The Role of Mediterranean Fruit Tree Orchards and Vineyards in Maintaining the Traditional Agricultural Landscape

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Abstract

The Mediterranean area represents one of the most suitable and diversified environments for horticultural crops, being this propriety well expressed in the commonly accepted definition of "Mediterranean cultivated garden". In Italy, fruit crops have been in the past introduced and expanded in different environments depending on the species and adaptability to the physiographic characteristics of the regions. The climate and the diversity of environmental contexts, the specificity of soils, the plasticity of the cultivated genotypes, have allowed a tight and typical relationship among land and farmers. Since the past centuries olive and fruit orchards, vineyards and *Citrus* plantations have represented the typicity of the Italian rural landscape. The physiognomy of tree cropping systems has been changed rapidly starting from half of the past century owing to the introduction of new genetic resources, the change in the concepts of quality, the modernization and intensification of the agronomical techniques, resulting in loss of environmental and biological diversity. Nonetheless, some historic fruit orchards and vineyards have survived. The research is focused: a) on the recognition and mapping of the traditional landscapes of fruit crops in two representative Mediterranean regions; b) on the identification of their typological traits; c) on the definition of their environmental and technical sustainability based on an interdisciplinary methodology. Through a multi-criterial analysis it was possible to recognize and measure the sustainability of these cropping models and their ecological function, turning into preservation of environmental resources, environmental quality and quality of life. The study also underlined the crucial role of the traditional agricultural landscapes in the maintenance of local identity, history and economy. By representing a cultural heritage, traditional agricultural landscapes and traditional farming might justify preservation and valorisation actions.

INTRODUCTION

Fruit cropping systems, in both monospecific and mixed stands, olive groves and vineyards represent in Italy some of the most important land-use types of the past as well as of the contemporary time and they are, therefore, connotative traits of the Italian rural landscape (Barbera et al., 2004; Bevilacqua, 1989; Biasi and Varoli Piazza, 2007; Gullino et al., 2010) that have also impressed travellers, painters, writers. The rural landscape, that is a space resulting from the interaction among factors such as land form, soil and climate on one hand, and regional culture, habits and history, on the other, is today a complex of land-use mosaics showing modern and traditional forms that have survived transformation or abandonment (Marececk, 2008; Vos and Meeks, 1999). The consideration of the landscape function exerted by the fruit cropping systems, (i.e., the maintenance of the rural space and of the environment's integrity, characteristics and quality) has gained importance and is now commonly considered besides the main function to produce for the market (Antorp, 2005; Barbera and Cullotta, 2009). The landscape has been recently recognized being a common good as stated by international organisations like the UNESCO under the World Heritage Convention (Vienna and Ottawa Conferences on

Cultural Landscapes, 1996, 2001) (Zimmermann, 2006) and by the Council of Europe's European Landscape Convention (ELC Florence, 2000; Priore, 2006). The Traditional Agricultural Landscapes (TALs) are recognized as precious habitats that need to be somehow preserved. Nonetheless, it is not clear how to proceed as demonstrated by the lack of concerted actions. Furthermore, TALs even lack a common definition, having been defined for instance as landscapes that change gradually, rather stable and that have unique character or identity (Antorp, 2005), as traditional agricultural uses with tight functional relationships between architecture and crops (Bevilacqua, 1989), as agro-ecosystems with high ecological sustainability (Abbona et al., 2007) or places that have a 'total cultural content' and an 'associative value' (Zimmermann, 2006). The high complexity of these agricultural landscapes does not fit with simple definitions, and the need for one systemic, interdisciplinary knowledge of these spaces is emerging. Italy, like many other European countries, is rich in traditional agriculture, although only little studied for its consistency of inventory, characters and function. Many studies on historic agricultural landscapes have been carried out through case studies and the information on their nature, constitutive characters and features are therefore still fragmented. Different approaches have been used from the evaluation of single functions (Farina, 2000; Stephenson, 2008), to the proposal of multiple-criteria inventories (Barbera et al., 2010a; Maniglio Calcagno, 2003; Zimmermann, 2006; Meeus, 1995; Vos and Meekes, 1999; www.pan.cultland.org), and more recently their inclusion in sustainable land planning actions (Marignani et al., 2008; Pena et al., 2010; Swensen and Jerpåsen, 2008). A protection policy is carried out by the UNESCO that has included in the list of Word Heritage Sites famous Italian rural landscapes like the Orcia Valley, the hills of Prosecco sparkling wine production and the Cinque Terre (www.unesco.org). Nonetheless, a commune integrated approach is still lacking. In the first instance there is urgent need for an accurate survey of the distribution of the TALs, some of which are in various states of decline and at risk of disappearance, and of the comprehension of their structure and function.

This study represents the validation of an integrated multidisciplinary methodology (Barbera et al., 2010b) formulated for the recognition and mapping of the traditional landscapes of fruit trees and vine cropping systems and for the evaluation of their typological constitutive traits and function. In particular, the aim of the research was the survey and mapping of the traditional fruit tree and vine cropping systems in model Mediterranean areas, the measure of the tree cropping system's role in constructing the network of TALs, and the definition of their constitutive traits and function (structure, management, complexity) and status (integrity or misuse).

MATERIALS AND METHODS

Study Areas and Scale of Investigation

The study has been carried out in two Mediterranean administrative regions, i.e., Sicily and Latium (Fig. 1) chosen as areas representative of Italian environmental, physiographic and cultural variability. In particular two large territorial areas, i.e., the Tuscia region northern of Rome (in Latium) and the Mount Etna region (in Sicily), were chosen. The methodology used considered a hierarchal spatial delimitation of land areas for identifying and characterizing the localization of TALs (Barbera et al., 2010b). Thus, the following levels of analysis were considered: Landscape System (LS), Landscape Unit (LU) and Testing Area (TA). LSs were delimited by socio-economical criteria, i.e., the agrarian regions, a land classification adopted in Italy since the beginning of the last century (1929), aiming statistical and economic evaluations of the agricultural land, mainly based on contiguous territories with prevalent common land-use types. LUs were identified by a finer environmental analysis, mainly based on physiography, lithology, soil, climate, land use. TAs were chosen for their representation of the landscape system's variability and as a representative localized area of the LU.

Location and Mapping of the Traditional Fruit Trees Cropping Systems

The location and mapping of the TALs inside the LSs, LUs and TAs was done based on the criteria of the diachronic land-use analysis, detecting the land-use persistency and the land-use change. By an appropriate Geographic Information System (GIS), using ArcView 3.2 software (ERSI), land-use maps and aerial photos interpretation, depending on the level of analysis, an object-oriented land cover map was produced by selecting land cover classes related to tree cropping systems, i.e., vineyards, olive groves, fruit orchards, specialized (monospecific) or in coltura promiscua that have persisted on the same territory over the past 50 years. In particular, diachronic analysis of existing land-cover maps in vector form has been carried out by overlaying the Corine Land Cover map (CLC, 2000, 1:100.000) and, at an higher detail level, land-use maps obtained by aerial photography interpretation (aerial photos 2006, 1:10.000) with the Land Use map of the Fifties and Sixties (TCI, CNR 1958-1961), this temporal threshold being chosen as the beginning of a deep rural landscape transformation from the heterogeneous poly-culture to the modern and simplified monoculture that has caused landscape homogenization and loss of agro-biodiversity across the Italian peninsula. The areas showing a significant concentration of tree crop systems persistence were considered for further analyses of fruit trees and vines landscape characteristics (1:5000) and function.

TAL Characteristics and Functions

The analysis of the TAL characteristics was based on a multidisciplinary approach. The complexity, i.e., landscape, structural, biological, functional complexity, has been chosen as the attribute driving their correct analysis. In particular, it has been carried out: a) a landscape metric analysis for measuring the consistency, form, structure of the selected land-use classes for the evaluation of the ecological status following the landscape ecology approach (Forman, 1995), by detecting: Mean Patch Size (MPS), Edge density (ED), Mean Shape Indexes (MSI), which are usually used for landscape pattern interpretation and to evaluate some aspects of habitat connectivity (Tischendorf, 2001). Furthermore, landscape ecomosaic maps and connectivity maps have been produced by manual photointerpretation of aerial photographs and production of a map of ecosystems; b) the biological complexity was evaluated by measuring the cultivated and natural biodiversity within the agro-ecosystem through biodiversity indicators, like the number of cultivated genotypes, the consistence and type of vegetation covering associated to the cropping systems like hedgerows, tree alleys, shrubs; c) the structural complexity was tested through the compilation and description of standardized inventory sheets based on multi-source information (field survey, bibliographic historic data, interviews) for orchards' architecture, employed materials, related rural architectures, etc.; d) finally traditional agricultural practices were recorded with special regard to environmental resources (soil and water management), harvest and postharvest techniques.

RESULTS AND DISCUSSION

The Map of the Traditional Fruit Tree Cropping System

Both the study areas presented persistence of fruit tree related land-use classes over the time span considered. Traditional tree plantations are a dominant landscape component, confirming the connotative nature of these cropping systems in the visual perception of the rural landscape. The resultant object-oriented land-use map (Fig. 2) showed areas with high persistence of traditional fruit tree systems. In particular, three zones of high concentration of these land uses were detected in the Mt Etna area, i.e., mainly persistence of *Citrus* orchards along coastal and sub-coastal areas, persistence of vineyards and orchards in coltura promiscua in the northern and eastern side of Mt Etna, and persistence of pistachio orchards, coltura promiscua and *Citrus* orchards in the western side. Similarly, in the Tuscia territorial area four LSs showed fruit tree crops' persistence, mainly represented by olive groves, coltura promiscua, vineyards, chestnut

and hazelnut groves. The criteria of persistence proved to be the first suitable step for spatially orienting the TAL location and mapping. Nonetheless, the observable cases within the areas of persistence highly differed from the real maintenance of the traditional cultural system. To the point, currently these areas of crop persistence can be found under different condition and processes: a) full maintenance of the traditional cultivation asset; b) adjustment of the traditional system; c) renewal or even land-use change of the traditional land-use; d) misuse or abandonment (Fig. 3). These cultural and ecological dynamics proved therefore the necessity of a high detail scale of analysis and direct visual inspection of the persistence areas obtained from the diachronic spatial analysis.

Type, Consistence and Variation of TALs

The extent of cropping system's persistence varied within the analyzed LSs and on the LUs, defined by socio-economic homogeneous traits and by physiographic and environmental characters, respectively (data not shown). The incidence of the tree cropping persistent systems, considered altogether in respect to the totality of the persistent land-use classes detected within the study areas, varied extremely from 34% of the LS Western site of the Mt Etna to the 2.7% of the Latium's LS Inner Maremma (Table 1). This may confirm that socio-economical forces may be the main driving factors in determining rural physiognomy, rural landscape development, or maintenance (Marino and Cavallo, 2010). The GIS technology has allowed us to understand and measure the nature of the changes that occurred to the three main cropping systems over the considered period of time (1958-1961/2000) by indicating the land-use categories in which the traditional land-use classes, i.e., fruit tree crops, olive groves or vineyards present in the fifties or sixties, have been transformed (Fig. 4). Transformation has generally turned out in loss of agricultural landscape diversity and in biological simplification, resulting from agricultural specialization at the expenses of the coltura promiscua or traditional vineyards or cultivar homogeneity (Figs. 4A and B). The expansion of the olive groves, indeed, also came from coltura promiscua and traditional vineyards. Land-change detection has proved high persistence of fruit cropping systems in the LS of the West side of Mt Etna, ranging from 35.8 to 55.6% for each class, but with a low incidence in respect to the total other land-use class persistence (Table 1). The coltura promiscua typology is still widely represented. On the other side in the LS Inner Maremma specialized olive groves and coltura promiscua, mainly olive groves associated with vineyards or annual crops like cereals, the persistent area represented a lower percentage of the actual extension (between 16 and 22%) and, as previously reported, only the 2.7% of the total land-use persistence (Table 1).

Structure and Functions of the TALs

Biodiversity richness represents a common trait of the traditional fruit tree and vine cropping systems and represents an important aspect of their biological complexity and ecological meaning (Fig. 5). The land-use forms like the coltura promiscua or other traditional fruit tree and vine cropping systems showed a high frequency of species, being "out of forest trees", hedgerows, tree alleys, maquie, and other cultivated species highly represented, contrary to the modernized cropping systems, whose increase in productivity has occurred at the expense of biodiversity. This peculiarity is proved by the germplasm richness and uniqueness of the cultivated trees of the piedmont belt of Mt Etna (Table 2). Furthermore, high biodiversity is also assured by the presence of several and different microsites revealed in the traditional cropping contexts by direct census of minor landscape elements like drystone terraces, wall enclosure, pathways, but also rural recoveries or country houses, cultural traits resulting from a tight interaction among architecture and crops (Barbera et al., 2004, 2010a; Bevilacqua, 1989).

The TALs are also structurally complex systems with highly diversified land-covers, confirming therefore their high ecological significance. In fact, habitat complexity is of crucial importance for the maintenance of biodiversity and ecosystem stability (Farina, 2000; Marecek et al., 2008). The traditional landscape mosaic proved to be

always highly patched and characterized by an optimized integration of various natural and cultivated landscape components (agroforestry systems), thereby providing for landscape complexity, connectivity and continuity. Our investigation proved that territories where TALs were present had a thick ecological connectivity defined by the presence of numerous natural or artificial habitats (remnant forests, shrublands, Mediterranean maquie, planted forest stands, etc.) connecting each other through continuous or discontinuous corridors. These are important for the maintenance of the landscape integrity and continuity, and of the ecosystem functionality (Fig. 6), as found in other areas (Altieri and Nicholls, 2002; Farina, 2000; Mahkzoumi, 1997).

Finally, the study has proved that the TAL functional complexity is based on those traditional agricultural practices that maintain the traditional landscape themselves. In fact, TALs might persist only if traditional land management is maintained (Barbera et al., 2010a). This is based on low mechanization levels, local resource employment, sustainable resource management, and reliability on traditional farming knowledge and expresses TAL's multi-functionality.

CONCLUSIONS

The systemic approach presented in this study has represented a suitable tool for studying the TALs, being able to access their structural and functional complexity. The crucial role of the traditional tree cropping systems within the organization of the studied areas has been demonstrated. They represent important residual areas of fruit orchards, olive groves and vineyards of high ecological-environmental functions, and this comes from the continuity with the other land-cover classes, the diversity of habitats and genetic resources, the sustainability of the management practices. They also proved to be authentic cultural landscapes with an harmonic and suitable integration of natural and anthropic factors. Their loss might be considered as a sort of land 'desertification', implying loss of environmental diversity, natural and agronomic biodiversity, history and rural culture. This study might represent a contribution to allow coordination among research and planning activities with the aim of a sustainable land management and preservation of the traditional agricultural landscape, prioritize restoration objectives and guide restoration efforts.

ACKNOWLEDGEMENTS

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Tables

Table 1. Role of fruit tree orchards in defining the physiognomy of land use persistent areas, i.e., sites of potential TAL presence. Study case: Western side of Mt. Etna (Sicily) and Inner Maremma (Latium).

Fruit and vine crops	Total surface CLC, 2000[z] (ha)	Persistent surface 1958-61[y]/2000[z] (ha)	% in respect to 2000	% in respect to total persistent land use classes
Western side of Mt. Etna (Sicily)				
Coltura promiscua	8214.4	4566.0	55.6	27.0
Citrus orchards	1520.0	791.0	52.0	4.7
Vineyards	1216.8	436	35.8	2.6
Inner Maremma (Latium).				
Olive groves	4814.62	796.48	16.58	2.0
Coltura promiscua	1193.56	257.15	22.38	0.7

[z] Corine Land Cover map and aerial photo interpretation.
[y] TCI, CNR Land Cover map.

Table 2. Biodiversity richness found in the whole Mt Etna Region (Source: main results from research Project "Improvement and valorisation of Mt Etna's fruit productions" by University of Catania, Sicily Region, 2007) (see AA.VV., 2007).

Species	Cvs (n)	Main cultivars	Main traits	Location (Mt Etna side)
Pear	35	Coscia, Gentile, Putiru d'estate, Ucciarduni, Virgolese	wide maturity calendar; associated to apple tree	NW SW
Apple	15	Gelata Cola, Cola	wide maturity calendar;	700-1500 m a.s.l. S-SE
Cherry	22	Ciliegia di Don Antoni. Napoleona precoce	scattered trees; high genetic variability	100-800 m a.s.l. E
Pistachio	1	Bianca	high landscape and agronomic interest	W
Opuntia	3	Gialla, Rossa, Bianca	naturally present, high genetic variability	S
Hazelnut	7	Carraffara (syn. Nostrale, Comune)	high genetic variability	SW
Chestnut	25	accessions	small sized fruits	400-1200 m a.s.l. S-SE
Walnut	40	accessions	high genetic variability	naturally present
Other crops	-	-	-	naturally present

Figures

Fig. 1. Location of the study areas: the "Etna" land in W-Sicily and the "Tuscia" area with its *Maremma* Landscape system of N-Latium.

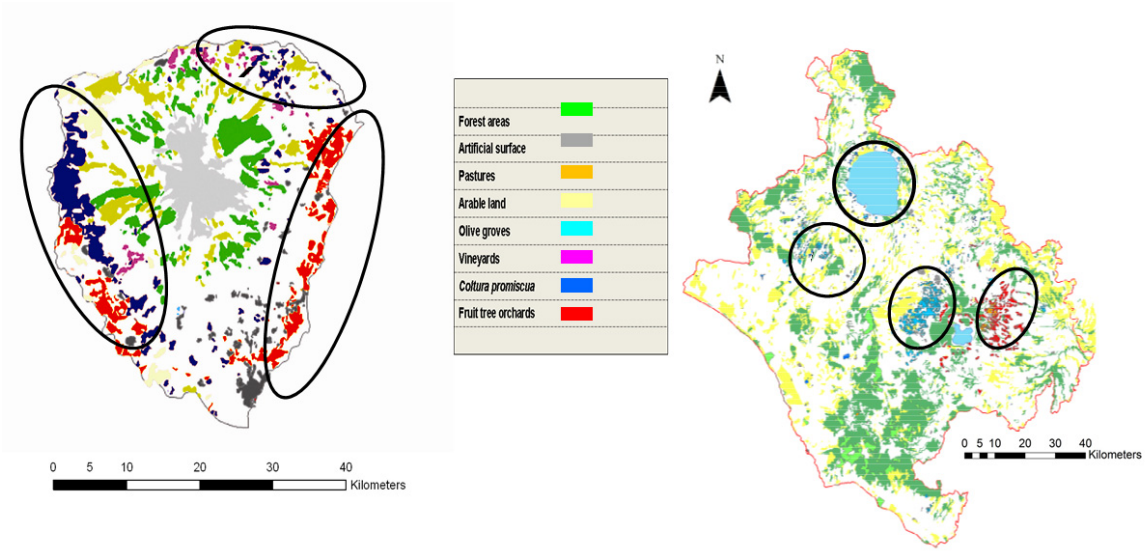

Fig. 2. Objective-oriented land cover map of the two study areas obtained by mapping persistent selected land cover classes (in the legend) as olive groves, vineyards, fruit trees orchards (*Citrus*, pistachio orchard, hazelnuts or chestnut groves) from the Fifties of the last century. The delimited surfaces are the areas of highest persistence concentration of traditional crops.

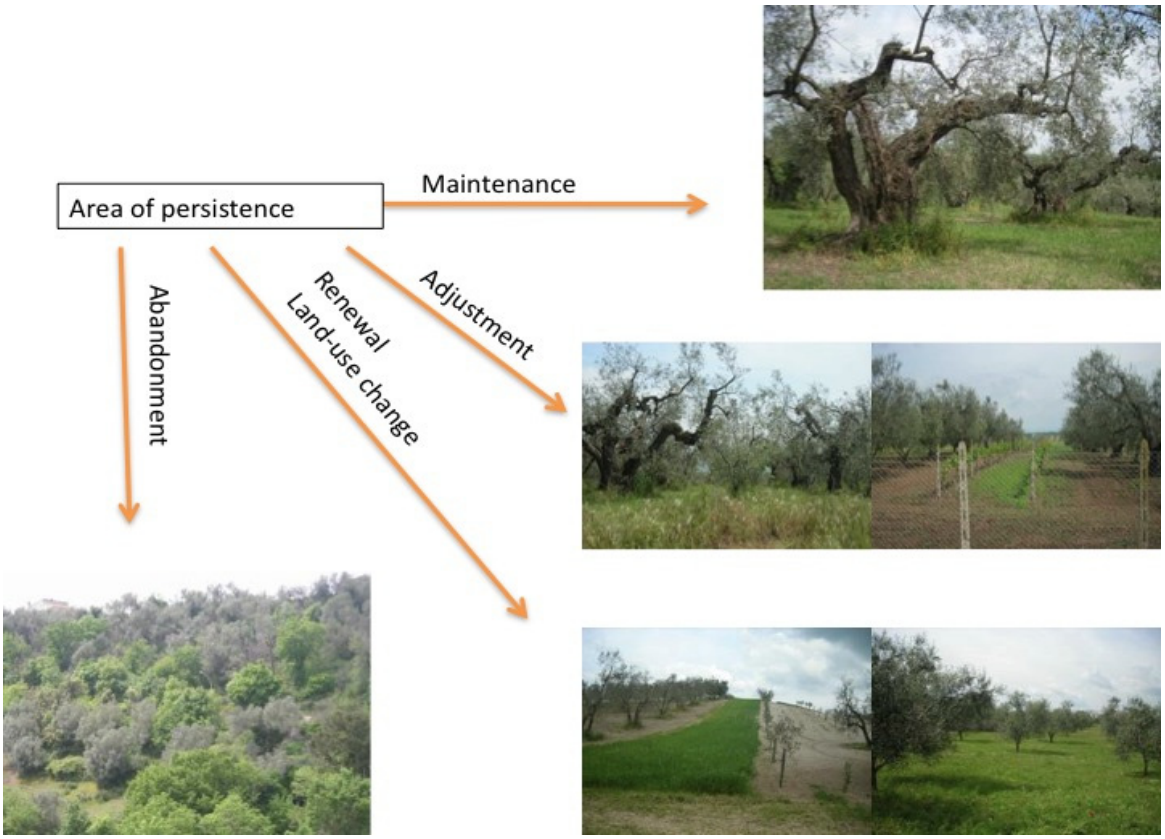

Fig. 3. Possible scenarios in the areas of fruit tree and vine persistence. Study case: Tuscia Territorial Area, Landscape System Inner Maremma, main persistence olive groves.

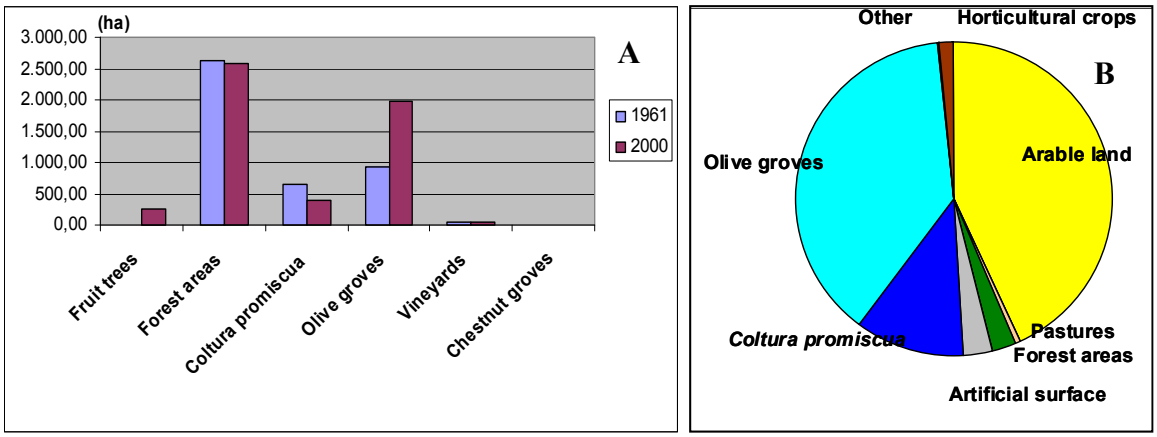

Fig. 4. Land-use change analysis over the past 50 years. (A). Land-use classes in which the coltura promiscua has changed in the last 50 years (B). Study case: Tuscia territorial area, Landscape System Inner Maremma.

Fig. 5. Traditional fruit tree systems of the Mt. Etna region in the typical coltura promiscua.

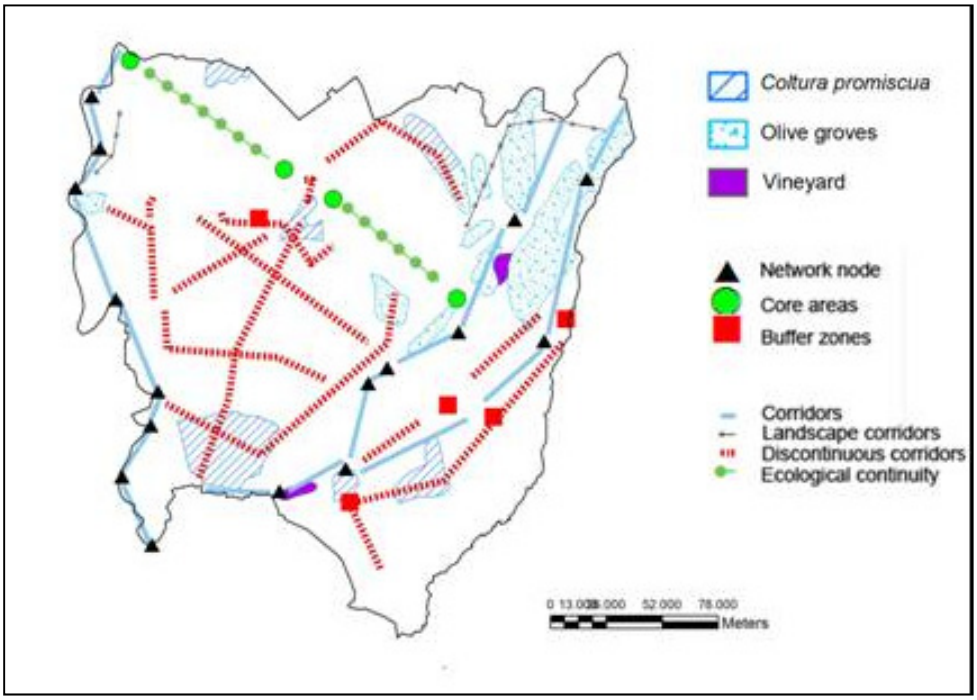

Fig. 6. Connectivity map of in the traditional landscape of olive groves. Study case: Tuscia territorial area, Landscape System Inner Maremma.