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The degradation of traditional landscape in a mountain area of Tuscany during the 19th and 20th centuries: Implications for biodiversity and sustainable management

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Abstract

This paper presents the results of research carried out in one of the study areas of a project developed to build the landscape monitoring system currently used by the Region of Tuscany (Italy). A methodology (HCEA) was developed to analyse and compare landscape data over successive periods from 1832 to the present. The area studied, the Regional Park of the Apuane Alps on the slopes of mount Pania della Croce in the community of Cardoso, was selected to evaluate the effect of Park management on landscape quality. The results show that since 1832 there has been a dramatic decrease in landscape diversity in terms of landscape patches (−86%) and land uses (−76%) as well as a related reduction in biodiversity. The process is linked to the abandonment of traditional farming and forest activities such as management of chestnut orchards, and the increase in woodland cover, from 30% to 77%, on abandoned fields and pastures, reducing the complexity of the previous landscape mosaic. The general trends may be characterized as a degradation of cultural landscape and its evolution towards seminatural models. This process has been accelerated by the way current directives of the European Union regarding nature conservation and rural development have been applied and the prohibition, by law, against restoring open spaces that are today covered by woodlands.

Keywords: Agriculture; Apuane Alps; Cultural landscape; Forests; Italy; Land use change; Landscape diversity; Traditional knowledge

1. Introduction

The landscape of Tuscany represents the form that man has consciously and systematically imposed on the natural landscape through history for the purpose of enhancing agriculture, forestry and other productive activities. Most of the values represented by this cultural landscape today are connected to traditional techniques and practices that shaped this territory for several centuries. Although Tuscany is a region where the concept of sustainability is the basis for land management under Regional Law[1] and where environmental directives and landscape protection have been developed, there is a growing feeling, shared by several scholars and administrators, that the quality of landscape had degraded in the recent decades, particularly the quality of rural and forest landscape, even in protected areas. This impression, however, is not consistent with reports on the quality of air, water, soil and biodiversity, nor with certification standards, which indicate that the environmental condition of the regional territory is relatively good.

In order to have a clearer view of this problem, the Dipartimento di Scienze e Tecnologie Ambientali Forestali (DISTAF) of the University of Florence, in collaboration with the regional government, developed a research project involving several research institutions and an international team of scholars from the fields of history, agriculture, forestry, economics, ecology and geography. The main goal of this project was to develop a methodology to evaluate landscape dynamics, at appropriate spatial and temporal scales, with special attention to factors and processes responsible for landscape change and the quality of these changes. The result was the development of a methodology called "Historical and Cultural Evaluation Approach" (HCEA) (Agnoletti, 2006a), to assess the cultural identity of an area as the central paradigm

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[1] The law on the Management of the Territory, n. 5 of 1996, today revised as n. 1 of 2005.

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driving and supporting regional planning, and to create a monitoring system for landscape resources that can be used for repeated assessments of the same areas over time. The system of study areas created with the project has been utilized by the Regional Government of Tuscany to monitor landscape changes (Agnoletti et al., 2006a) and has contributed to the definition of the measures for landscape in the Italian National Strategic Plan for Rural Development. This is the first time in the history of Italy that landscape has been introduced as a strategic element for the improvement of the competitiveness of the agricultural and forestry sector, the environmental quality of rural areas, the quality of life and diversification of rural economy.

The study presented in this paper relates to one of the areas of this larger project. The aims of this study area were: (1) to analyse the effects of the suspension of traditional practices in a mountain area where difficult environmental conditions have historically forced local populations to develop locally adapted distinctive management practices and techniques to survive, and in the process have created and maintained landscapes of outstanding beauty while sustaining production of multiple goods that contributed to biodiversity at the landscape level; and (2) to analyse the effects of the creation of the Park of the Apuane Alps, and the role of the Special Protected Areas created according to EU NATURE 2000 network included in this study area on the conservation of traditional landscapes and their biodiversity.

2. The study area

The study area of Cardoso is located within the Regional Park of the Apuane Alps. This 21,000 ha Park is situated in the provinces of Lucca and Massa, and includes 16 villages. The study area has an extension of 1054 ha, and extends from the top of mount Pania della Croce (1858 m above sea level) down to the river Cardoso, and includes one Special Area of Conservation and one Site of Community Importance belonging to the NATURE 2000 network. The climate of the area is sub-Atlantic, dominated by the maritime winds, with an average rain fall during the last thirty years between 2000 and 3000 mm, and mean annual temperatures ranging from 15 °C at sea level and 7.5 °C close to the mountain tops.

The potential vegetation between 300 and 1000 m elevation includes an overstory of *Ostrya carpinifolia* and *Quercus pubescens*, with an understory comprised mostly of *Erica carnea*, *Amelanchier ovalis* and *Viburnum lontana*. This natural vegetation belt has been dramatically affected by changes induced by man. The evolution of an economy based on pastures, woodlands and fields, as well as the development of the first villages in this area can be traced back to the 8th–5th century B.C. (Decandia, 1994). Before the Romans the populations living there, mostly Liguri, had already cultivated the land using ‘‘slash and burn’’ techniques and rotation to alternate crops. The coming of the Romans during the 2nd century B.C. extended cultivated areas and reduced forests.

One of the most important historical land use trends during the centuries which followed is probably the increasing cultivation of chestnut orchards (Pitte, 1986), often referred to in written documents of the 13th century as the ‘‘bread tree’’. This species has dominated the local economy for centuries, as population growth would have been impossible in mountain areas without chestnut flour, used by the farmers to integrate their diet, since cereal production at this altitude was quite limited. The tree was also used for many other purposes. In Italy the cultivation of chestnut has been extended from sea level up to 1500 m a.s.l., often independently of soil conditions, and far beyond the normal climatic limits of this species.

The chestnut can perhaps be considered one of the most important cultural forest tree in Italy generally, and more specifically in Tuscany and in our study area, where it often presents the feature of veteran trees, several centuries old, although it is now far less common than it was in the past. At higher altitudes pastures were regularly burned until a few decades ago, and this has deeply affected the species composition of meadows. The situation of woodlands is similar in that they cannot be described according to potential vegetation patterns due to the fact that human activities have totally changed their species composition. The cultivation of chestnut, as well as vines and cereals, involved terracing of hill slopes, a process already begun during medieval times but probably increased during the 19th century, a period of unprecedented population growth in the Italian mountain regions, when the population increased 50–70% between 1861 and 1920 (Fig. 1).

3. Methods

It is difficult to understand a cultural landscape, even its ecological components, without adopting a historical perspective (Motzkin et al., 1996), especially in the Mediterranean region (Naveh, 1991; Grove and Rackham, 2001). Therefore, for our study, history was not considered an option, but rather

Fig. 1. Farmers collecting leaves of chestnut to be used as fodder for cows. In many areas timber was not the main product of the forest. Rather, these woodlands were managed to produce a variety of products based on local traditional knowledge that has not been formalized into modern forestry textbooks and some of which has already been lost.

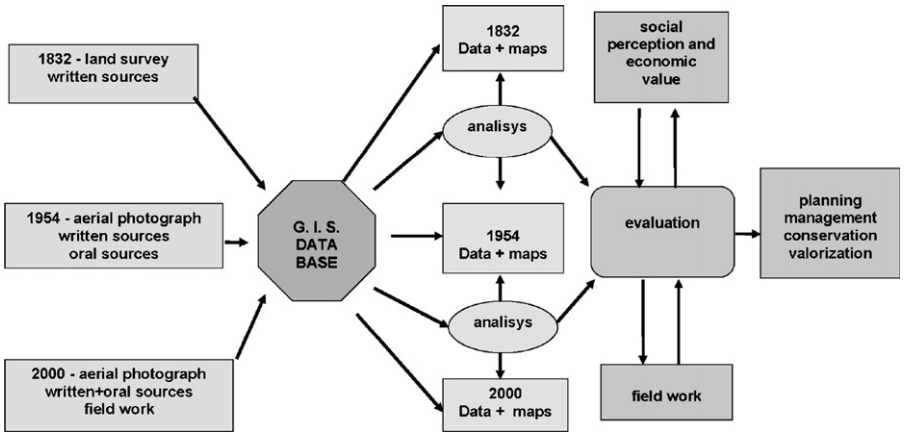

Fig. 2. The structure of the HCEA methodology used to build the monitoring system of the Tuscan landscape.

the central focus of the methods used in our work, which aims to understand the trajectory of traditional landscapes and indicating significance and vulnerability of landscape resources as well as the degradation processes affecting them.

Within the study team there was an agreement that rather than focussing primarely on geo-morphological features or vegetation models commonly used to describe landscape, our study would instead focus on what was already appearing to be relevant in some of the most interesting studies to date, although not fully addressed, i.e., the role of the transformation of the landscape mosaic (Vos and Stortelder, 1992). Therefore, most of the attention in our study was given to ''spaces'' linked to land uses and their changes through time, considered to be the most relevant issue in the historical dynamic of the Tuscan landscape, as well as for biodiversity. There is clear relationship between biodiversity and land uses shaping traditional landscapes, as they are also valuable ''habitats'' for flora and fauna (Wagner et al., 2000; Ortega et al., 2004; Atauri and De Lucio, 2001). Unfortunately, the European official Habitat List, used to create the NATURA 2000 network of protected areas in Tuscany, is failing to consider many habitats deriving from human influence, as it is mostly concerned with ''natural'' habitats. This omission jeopardizes the preservation of most of the habitats created by man.

During a 6-year period starting in 2000 the project selected and analyzed 13 study areas covering 23,753 ha, or approximately 1% of the regional territory, with an average study area size of about 2000 ha. The selection of these areas was made according to the following criteria:

(1) coverage of the main geographical areas of Tuscany: Apennine Mountains, central hills, and coastal plains;
(2) inclusion of territories with ongoing agricultural and forest activities, abandoned areas and areas placed inside the regional network of protected areas;
(3) availability of evidence and sources needed to interpret landscape changes and understand its causes.

In selecting study areas we also aimed to represent the different geographical and socioeconomic conditions of the region. In fact, nine areas are located in the hilly region, representing 65% of whole territory; two are in the mountains (25% of the whole territory), and two on the plains along the coast. Some of the mountain and hill areas also include plains, resulting from the selection of site boundaries that included portions of both hills and plains; study areas also included abandoned land, farms, urban and suburban areas. This approach to study areas selection was preferred to methods using statistical grids applied to the territory (Farina, 1998; Köhl, 2003), as it allowed us to select locations and study areas of appropriate sizes that would favour a better understanding of the structure of the landscape in relation to socioeconomic conditions at the farm unit level, and facilitate the analysis of the diversity of landscape mosaics. This meant the selection of areas that include one or more farming estates, with several farmhouses, according to the traditional sharecropping system featured by Tuscan rural economy since medieval times. These estates usually provide opportunities for accessing written sources (preserved in their offices, or in public and private archives) for historical data, as well as oral sources for recent periods.

In order to develop a dynamic picture of landscape changes, three historical moments with different kinds of available documents were selected: 1832, 1954 and 2000. The year 1832 was chosen because of the availability of a detailed survey represented by the Tuscan Land Register, the cadastre describing almost the entire territory at the scale 1:5000, started by the French at the end of the 18th century and continued by the Lorena Grand Duke after the restoration of the Grand Duchy of Tuscany and the defeat of Napoleon. This period probably also represents the age with the highest complexity of landscape patterns, due to the strong development of agriculture and demographic growth, although an even higher complexity could be found during the second part of the 19th century (Agnoletti, 2006a). The black and white aerial photographs of 1954 are considered the last pictures of the traditional rural Italian landscape. These document the years before the mechanization of agriculture, the use of chemical fertilizers and the abandonment of many farms due to industrial development, the so-called Italian ''economic miracle''. The use of colour digital aerial orthophotos, taken between 2000 and 2004, allowed us to analyze the present landscape, their

interpretation accompanied by field work to ‘‘ground truth’’ our analyses. All these data were digitized and included in a GIS database (Fig. 2).

Analyses based on historical photos and cadastral maps have been previously developed not only in Tuscany (Vos and Stortelder, 1992; Agnoletti and Paci, 1998), but also in the United States (Foster et al., 1998; Knowles, 2002). However, in this project a systematic methodology was applied to all the study areas (Fig. 2), developing tools to compare different years and specific indices to evaluate the historical value of the territory analyzed. Different sources were used and integrated (oral interviews, written sources, sampling plot data) while investigations on economic value and social perceptions were carried out by means of interviews with residents and tourists. The features of the landscape mosaic were studied in each area, using a minimum cartographic unit of 1000 m^2. This choice offered a much more detailed description of the landscape matrix that cannot be achieved at a scale of 1:100,000 used by Corine Land Cover 2000 for Italy, with its minimum cartographic unit of 20 ha, which presents very different features of the landscape matrix surveyed and thus affects management strategies based on these results (Bologna et al., 2004; EEA, 2006). Surveys of the individual stands were also undertaken to study vegetation structure and composition. These studies covered the identification of the structural and evolutionary vegetation types in abandoned fields, pastures and forests. Some transects were also made to better understand floristic diversity in each area. Synchronic comparisons verified the level of floristic diversity between identical types of crops, especially in the presence of secondary successions. In some areas specific studies on soil and geology were carried out to support the interpretation of changes in land use types. Investigations were also extended to supply further data on specific trends or issues, such as the extension of conifer forests for afforestation or of vineyards spurred by recent market developments.

The main dynamics were synthesized in graphs comparing each pair of years (1832/1954, 1954/2000, 1832/2000), while a more detailed evaluation was made using a cross tabulation matrix. In this paper, we will focus primarily on the results of our analyses of changes occuring between the earliest (1832) and most recent (2002) years included in our larger study. Landscape mosaics were characterized and evaluated also by using some of the indices typically applied in landscape ecology. The items selected for the legend after the evaluation to synthesize the main dynamics were: built up, deforestation, extensification, forestation, intensification, conifer expansions, and stable. The category ‘‘stable’’ included the percentage of territory not affected by any change in the main land use category (e.g. woods, pasture, fields, etc.). This means that general categories such as ‘‘woodlands’’, which included several different kinds of woodlands, remained ‘‘woodlands’’ in the period considered, but might show internal changes related to woodland types. The indicator ‘‘built up’’ refer mostly to urban areas and material structures. The information collected in this way is useful for many different kinds of evaluations, such as assessments of secondary succession, hydro-geological risk, technological changes, etc., but particularly for the application of landscape ecology indices, the construction of the historical index, HI (Agnoletti et al., 2006b) and the evaluation of integrity, significance and vulnerability of landscape according to UNESCO WHL (Fowler, 2003), as well as for restoration purposes. Maps showing the dynamics on the territory were produced to enhance the understanding of changes and their location in the study area, as was done previously by Foster (1992) and Vos and Stortelder (1992), but on a smaller scale and using GIS.

The historical index (HI) is a tool developed to assess the value of a cultural landscape analysing the changes, in time and space, of any single land use or patch, creating a hierarchy in which every element has a ranking according to the value of the index. The index requires the definition of a *spatial scale* expressed in hectares (Sr), and a *temporal scale* expressed in years (Tr) representing the limits in which the index is applied. Other variables are the *historical geographic distribution* (Hgd), which is the past extension of the land uses at the beginning of the period considered, and the *present geographic distribution* (Pgd), the present extension of the land uses, both expressed in hectares. The other element of the index is the *historical persistence* (Hp), the number of years of existence of a given land use in the temporal scale considered, and its value will vary from 0 to 1. After choosing the spatial scale and temporal scale, the algorithm to calculate the Hi is the following: Hi = Hp (Hgd/Pgd)

The index attributes a higher value (Hi) to those elements with a long historical persistence (Hp), but a present geographical distribution (Pgd) smaller than that in the past. Using the database created with GIS every land use can be analyzed, considering its historical persistence (Hp) and the variation in the extension (Hgd − Pgd). The data resulting not only creates a hierarchy that can be referred to single or groups of land uses, but can be represented in maps of the area studied. The maps created can refer to the ‘‘general’’ Hi and the ‘‘topographical’’ Hi. In the first case the different colours of the map indicate a single or a group of land uses that have different values of the index. In the case in which one distinctive element of the territory has disappeared, the index itself may not be calculated. This index has been applied for the Landscape Park of Moscheta (Agnoletti et al., 2006b) and in the guidelines or the environmental impact assessment of windmill farms in Tuscany, while an improved Historical index, based on a ‘‘classification and regression tree model’’ is presently being developed (Puletti et al., 2006).

The analysis provided information on: (1) structure of the landscape; (2) dynamics of the landscape; (3) structure of the individual landscape patches; (4) dynamics of the individual landscape patches. The importance of the method for forest management is that it enables us to better assess the role of the forest in the landscape of Italy by considering the role of forest units in the larger context of a matrix enclosing different land uses and with an appropriate time scale. A ‘‘photograph’’ of the present is not sufficient to assign values to landscapes resulting from several centuries of human influence. In this respect although not all the regions have detailed land surveys for the

past, the availability of aerial photographs from past decades allows the development of a similar approach in other countries. In the case of Cardoso, the study area presented in this paper, the use of the aerial photographs of the year 1981, instead of 1954 as in the other study areas of the larger project, was due to the request of the Nature Conservation Service of the Regional Government, which sponsored this particular study, to monitor the effect of the creation of the Park on landscape and biodiversity conservation. The park was created in 1985, therefore the aerial photo of 1981 represented a starting point to develop a useful comparison with 2002.

4. Results

4.1. The landscape in 1832

In 1832 we can see the presence of a complex landscape mosaic organized in more than 65 land uses and 618 patches, dominated by pastures and meadows (38%), cultivated land (32%), while the woods cover only 20% of the territory (see Fig. 3). Thus we have a high diversity of spaces, due to many different land uses strongly affecting the overall biodiversity (Baudry and Baudry-Burel, 1982). Farming is carried out using traditional techniques based on small-scale cultivation, terracing of slopes and using many trees in the fields. The reduced amount of closed forest does not mean a reduced amount of tree species in the area, they were an important element of 27 different types of fields, pastures and meadows, all described as wooded. An estimate of the number of trees per hectare in 1832 could not be made, but it must be kept in mind that farmers used to plant many trees in the field to provide fodder for cows feed cows, and to produce timber, fuel wood and other products such as bark and fruits. Moreover, in Tuscany pollarding was described as the third most common techniques used in coppice woods with the specific objective of increasing winter fodder production. The number of individual trees per ha estimated in other rural areas of Tuscany was 120 ha^{-1}, more or less the number of trees in a chestnut orchards, but in the Val Padana valley (northern Italy) there may have been as many as 160 tree species/ha (Cazzola, 1996). In this area, vines cultivated in traditional vineyards were bound to maple trees (*Acer campestris*), a technique used since Etruscan times (Sereni, 1997), but mulberry trees, walnuts, chestnut, heather and many fruit trees are known to have grown in the arable land. The land use classes described in Fig. 3 shows that different types for each class existed, and cultivated fields not only included different crops (e.g. rye, wheat, corn) but also different tree species growing in each type. In the same way the land use class ‘‘pastures’’ can be categorized into ‘‘bare pastures’’ and ‘‘wood pastures’’, the latter again divided into 11 different types based on the different trees species in the wood pasture.

4.2. The landscape in 1981

The interpretation of the aerial photographs of 1981 shows the dominance of woodlands in the area and the significant reduction of land uses from 65 to 16. The quantitative data referring to the extent of each land use category show that 68% of land cover is made up of woodlands, followed by pasture land (24%), cultivated areas (6%), and built up areas (2%). The reduced importance of traditional agriculture in the area is not only reflected by the reduced extent of cultivated areas, but also by their distribution within the area (see Fig. 4). By 1981 they now appear to be scattered in small number of patches, often under the form of terraced fields, far from the village of Cardoso. It is also evident that new land uses resulting from secondary successions are occurring in abandoned fields, a new important element in the landscape of the area. Considering terraced cultivation detected by photo interpretation, at least 57% of these are in an abandonment phase, while among the areas now included in the category ‘‘pastures’’, 30% can be interpreted as areas with sparse vegetation, and 27% as uppermost areas characterized by rock outcrops. Is worth noting that secondary succession is taking place in locations mostly along the upper belt and mountain tops.

The landscape mosaic of 1981 is therefore defined by the forest, organized into eight land use classes, including areas with scarce vegetation. Considering the forest types, mixed stands derived from former chestnut orchards dominate the woodlands, covering 67% of total forest land. It is important to note the presence of mixed stands with hornbeam (*Carpinus orientalis*), about 20% of total forest cover, due to natural forest succession towards the potential vegetation type of the area, and the presence of mixed stands with dominated by beech, not reported in the land register of 1832, which are also the result of natural successional processes.

4.3. The landscape in 2002

The current landscape of the area presents a structure dominated by the forest vegetation, extending from the bottom of the valley to the mountain top, where pastures still prevail along the ridges of the Mount Pania della Croce. This continuous forest layer, covering 74% of the area, is interrupted only by small groups of farmhouses and some residual terraced cultivations, while pastures and rock outcrops, particularly at higher elevations, together represent 20% of the total area (Fig. 5).

The extremely simplified structure of the landscape mosaic is accompanied by an internal diversity of forest types, partly reported also in description concerning 1981 where only photo interpretation could be used. The most common forest types in 2002 are those still characterized by the presence of chestnut trees, both under the form of ‘‘woods with the prevalence of chestnut’’ and ‘‘mixed woods with chestnut’’, representing 48% of the area and 64% of the total woodlands, but not anymore under the form of chestnut orchards. These are followed by stands with the prevalence of hornbeam (20%), distributed mostly on calcareous soils in the north east side of area, while simple mixed woods represents 5.4%, of the total woodlands. Other smaller forest types are represented by beech stands on higher altitudes (2.4%), shrublands (0.4%) and riparian woods (0.2%), along the streams in the bottom of the valley.

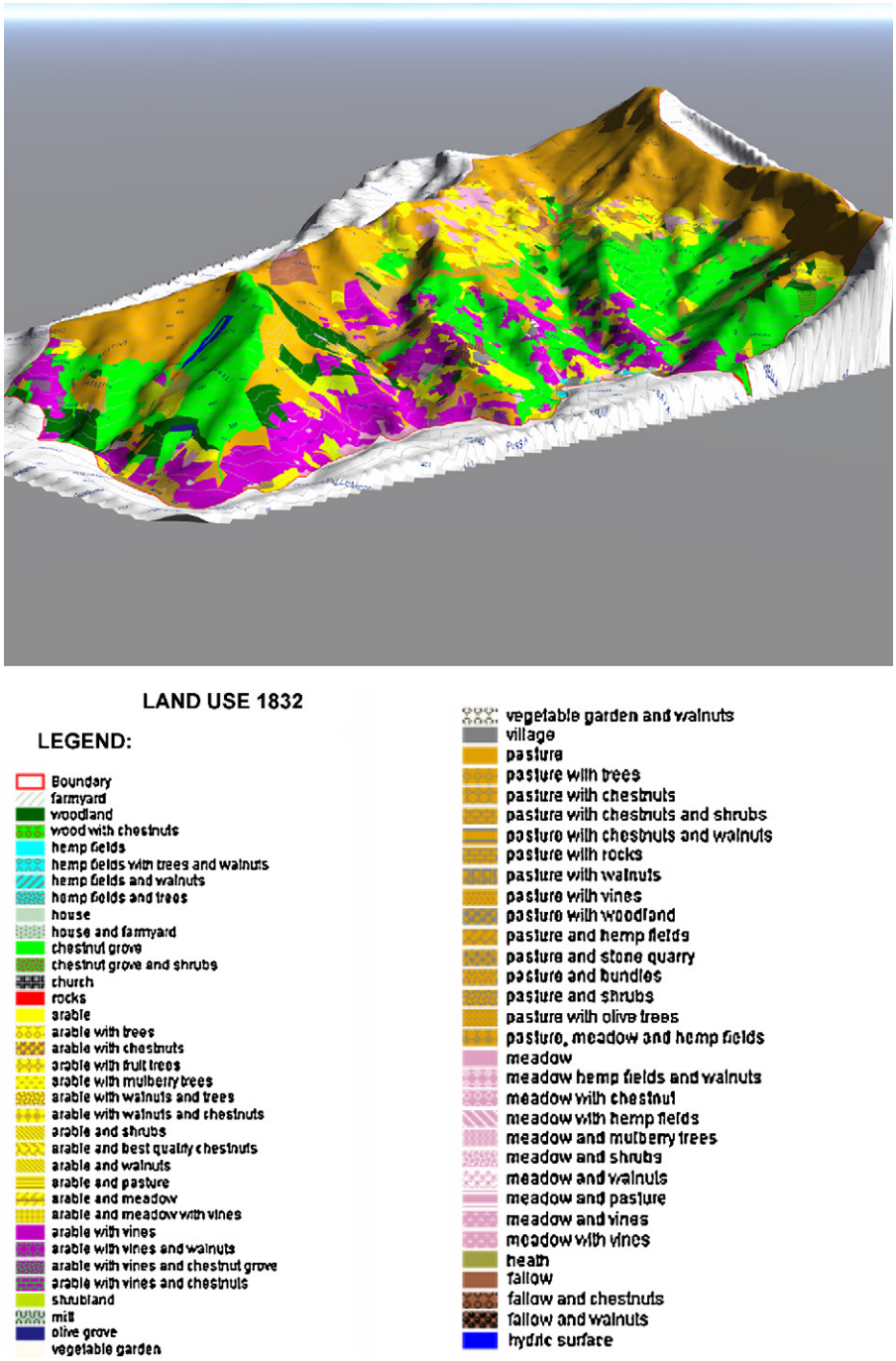

Fig. 3. The landscape mosaic of the study area in 1832 was characterized by 65 different land uses. The number next to each land use class indicates a different type of wood, field, meadow, pasture described by the cadastre.

4.4. Landscape dynamics between 1832 and 2002

Considering the changes in the three main land use types shown in Figs. 6 and 7, it is worth noting the sharp increase in woodlands and the dramatic decreases in arable land (from 234 to 26 ha), pastures (from 483 to 107 ha), and mixed cultivations with vines (decreasing by 89%) during this period. Wooded pastures that constituted 27% of the landscape in 1832 have largely disappeared, being reduced 93% by 2002. The loss of arable land and pastures and secondary succession occurring over this period explains the expansion of woodlands from 315 ha in 1832 to 818 ha in 2002. Between 1981 and 2002 this trend appeared to be slowing, but woodlands continues to expand throughout the area (see map of landscape dynamics, Fig. 8), a process reported in similar situations in Europe and the USA (Foster, 1992; Foster et al., 1998). The data presented in Table 1 allows a more detailed analysis of changes that have occurred in all the land use types defined in 1832. However, as it was necessary to reclassify the 65 land use classes of 1832 to allow a comparison with 2002, a certain amount of information are lost in this matrix, although it is possible to follow the evolution of the most important types.

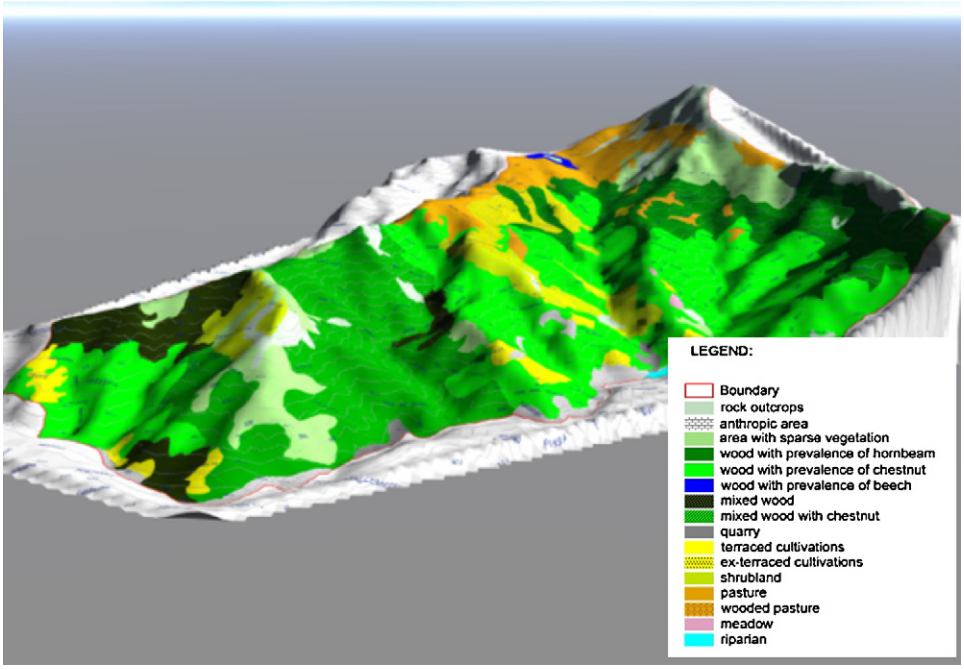

Fig. 4. The landscape of the study area in 1981 showing the significant increase in woodland extent and a sharp reduction of the number land uses relative to 1832.

The expansion of forest land occurred throughout the area. This is largely the result of the abandonment of agricultural and forest practices, though these are not the only reasons. Landslides occurred in 1996 as a result of the abandonment of management of terraced chestnut orchards. It is important to note that the new woods found in 2002 are growing on former pastures, wood pastures, and fields with vines land uses that once covered a large portion of the area, and that the class ‘‘chestnut’’ no longer occurs in the land use classification of 2002.

The dramatic loss of diversity tied to land use, and therefore of habitats created by man’s activities, is reflected by the decrease in the number of landscape patches, from 618 in 1832 to 84 in 2002, a reduction of 86%. The average size of these patches increased from 1.70 to 12.54 ha over this period. Today we have only 23% of the diversity of habitats related to land

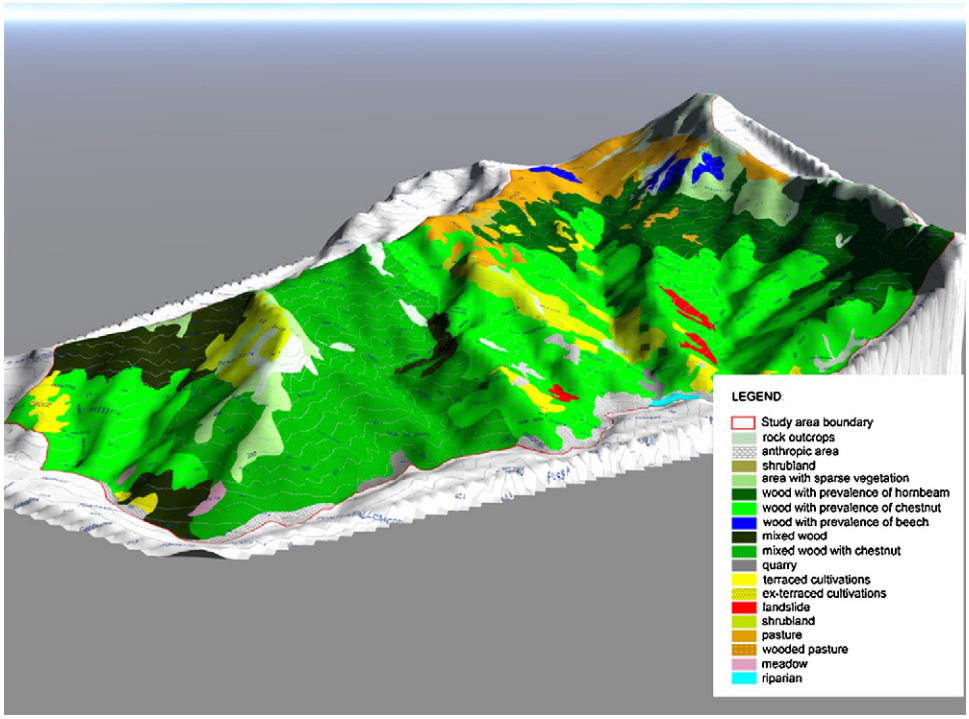

Fig. 5. The landscape of 2002 presents a further increase of woodlands but also landslides due to abandonment.

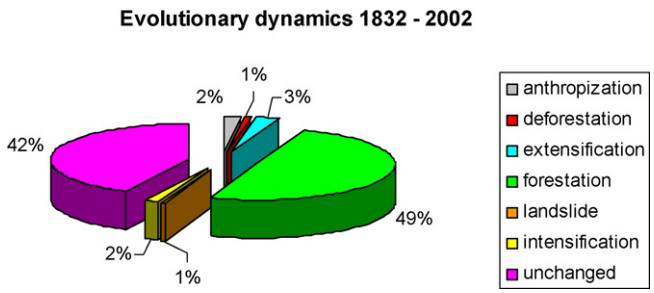

Fig. 6. The dynamic of the main processes affecting landscape changes in the area. Anthropization refers to built up areas, infrastructures, roads, etc.

uses that existed in the year 1832. In the three main categories of land uses that characterized the environment in 1832: pastures, woodlands and fields, all of the habitats related to meadows and pastures, as well as cultivated fields with hemp or with tree species such as mulberry, walnut, chestnut, olives and vines, have completely disappeared.

The change in the average size of each patch is also very significant. Today we have fewer, but larger patches, while in the past there were many small patches, such as cultivated fields, along with very large patches of forest (see Table 2). This trend, observed in the other study areas of our larger regional project, indicates that the present diversity of the regional landscape is now mostly based on the features of larger subsystems within the main geographical areas, confirming a general change from a fine grained to a coarse grained landscape as occurred in other areas in Europe (Angelstam, 1997). In the cadastre of 1832 we can actually find land uses classes with areas as small as 0.09 ha: this gives us an idea of the high complexity of this former landscape mosaic, and how the texture of the landscape and its diversity have been simplified to a pattern dominated by woodlands.

During the period 1981–2002, while the unchanged areas make up 94% of the total, forestation is still the most significant process (4%). About 63% of former terraced cultivation are now covered by woodlands; 1.53 ha of former chestnut groves are now mixed woodland, while 5.2 ha of abandoned terraced chestnut orchards are now affected by landslides. The principal classes of historical land uses with a strong tendency to disappear can be found in the historical index table (see Fig. 9) As shown in Fig. 9, the highest index values are for ‘‘meadows’’

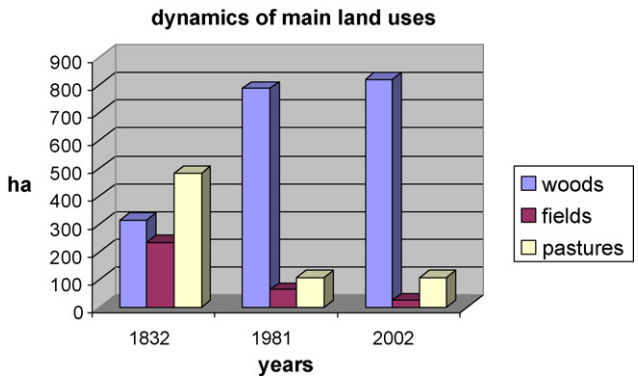

Fig. 7. Changes the three main land use types between 1832 and 2002.

(24.46), which have undergone a marked contraction from the 19th century onward, followed by ‘‘pastures with trees’’ (13.53) and ‘‘cultivated fields’’ (4.57) and ‘‘pastures’’ (3.83).

5. Discussion

Almost all the landscape changes that have occurred in the study area are due to changing human influences in this part of the Apennines. The abandonment of farming activities accompanying the sharp decrease in the resident population has clearly favoured natural ecological succession and the degradation of cultural landscape.

Intensive farming in this area continued up until the 1920s, although there were already clear signs of a crisis in food production, partly offset by increased wheat imports. The first signs of an inversion of demographic trends appeared around 1921, but the dramatic population drop in this part of the Apennine mountains occurred quite rapidly only after the Second World War, as Italy was transformed into an industrialized country. In the decades between 1950 and 1980 the resident population dropped to levels similar to those of the early 19th century, inducing dramatic changes in all features of this mountain environment due to the suspension of farming activities.

The changes that occurred in the area between 1832 and 2002 can be considered at different levels; i.e., the evolution of the main processes affecting landscape (see Fig. 8), the main land use types, land use and biodiversity. As shown in Fig. 6, the role played by the forest in the changes affecting the area is evident, as forestation is associated with 49% of the changes that have occurred. Further, it must be noted that even the 42% classified as ‘‘unchanged’’ does not actually mean that there have been no changes, but only that the general land use categories considered (e.g. ‘‘woods’’, pastures, fields) have not been transformed into other land use. As the cross-tabulation in Table 1 shows, within these general categories there can be changes due the evolution of the internal structure of each land use type considered. Landscape changes have also brought about a reduction in biodiversity, not necessarily species diversity, but rather the diversity related to spaces linked to habitats represented by the many land uses, and therefore diversity at the landscape scale. This tendency is supported by the marked reduction in the number of ‘‘patches’’ that served to diversify the 19th century landscape, reduced 86% by 2002, accompanied by a large increase of their average size, leading to both an enlargement and simplification of the landscape mosaic.

The reduction of grazing has contributed to the disappearance of specific types of forests called ‘‘pastured woods’’ (in opposition to ‘‘wood pasture’’), very typical of the Mediterranean region (Grove and Rackham, 2001), which requires a reduced number of trees to allow a development of large tree crowns to enhance production of nuts, a management system still popular in Spain (Fuentes Sanchez, 1994). About 229 ha of terraced arable land have been turned mostly into woodlands, while arable land with tree rows have disappeared completely. In addition, all mixed cultivations with vines which occupied

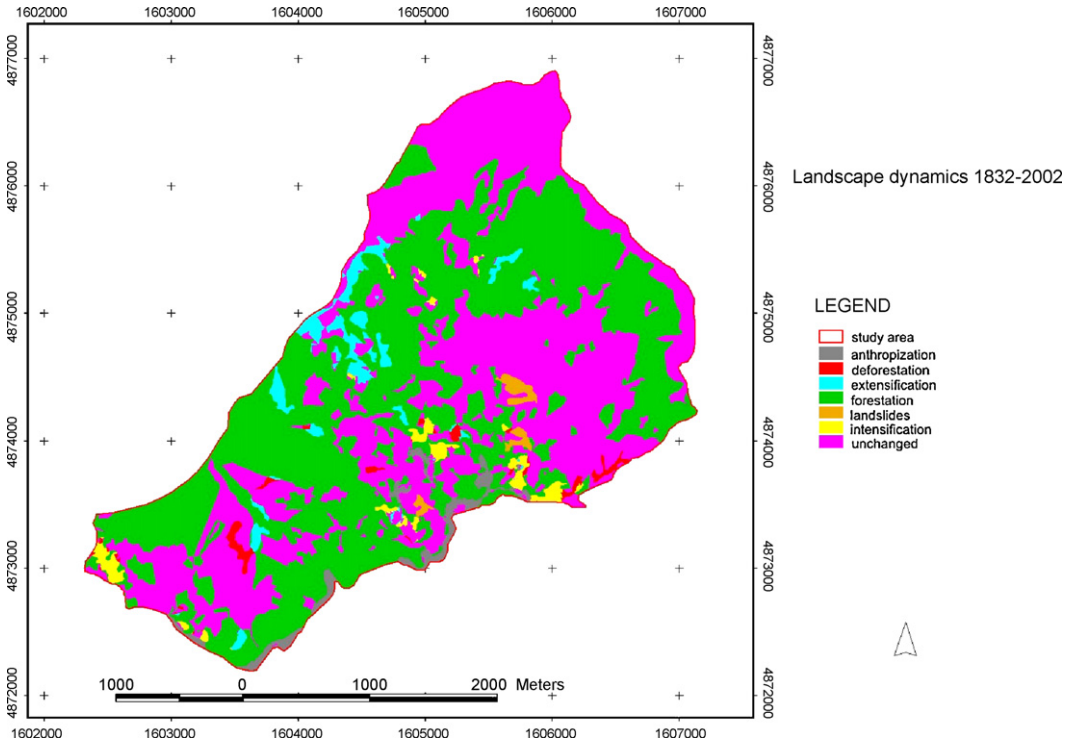

Fig. 8. Map of landscape dynamics between 1832 and 2002.

10% of the territory in 1832, have disappeared, as have all arable lands with trees. Traditional agriculture is now carried out by elderly farmers in only 26 ha.

These historical trends are reflected at the national level. During the last century in Italy 13 million ha of agricultural land have been abandoned and forests have increased from 3.650 million ha in 1906 to 10.5 million ha in 2006 (National Forest Inventory http://www.ifni.it) (Agnoletti, 2006a). During this same period, woodlands have increased approximately 25% in Tuscany and now cover 47% of the region. These changes have been accompanied by a marked reduction in forest utilization. Given the reduced importance of agriculture and livestock raising, as well as the current European Union agricultural policy, it is very unlikely that this trend will be reversed or significantly affected, even by climate warming.

The suspension of traditional forest practices in the study area is evidenced by the absence of chestnut orchards, previously found on 267 ha, which have disappeared as a landscape unit and therefore as a habitat. Today we have in their place mixed woodlands with different percentages of chestnut, beech and hornbeam. However, even if chestnut orchards have disappeared, chestnut remains one of the dominant species; in other words, all the former pure stands of chestnut are now mixed forest stands with some hornbeam and oak, due to abandonment of their cultivation and natural succession processes. This trend is supported by the Park's past management policies which have favoured mixed woods and the expansion of forest land. In this respect it is interesting to note that the landslides that affected 70 ha of this area during a severe climatic event in 1996, occurred on abandoned chestnut groves and terraced fields. The abandonment of chestnut grove cultivation seems therefore to have played a role in the destabilization of the mountain side and in the severity of the environmental upheavals that took place. This also suggests that the interruption of rural practices has probably contributed to degradation and erosion. However, the data concerning this aspect of our study have not been presented in this paper.

The use of the historical index shows that the elements that currently concentrate the major landscape emergencies are: meadows, pastures, pastures with trees and cultivated lands, that are slowly disappearing. It is also interesting to observe that the portions of territory with higher historical values and higher risk of disappearance is concentrated in the upper area of the Pania mountain, where pastures and meadows have been preserved (see Fig. 10). However, in the higher elevations of the study area (light blue colour in Fig. 10) there is a belt in which the pastures and the remnants of the old terraces built to cultivate these mountain slopes, form a landscape with a great historical value, enhanced by the scenic value of the harsh slopes of Pania della Croce mountain.

The institution of the Park did not modify these trends. Over the 20-year period between 1981 and 2002, the reduction of diversity linked to the increase in woodlands continued. Is worth noting that our study area is located completely within the Park, and that a portion of it is inside two protected areas: the Site of Communitarian Importance "Monte Corchia, Le Panie" and the Special Area of Conservation "Primary and secondary prairies of the Apuan Alps". It is therefore an area subject to three types of protection according to the specifications of the regional law n.56 enacted in 2000, the European Habitat Directive of 1992, and EU NATURE 2000, which reported an official list of natural and semi-natural

Table 1
Cross Tabulation 1832–2002. The extension of each land use is in hectares. Columns represents the land uses in 2002, lines the land uses in 1832

		2002													
	Land use 1832 reclassified	rock outcrops	anthropic area	shrubland	area with sparse vegetation	*woodland	chestnut grove	quarry	terraced cultivations	ex-terraced cultivations	landslide	pasture	wooded pasture	meadow	Overall amount
1832	anthropic area		2.1177			0.6434	0.4213		0.4175	0.0638	0.0439			0.0067	3.7143
	shrubland					1.4775	0.2168								1.6943
	woodland	0.7119	0.053		0.5478	28.8729	15.7816	0.2127						0.125	46.3049
	hemp fields		0.6572			0.3771	0.1063	0.1558	0.0222						1.3186
	chestnut grove	6.1746	2.0998	0.1578	9.0175	46.2589	193.8046	0.6037	2.3975	0.004	6.5049		0.0014		267.0247
	quarry					0.4612	0.0243								0.4855
	fallow		0.1236			6.2681	1.5052			0.311			0.0623		8.2702
	fallow with trees		0.3799				1.5189		0.5836		0.0169				2.4993
	arable	0.0498	3.8561	1.0505	0.5009	54.771	40.8528	0.3375	2.4293	5.0131	0.1546	8.9283	2.2504	0.3132	120.5075
	arable with tree rows	0.2145	0.8496			3.2443	3.9566	0.0004	0.7887		0.3335				9.3876
	arable with vines	0.2161	4.3364			54.7951	31.0648	1.9057	12.6657		0.1152			0.7664	105.8654
	pasture	63.0465	0.3592	1.494	26.8145	181.9919	27.5117	0.0591	0.0047	0.3289		85.333	0.884		387.8275
	wooded pasture	0.9771	1.8939		0.2345	38.6083	15.4618		0.7571	0.1774	0.0299	0.202	0.0591	0.0211	58.4222
	meadow	0.1019	0.1638	0.6375		15.5963	8.211	1.2172		0.3647		6.8088	1.0621	0.1714	34.3347
	meadow with trees		0.2248			2.7957	1.3158	0.1148	0.0205		0.0008				4.4724
	hydric surface				0.903	0.476									1.379
	Overall amount	71.4924	17.115	3.3398	38.0182	436.6377	341.7535	4.6069	20.0868	6.2629	7.1997	101.2721	4.3193	1.4038	**1053.5081**

*In this category mixed woodlands with chestnuts are included

Table 2
Indices describing the changes in the structure of the landscape

	1832	1981	2002
Number of land uses	65	16	18
Number of patches	618	87	84
Average extension of each patch (ha)	1.70	12.11	12.54
Standard deviation	7.33	37.61	41.24
Shannon index	2.02	0.63	0.78
Number of hill	9.00	8.52	8.21

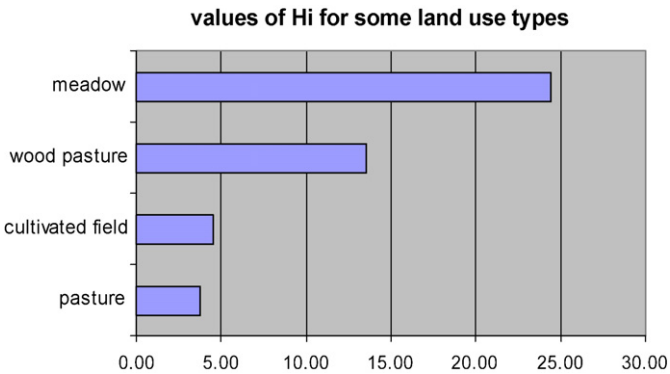

Fig. 9. Graph showing the values of the historical index for the most endangered land uses.

habitats to protect. In general, the habitats included in the list do not seem to have a close relationship with the habitats that characterize the cultural landscape of the study area, but rather the list includes many elements or habitats that are the result of secondary vegetation succession. The description of the protected areas created through the European Habitat Directive seems to offer a ‘‘reading’’ of the territory that denies, or at least ignores, its cultural origin, which is the case not only for Mediterranean woodlands but also boreal forests (Axelsson and Ostlund, 2000). While prairies, with various species, are included in the habitat list, it is difficult to explain the absence of chestnut groves among the habitats that should be protected. What is protected, however, is ‘‘woodland with dominance of chestnut’’, in spite of the fact that this woodland type represents an ecological transition phase. The absence of chestnut groves from the list of habitats meriting protection is also the result of earlier negative evaluations of its role from an environmental and aesthetic point of view (Cavalli, 1990), mostly because of its artificial origin, but also for the assumed low biodiversity value of these woods compared to natural forest. These assumptions are not confirmed by several studies reporting different evaluations (Romane and Valerino, 1997; Poggi, 1997). Chestnut orchards represent ecosystems characterized by specific types of flora and fauna, now strongly reduced, which should justify their inclusion among the ‘‘habitats’’ to be protected.

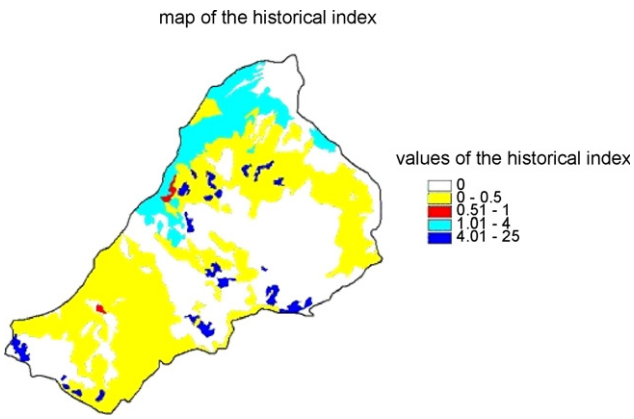

Fig. 10. Map of the historical index locating the areas where historical land uses are endangered. The historical index is useful in all cultural landscapes endangered by degradation.

6. Conclusion

Our research shows that the dramatic changes that have occurred in the landscape of the study area are the result of the suspension of human influence and the interruption of traditional practices over the past two centuries. Both the landscape mosaic as well as the structure, density, and the specific composition of tree vegetation have been deeply altered by this process. A significant missing element of the current landscape is certainly the chestnut grove, one of the most important cultural trees of Italy. The application of the historical index shows that the elements that are most likely to disappear from the landscape are meadows, pastures, pastures with trees and cultivated lands. The higher elevations where meadows and pastures are concentrated can be considered as the area with the highest landscape value within our study area, since they include land uses for which a conservation strategy is urgently needed. From this point of view, a management plan that aims to protect what remains of the historical heritage of the territory, should focus on protection of these elements and initiate restoration efforts, focussing on chestnut groves and on wood pasture and cultivated land with trees and with vines. The study also indicated a relationship between abandonment of traditional land management practices and hydrogeological stability, as demonstrated by the correlation between landslides and changes in land use linked to abandonment, principally in terraced chestnut groves. It is important to emphasize that the abandonment of traditional farming activities and silvicultural practices can be an important factor aggravating these land instability problems.

It is reasonable to expect that in the absence of interventions for restorating traditional practices related to terracing, wood pastures, pastures and meadows, the landscape will become even more homogeneous in the future. The likelihood of this is increased by the general assumption that forest fragmentation is detrimental to biodiversity and the promotion of policies and management strategies developed to reduce such fragmentation (Larsson, 2001).

The results of this study, as well as those of our larger regional project, have convinced the Regional Government of Tuscany to of the need to produce guidelines for the conservation of landscape in protected areas, and to support the creation of Tuscany’s first landscape park in a mountain area

near Florence (Agnoletti et al., 2006b).[2] In fact, although natural protected areas in Tuscany cover 25,177 hectares, representing 11% of the regional territory, there are no landscape parks. However, present Tuscan forest law, as well as Italian law, does not allow the restoration of any land use where a ''forest'' older than 15 years has developed, unless an equal extension of new forest is planted somewhere else, on public or private property, which creates difficulties for landscape and biodiversity restoration projects (Agnoletti et al., 2006b). This situation should encourage a re-evaluation of the current approach towards sustainable forest management and nature conservation, particularly in view of commitments under the European Landscape Convention, signed by 33 countries, including Italy, and the protection of cultural landscapes under the UNESCO World Heritage List.

In this respect it must be noted that the role of traditional knowledge and cultural values is given little consideration in forestry in Italy. In Tuscany forest policy focuses on climate change, fire prevention and production issues (AA.VV, 2006). Landscape values are instead supported in regional planning processes, and recently by new approaches adopted in rural policies. The current National Strategic Plan for Rural Development 2007–2013, for the first time in the history of Italy, has put the conservation of cultural landscapes and related traditional knowledge among the objectives financed with the funds provided by the Common Agricultural Policy of the European Union (Agnoletti, 2006b). The national plan addresses the links between culture and biodiversity as a key element for the understanding of the Italian landscape. The financial resources now available will help the Italian regions[3] develop appropriate strategies to address the goals expressed by the Plan, which are also now reflected in policies at the international level. For example, the Vienna Resolution 3, adopted by the Ministerial Conference for the Protection of Forest in Europe in 2003, addressing the preservation of the social and cultural dimension of sustainable forest management in Europe, has led to the proposition of guidelines for the implementation of cultural, historical and landscape values in the member states.

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[2] The author is the coordinator of both projects.

[3] In the present structure of the Italian State, rural development is managed by each of the regions and autonomous provinces of the country. The Ministry of Agriculture and Forestry has the responsibility to organize the general policies and the main objectives.

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