the High Atlas Mountains, it lies near the Tizi n'Tichka main road leading to the village of Ait Ben-Haddou, a site included in UNESCO World Heritage List (UNESCO 1987; Gelbart 2009). The area is also included in the Man and Biosphere (MAB) program of UNESCO as part of a wide area of about seven million hectares, including several oases, an agro-ecosystem with several thousand years of history (MATEE 2006). It is a green and fertile cultivated area placed in a valley that stands out against, and contrasts with, the bare and arid slopes of the surrounding mountains. In the northeast part of this valley there is the fortified village of Telouet. For this study, a roughly 3-km-long stretch of the valley going southwest from the kasbah of Telouet to the site of Sidi Daoud was selected.

In these valleys of the Atlas mountains it is possible to observe a remarkable balance between human action and the natural environment, and between private property and commons, that is typical of a large part of the North African mountain ranges: gently sloping irrigated terraces on the lower valley slopes, pastures for sheep and goats on the upper slopes, traditional intensive agriculture on the fertile valley bottoms. In the past, the farming of irrigated terraces was mainly based on a three-crop biennial rotation, but the current trend is to reduce this to two crops: one of cereals (wheat, barley or maize), the other of vegetables or fallow. The main trees cultivated are olive, almond and pistachio, but in the lower parts of the valley date palms are also found. From the end of August to late September the flocks of sheep and goats are led down into the cultivated valley bottom to graze on harvest residues, in fallow fields and on various kinds of commons, such as the broad strips alongside the roads (Bencherifa and Johnson 1991; Bencherifa 1988).

Irrigation systems are a central landscape element in these areas of the Atlas and their management has been able to transform this arid landscape in a garden. The methods used are very simple but quite effective: rocks and shrubs are used to deviate mountain streams

into canals called *seguias*. Simple gravity and free drainage from these slopes down to the valley bottom prevent water stagnation. Walnut or almond and, more recently, apple or pear trees are planted along the *seguias*, both to produce fruit for the market and to reinforce the banks. Trees such as junipers were once really important, since terrace walls were made using chunks of juniper instead of stones (Barrow and Hicham 2000). On the Telouet valley bottom, crisscrossing canals form a web of tiny plots separated by periodically irrigated earth banks.

The Itria valley (Italy)

This valley is one of 120 pre-selected areas for inclusion in the Italian National Register of Historical Rural Landscapes, because of the characteristics of its agricultural landscape. The Itria valley, also known as the Valley of the Trulli, encompasses the municipalities of Alberobello, Noci, Cisternino, Castellana Grotte, Putignano, Locorotondo and Martina Franca, in the southern part of the Apulia region in southern Italy. Many of these towns are situated on terraces on the slopes of hills crowning the elongated depression of the valley. The area is included among UNESCO World Heritage List under the name of Trulli di Alberobello (UNESCO 1996). Due to the abundance of limestone formations providing construction material for the buildings known as *trulli*, these buildings are most widespread in this area. Over the centuries, *trulli* (the oldest known dates back to 1559) evolved from simple shelters into true dwellings (SiTI 2009). The area is included in the Eastern Murgie Natural Reserve and in the site of community importance (SCI) “Southeast Murgia” of the Nature 2000 Network, and is under landscape restrictions as per Italian Law 1497/39.

Considering the clearly historical matrix of the local landscape, the fact that a natural reserve and a SCI have been established here is an interesting fact, since the area has not a natural origin.

One of the most significant historical features of the landscape of the Valle d'Itria, which dominated the human and rural landscape as late as the 1950s or 1960s, is that a significant part of the population lived in scattered houses, surrounded by small-scale cultivations. Various crops are grown on small and sometimes tiny plots edged by dry-stone walls (*pareti*). On each plot there is almost invariably a *trullo*, where peasant families used to live for most or all of the year. As early as the late Middle Ages and the early Modern Age, a widespread land ownership system based on small or middle-sized peasant holdings developed, with long-term emphyteutic contracts that encouraged the planting of tree orchards and vineyards. The century following the unification of Italy in 1861 witnessed the rapid expansion of vineyards in Itria Valley, covering up to 55–60 % of the surface, as well as the highest degree of dispersion of the peasant population in the countryside; although some more or less vast land surfaces managed by farmhouses were set aside for grain and grazing, and there were wide wooded areas too. *Trulli* and vineyards remained indissolubly paired at least until the 1950s or 1960s (Scianatico et al. 2009).

The Italian National Register of the Historical Rural Landscape specifies that the landscape of the Itria Valley owes its values to the preservation, in most of its areas, of the traditional equilibrium between different land uses, the presence of *trulli*, and the highly fragmented land use mosaic. The current threats to the landscape of the Itria valley are related to several phenomena starting in the 1970s, when the drastic reduction of the cultivated land led to the deterioration and the abandonment of *trulli* and to the inadequate maintenance of dry-stone walls often replaced by less expensive concrete ones.

Results

Since the total extensions of the three study areas is different, the extension of individual lands uses is less important than the ratio of this extension to the total area under consideration, and the structure of the landscape mosaic.

In the Vinales Valley study area, twelve classes of land cover have been identified (Fig. 1). Our data indicate that 48 % of the studied area is occupied by various kinds of cultivated land (simple and treed arable lands, permanent wooded crops and tobacco crops); 34 % is covered by trees, including the mixed forest on the *mogotes* and the riparian vegetation, which shows an interesting “tentacular” pattern that permeates the agricultural fabric; about 12 % of the area is taken up by meadows and pastures; and only 6 % is given over to urbanization, both continuous and discontinuous (Table 1). The agricultural portion of the landscape mosaic appears to be very fragmented, with an average agrarian surface of 0.48 ha (Table 4). There is a clear-cut predominance of arable lands, mainly used for tobacco, which put a characteristic stamp on the local landscape, making it appear rather “fine-grained”. The *mogotes* are clustered together in the center of the valley, surrounded by farmland. Their position, besides having a particular value from a spatial point of view, also creates a distinctive aesthetic peculiarity. The verticality of the limestone hills normally catches the eye of the observer more than the horizontal components of the landscape, and their uniform tree cover makes for an interesting contrast with the fragmentation of the agricultural landscape.

The Telouet valley landscape still appears to be well preserved as regards its agricultural components, while the settlements, and especially the castles, are often abandoned and in ruins. Agriculture still plays an important role in the population's subsistence strategies, and retains high landscape and aesthetic value. On the basis of photointerpretation eighteen classes of land cover have been identified (Fig. 2). The land use “fallow” refers to all the residual areas, both those lying between cultivated plots and those lying alongside the roads, or alongside continuous or discontinuous urban fabric. In some cases the insufficient resolution of the satellite images made it hard to distinguish this type of land-use from grazed land. Fifty-eight percent of the studied area is occupied by various kinds of crops (ploughed fields with or without trees, orchards and vegetable gardens).

Arable lands account for 45 % of the total area. Spontaneous vegetation, including mixed forest and riparian vegetation, covers only 5 % of the overall surface. Fourteen percent is occupied by developed areas, classified as continuous urban fabric, discontinuous urban fabric, scattered houses, and the *kasbah* or castle. Areas classified as fallows account for 10 %, and pastures—bare and with trees or shrubs—account for only 6 %. Arable lands are thus the dominant landscape feature (Table 2). The agricultural mosaic is highly fragmented, and this regards not only the cultivated land, but also the non-agricultural land uses. The average surface area of cultivated patches is just 0.09 ha, but the overall average patch surface area is also very small (Table 4). This is thus a very fine-grained landscape, more so than those of the Vinales and the Itria valleys. In spite of the prevalence of bare arable lands, the richness of the tree cover compensates for the lack of actual woods in the cultivated areas, and also contributes to biodiversity. The most noticeable visual features of the local landscape are certainly the contrast between the desert mountain slopes and the intensively cultivated land on the valley bottom, particularly rich in trees, all placed inside the narrow and sinuous conformation of the valley.

The results of the Itria Valley study show that the 48 % of the area is occupied by various kinds of cultivations (Fig. 3), which include a considerable variety of land uses:

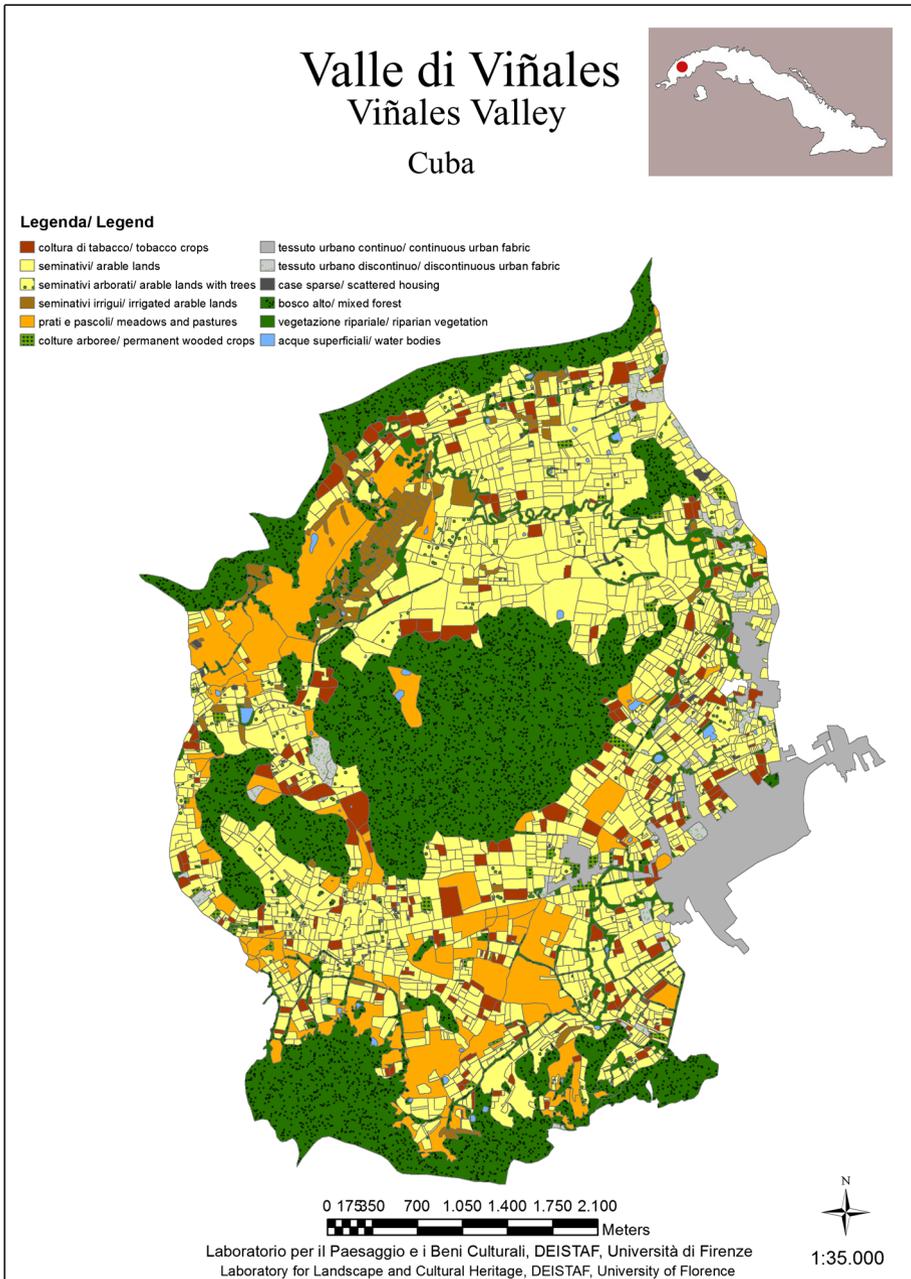


Fig. 1 Land use map of the Viñales Valley (Cuba)

arable lands with and without trees; arable lands with olive and fruit trees or vegetable gardens; monocultural vineyards and vineyards associated with other crops; vegetable gardens; orchards. Woodland covers only 10 % of the total area, while buildings and

Table 1 Land uses and edge density in the Viñales Valley (Cuba)

Land uses	Surface (ha)	Surface (%)	Perimeter (m)	Edge density
Tobacco crops	119.97	4.96	69,683	580.84
Arable lands	859.54	35.54	516,121	600.46
Arable lands with trees	97.82	4.04	66,134	676.08
Irrigated arable lands	53.32	2.20	36,091	676.88
Meadows and Pastures	282.29	11.67	90,658	321.15
Permanent wooded crops	16.22	0.67	13,487	831.50
Continuous urban fabric	121.44	5.02	21,228	174.80
Discontinuous urban fabric	29.65	1.23	17,049	575.01
Scattered housing	5.48	0.23	8973	1637.41
Mixed forest	775.86	32.08	132,984	171.40
Riparian vegetation	48.66	2.01	45,584	936.79
Water bodies	8.48	0.35	8145	960.50
Total	2418.73	100.00	Total	8142.81
			Average	678.57

courtyards, including *trulli*, occupy the 22 %. Finally, pastures and meadows (some with olive trees) account for 12 % of the total area (Table 3). As was the case for the other study areas, the Itria Valley too, is characterized by a highly fragmented landscape mosaic, with an average area of 0.29 ha, that decreases to 0.26 ha if only the agricultural patches are considered (Table 4).

From a comparative perspective, the three areas all display a prevalence of farmland over woodland and a relatively small average area of farmed plots: 0.48 ha in the Viñales Valley, 0.29 ha in the Itria Valley, and 0.09 ha in Telouet (Table 4). The Moroccan site has by far the finest-grained landscape mesh, due to the characteristics of its irrigated fields and historical farming practices. The number of land use classes in which the respective land covers have been divided is very different from one area to the other: 12 land use classes have been identified in Viñales, 18 in Telouet and 36 in the Itria Valley. Although the Itria Valley does have a higher variety of land uses, this partially reflects the fact that its photointerpretation was carried out on high-resolution orthophotos together with field observations. For the other two areas, Google Earth satellite images were been used, crosschecking their evidence with ground photographs and visits to the sites.

Table 4 shows that the Itria Valley has a very high number of land-uses, many more than the other study areas, and produces a greater variety of crops. Considering the markedly smaller extension of Telouet compared to the other two areas, the very large number of patches in its agricultural mosaic appears to be highly significant. The area has a lesser number of land-uses compared to the Itria Valley, but a higher fragmentation of ploughed fields as a result of traditional irrigation agriculture. This characteristic of the Telouet Valley landscape is enhanced by the very small average surface area of each patch. It is essentially a very large puzzle made of tiny pieces, and this, combined with the variety of land-uses, accounts for very high landscape diversity. This form of land use requires abundant labor for the continuous maintenance of the irrigation systems, and labor scarcity

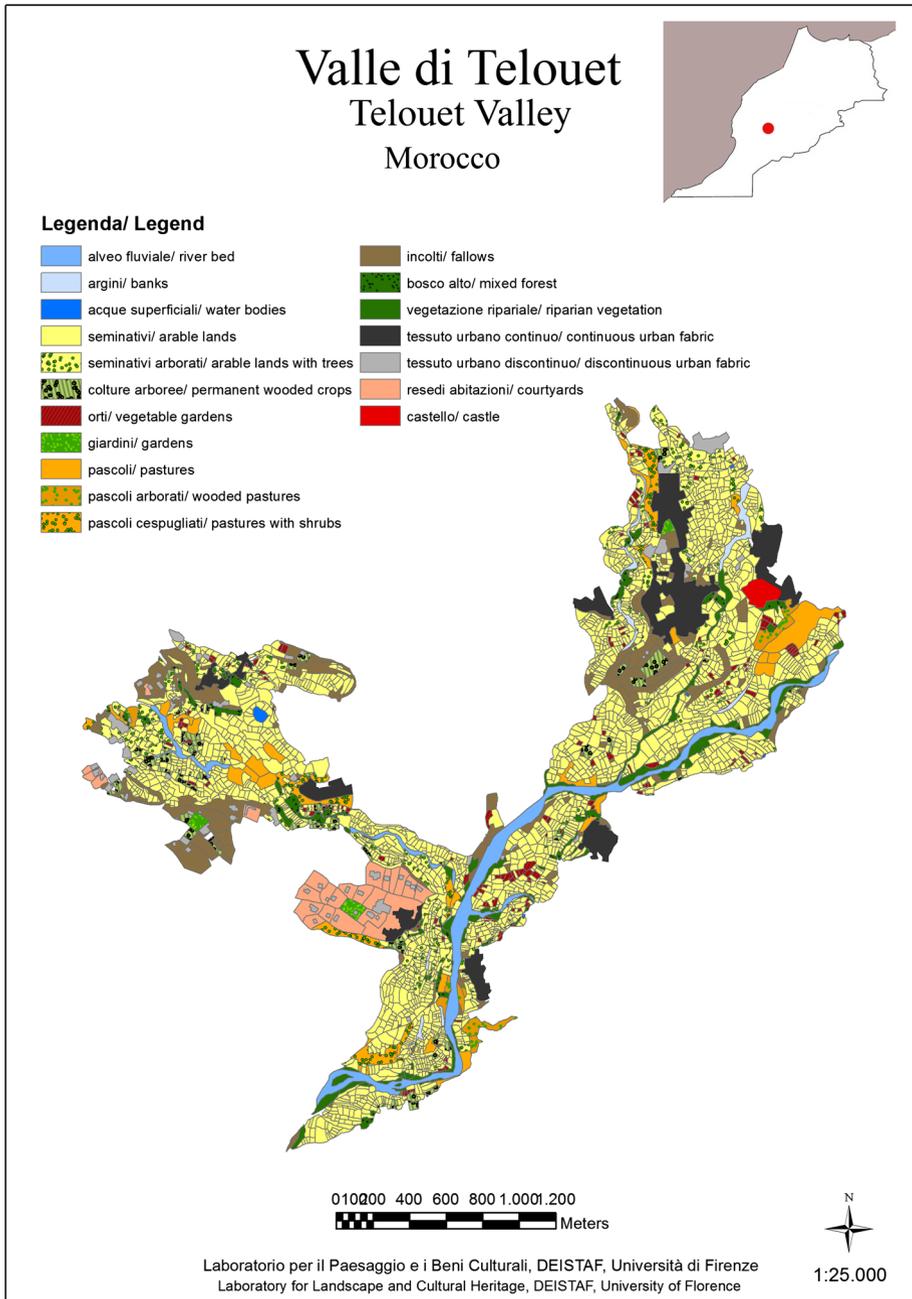


Fig. 2 Land use map of the Telouet Valley (Morocco)

is thus one of the critical socioeconomic issues of the area. A similar situation, with less land-uses diversity but more fragmentation, can be observed in the comparison between the Itria and Viñales valleys.

Table 2 Land uses and edge density in the Telouet Valley (Morocco)

Land uses	Surface (ha)	Surface (%)	Perimeter (m)	Edge density
River bed	22.80	5.05	14,400	631.58
Banks	4.34	0.96	5737	1236.42
Water bodies	0.60	0.13	557	928.33
Arable lands	203.20	44.96	293,848	1446.10
Arable lands with trees	35.47	7.85	44,000	1240.62
Permanent wooded crops	11.37	2.52	12,666	1113.69
Vegetable gardens	8.26	1.83	15,009	1817.51
Gardens	2.06	0.46	1104	535.92
Pastures	15.53	3.44	10,620	683.84
Wooded pastures	5.27	1.17	3714	704.74
Pastures with shrubs	10.95	2.42	7874	719.09
Fallows	45.35	10.04	42,569	938.68
Mixed forest	8.87	1.96	10,161	1145.55
Riparian vegetation	13.80	3.05	18,550	1344.20
Continuous urban fabric	33.27	7.36	12,261	368.53
Discontinuous urban fabric	10.40	2.30	11,538	1109.42
Courtyards	18.12	4.01	12,145	670.25
Castle	2.26	0.50	632	279.65
Total	451.91	100.00	Total	16914.13
			Average	939.67

A distinctive feature of the landscape of the Itria Valley is the presence of mixed cultivation, especially herbaceous crops combined with olive trees, vines and fruit trees. This is a historically significant peculiarity of the Italian rural landscape, in evidence since Etruscan times (Agnoletti 2013). Just as the masterful exploitation of water has allowed local farmers to make the Moroccan desert cultivable, in Italy farmers made up for land scarcity by growing several crops on the same plot to obtain several harvests. Significantly, until the last century, firewood was mainly obtained by trees grown outside the forests (through pollarding practices), and the density of trees per hectare in the countryside sometimes exceeded that found in some types of woods, contributing to the biodiversity of the rural landscape (Agnoletti 2013). This kind of cultivations, led to the creation of high-fragmented mosaic, where spatial diversity represent an important feature resulting from historical evolution.

The connectivity of the landscapes under consideration was also studied through the use of the Edge Density index. This index, along with the others we employed, helps to measure not only the fragmentation and heterogeneity of a landscape mosaic, but also the ecological connectivity between the various habitats in a given area. In the Viñales Valley (Table 1) we notice that the land-use class with the highest Edge Density is orchards, while woods have the lowest one. In the Telouet Valley (Table 2), vegetable gardens is the land use class with the highest Edge Density. Woods show a fairly high value, differently than in the other two study areas, while pastures have the lowest value. In the Itria Valley (Table 3), once again we find woods as the class with the lowest Edge Density and

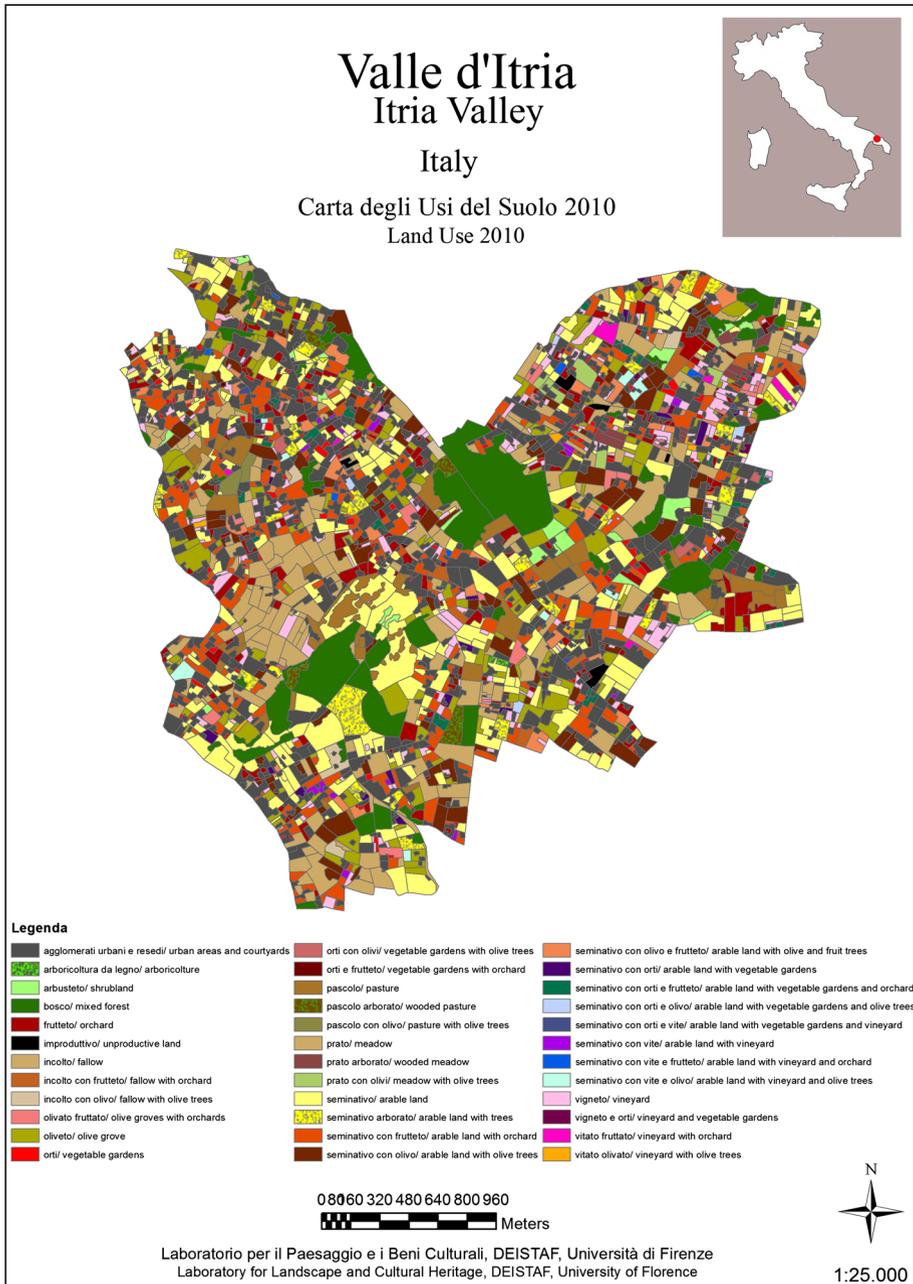


Fig. 3 Land Use Map of the Itria Valley (Italy)

vegetable gardens as the class with the highest. Clearly in these last cases these values depend more on the lower average surface area of patches rather than on the lower or higher irregularity of their edges. As the general overview presented in Table 4 shows, the

Table 3 Land uses and edge density in the Itria Valley (Italy)

Land uses	Surface (ha)	Surface (%)	Perimeter (m)	Edge density
Urban areas and courtyards	182.98	21.81	29,249	357.96
Arboriculture	0.33	0.04	915	452.97
Shrubland	8.16	0.97	2049	484.40
Mixed forest	81.71	9.74	34,181	547.25
Orchard	30.50	3.63	11,548	589.79
Unproductive land	2.26	0.27	2258	598.94
Fallow	45.75	5.45	19,225	636.80
Fallow with orchard	4.82	0.57	3138	651.04
Fallow with olive trees	3.77	0.45	3220	680.76
Olive grove with orchard	6.49	0.77	1561	690.71
Olive grove	53.32	6.36	1705	704.55
Vegetable gardens	8.31	0.99	78,743	708.06
Vegetable gardens with olive trees	1.77	0.21	34,880	725.16
Vegetable gardens with orchard	0.57	0.07	2182	739.66
Pasture	30.19	3.60	6233	763.85
Wooded pasture	4.23	0.50	35,410	773.99
Pasture with olive trees	2.02	0.24	2828	814.99
Meadow	62.46	7.44	10,418	831.44
Wooded meadow	3.47	0.41	46,746	876.71
Meadow with olive trees	4.73	0.56	1596	901.69
Arable land	111.21	13.25	1042	906.09
Arable land with trees	19.58	2.33	6103	940.37
Arable land with orchard	62.17	7.41	58,827	946.23
Arable land with olive trees	48.10	5.73	184,094	1006.09
Arable land with olive and fruit trees	12.53	1.49	31,415	1030.00
Arable land with vegetable gardens	3.28	0.39	340	1030.30
Arable land with vegetable gardens and orchard	4.04	0.48	1059	1091.75
Arable land with vegetable gardens and olive trees	1.15	0.14	3677	1121.04
Arable land with vegetable gardens and vineyard	0.40	0.05	4598	1138.12
Arable land with vineyard	2.10	0.25	477	1192.50
Arable land with vineyard and orchard	0.97	0.12	33,670	1216.40
Arable land with vineyard and olive trees	2.95	0.35	2579	1228.10
Vineyard	27.68	3.30	2585	1305.56
Vineyard and vegetable gardens	0.63	0.07	837	1328.57
Vineyard with orchard	2.42	0.29	842	1477.19
Vineyard with olive trees	1.98	0.24	13,418	1614.68
Total	839.05	100.00	Total	32103.68
			Average	891.77

study area with the highest average edge density the Telouet valley, immediately followed by the Itria valley. The very low value of the index for Viñales is heavily influenced by the high average surface of the woodland patches in the area.

Table 4 Landscape indexes for the three areas

Evaluating indexes of landscape			
	Viñales	Telouet	Itria valley
Number of land uses	12	18	36
Number of patches	2920	3301	2916
Number of agricultural patches	2394	2862	1588
Total surface (ha)	2418.73	451.91	839.05
Average patches surface (ha)	0.83	0.14	0.29
Average agricultural patches surface (ha)	0.48	0.09	0.29
Edge density	678.57	939.67	891.77

Discussion

The areas under examination exist in regions with very different historical, environmental, social and economic characteristics, though they have in common a very high complexity of the landscape mosaic. This can be considered one of the typical features of traditional landscapes (Antorp 1997) and a good example of biocultural diversity at landscape level. The spatial component of biological diversity is of crucial importance for biodiversity (Tilman 1994), but is also one of the most interesting scientific perspective to understand biocultural diversity, since spatial diversity in rural landscapes depends on human action. The role played by the spatial heterogeneity of the land matrix in respect to ecosystem complexity and resilience in cultural landscapes is a central element (Bengtsson et al. 2003; Benton et al. 2003). However, these approaches together with putting into evidence the interplay between patch disturbance and land-cover diversity as a key mechanism in biodiversity, also stress the role of rural landscape mosaics, increasing the number of ecotones and species (Harper et al. 2005). Much of this biological diversity is located at scales higher than plot or farm level, and depends on keeping a landscape-wide variety of land covers. When high species richness is kept at landscape level thanks to land cover heterogeneity, the decrease of biological diversity typical of large monocultures can be counterbalanced. According to (Marull et al 2014) in this way, a disturbance-complexity interplay leads to divergent and compensatory trends followed by α -diversity at plot scale (within-patch or within each community), β -diversity at landscape level (between-patch or between communities), and γ -diversity of the species pool hosted at regional scale (Loreau 2000; Roxburgh et al. 2004; Gabriel et al. 2006; Loreau et al. 2010). The colonizing capacity of the species hosted in a well-connected mosaic that combines early and late successional niches overrides the local decrease in α -diversity as a result of the possible negative impact of agriculture or forest practices. Therefore, the predominance of β -diversity kept by the spatial heterogeneity of a variety of intermingled land covers becomes the key mechanism of biocultural diversity maintenance in these landscapes. The effectiveness of farm management in increasing biodiversity reaches a peak at intermediate level of landscape heterogeneity, given that simple landscapes tend to behave as a single monoculture poorly endowed of biological diversity whereas highly complex ones retain great biodiversity anyway. Hence, a complex landscape matrix may enhance the overall biological diversity except when it comes to species that require specific habitats and other conservation policies.

While numerous methods for reconstructing historical landscapes of the past have been adopted to study their features (Egan and Howell 2001), as well as a great number of investigations and elaborate methodology with regard to the analysis of land-use and land-cover change (Zerbe 2004; Bender et al. 2005; Wanja et al. 2007; Agnoletti 2007; Helming et al. 2007), in this case we have the opportunity to study landscapes that are still under active traditional management. They have not been affected by abandonment and renaturalization, often favoured by nature conservation strategies, which usually creates dense and homogeneous forest cover, reducing biocultural diversity linked to the landscape mosaic. These strategies also favour wild life, such as predators and ungulates, strongly protected by nature conservation, but conflicting with agricultural practices and high human population density. For example, in regions as Tuscany (Italy), according to the landscape monitoring system developed in the last decade analysing a set of 13 study areas from 1823 to 2010, a reduction of landscape diversity up to 80 % has been observed (Agnoletti 2007) due to reforestation, although a reduction can be observed also in the case of industrialization of agriculture. These situations are often due to a lack of correct interpretation of the level of biodiversity associated to cultural landscapes and the lack of specific strategies supporting species and habitats related to them.

In the case of Morocco and Cuba, we are looking at situations where traditional agriculture is still an important part of the economic system and it is not disappearing, although it is in a process of slow transformation. In the case of Italy, however, as in many other countries where agriculture is becoming more industrialized, traditional agriculture has a marginal role. Thus, while in the first two cases (in Cuba and Morocco) it is the farming economy that sustains the traditional landscape, in the Italian case it is rather a combination of factors connected to the multifunctionality of agriculture that guarantees its conservation. Although the landscape has a different role and meaning in the three countries, this has not jeopardized the conservation of its traditional features and the complexity of the landscape. The environmental adaptation strategies of traditional cultures have resulted in similar landscape characteristics, almost independent of environmental conditions, as the drivers of this phenomenon are mainly social and economic. In this respect, particularly for the area of Telouet, the limitations imposed by water scarcity and hot climate have not prevented the possibility of developing a green and complex landscape mosaic.

Conclusions

The landscapes under study have existed for some centuries and today appear to be evolving slowly and retaining most of their features. They have a significant historical value (Agnoletti 2013) and still display the typical features of traditional landscapes as defined by Antorp (1997), being maintained with practices and techniques requiring few external energy inputs. Their land use system is characterized by long historical persistence and a strong connection with the local social and economic systems that produced it. The productive processes that led to the construction of these landscapes enhanced the activation of the local environmental resources, without depleting them. The complex structure of the landscape mosaic in these areas is an exemplary illustration of biocultural diversity according to the Florence Declaration (UNESCO and SCBD 2014, 2010).

As regards the protection, all three areas are eligible for inclusion not only in the UNESCO cultural landscapes and the Man and the Biosphere Reserves, but also in the FAO GIAHS program (Koohafkan and Altieri 2011). However, none of the above programs has yet taken into consideration this concept in the criteria or the operational guidelines for the nomination of the sites. In most cases the description of biodiversity in the dossiers for the nomination of these sites still uses categories referring to wildlife associated to natural or seminatural habitats and does not consider landscape mosaics. Nevertheless, UNESCO has recently introduced this concept in the recommendations for the management plan of one of the World Heritage Sites.

The biocultural diversity concept suggests the opportunity to revise some of the current approaches to biodiversity recognizing the wider meaning of this term and the need for a revision of the current conservation strategies. While UNESCO, FAO and CBD might adapt their guidelines in the near future, the 28 member states of the European Union can surely be considered as the best ground for a political implementation in the existing conservation tools. Considering the thirty-five signatory countries of the European Landscape Convention and all the 28 countries applying the EU Habitat Directive, the European Continent is probably the part of the world where the most important tools for biodiversity and landscape conservation have been developed. Presently the EU approach to nature conservation does not consider biocultural diversity and not even landscape mosaic as a goal of conservation. Biocultural diversity can apply also to Sustainable Forest Management, where cultural values associated to landscape and biodiversity play a very minor role (Agnoletti 2014). Europe, as many other places in the world, is basically a cultural landscape (Rackham 1986; Antorp 1997; Parrotta and Trosper 2012; Fowler 2003; Agnoletti 2013, Agnoletti and Santoro 2015) and the cultural origin of the European Union territory has also been recognized by the European Commission at least since 1999, when only 5 % of the territory was classified as natural (European Commission 2013). This suggest an adaptation of the strategies on nature conservation applying a different approach, taking into consideration, among other things, that not all the wild species (e.g. predators as wolves or bears) can be the main target of conservation, especially in cultural landscapes often characterized by dense human population, but rather the result man-nature interrelationships.

Species and their habitats have adapted to landscapes, changing their features, therefore a biocultural approach is probably best suited to understand and manage most of the biodiversity today existing at landscape level. In this respect historical processes and the spatial level of biodiversity must be properly assessed, recognized, and included in conservation strategies. Furthermore, this study shows that traditional features associated to landscapes having a relevant historical value, can be found in many regions of the world, including countries in temperate, subtropical and tropical countries. Therefore, their conservation is not necessarily associated to the existence of traditional societies or underdevelopment. In view of the need to propose examples of positive integration between human society and environmental resources, taking into account the food challenge and the climate challenge, biocultural diversity offers a useful perspective considering traditional farming practices as fundamental activities also for conservation strategies.

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