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Revitalizing Traditional Ecological Knowledge: A Study in an Alpine Rural Community

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Abstract This study aims to contribute to the debate on the value and the role of ecological knowledge in modern conservation strategies, with reference to the results of a case study conducted in the community of Montagne, located within a World Heritage site in the Italian Alps. This community is a paradigmatic example of the multiple transformations experienced by cultural landscapes in Alpine areas under the influence of global change. This study seeks to understand whether ecological knowledge is still in place in the community, and what the relationship is between the knowledge transmission and land use and social changes that have occurred in recent decades. To that end, the community is described by identifying the key variables (social, institutional, and ecological) that have historically shaped the landscape and the future priorities of the residents. Forest expansion, the most significant change in land use in the last 60 years, is analyzed using aerial photos; changes in biodiversity-related knowledge in the community are quantified by analyzing the inter-generational differences in plant species recognition. Results are discussed in the context of the current situation of the Montagne community, and the recommendation is made that policies and actions to promote traditional ecological knowledge protection or recovery in Europe be viewed as an important part of the recovery of community sovereignty and vitality. Lastly, concrete actions that can be implemented in our case study are proposed.

Keywords Land use change · Ecological knowledge · Alps · World heritage site

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Introduction

Over the past two decades, advocacy for conservation initiatives rooted in place-based and integrated-knowledge approaches has been one of the pillars of sustainability policy (Manuel-navarrete et al. 2006). Traditional knowledge and practices have been defined as essential social-ecological heritage of communities (Otero et al. 2013). Many international agreements explicitly refer to the importance of preserving them (e.g., UNCED 1992; UNESCO 2001) on the basis that the conservation of ecological knowledge is a primary factor for successful resource management and for the capacity of societies to cope with disturbance. Several studies have documented how traditional ecological knowledge can provide societies with a long-term perspective on ecosystem dynamics and thus assist them with analysis, monitoring, and actions in the context of global change (Turner and Clifton 2009; Peloquin and Berkes 2009; Prober et al. 2011). The ethnobiological literature (see Vandebroek et al. 2011, for a review) has shown the importance and usefulness of local knowledge systems with respect to a variety of issues, ranging from nutrition (Redzic 2006) to child health (Mcdade et al. 2007), cultural heritage protection (Lebbie and Guries 1995), and environmental conservation (Brosi et al. 2007). Nevertheless, severe intergenerational loss of biodiversity-based cultural knowledge is reported in many parts of the world, affecting the agricultural (Cerqueira et al. 2010), medicinal (Voeks and Leony 2004), and nutritional (Setalaphruk and Price 2007) knowledge of societies.

The literature—which primarily describes subsistence systems in resource-dependent and remote societies—shows a positive correlation between the erosion of traditional knowledge, the integration of societies into the market economy and formal education systems (Shen et al. 2012; Saynes-Vásquez et al. 2013), and the declining importance of the intergenerational transfer (i.e., parent–child interaction) of experiential knowledge (McCarter and Gavin 2011). Studies investigating knowledge transmission have suggested that significant intergenerational losses of ecological knowledge contribute to declining capacities of individuals and communities to manage and conserve their natural resources (Pilgrim et al. 2008). Pfund et al. (2011) observe that the widespread failure of many management efforts to sustain local resources is most likely a consequence of scarce ecological understanding combined with low local support, in addition to the depletion of goods and services. However, many studies note the importance of identifying adaptive forms of knowledge and different patterns of secular change with "modernization," in which some domains of knowledge decreasing while others remain stable or increase (Vandebroek and Balick 2012; Reyes-García 2013). Recent research has documented hybrid processes of ecological knowledge transmission that accommodate new forms of knowledge (Eyssartier et al. 2011; Xu and Grumbine 2014). This growing body of literature highlights that focusing only on the loss of knowledge obscures the fact that ecological knowledge adapts and is renewed when faced with environmental and socio-economic change. This is because traditional knowledge, practices, and beliefs merge with novel forms of knowledge and technologies to create new knowledge systems (Reyes-García et al. 2014). These studies—which have widened the field of observation, previously limited to the traditional ecological knowledge remaining in subsistence indigenous and peasant societies, to include societies that have disconnected from daily interaction with the land—refer mainly and contribute to resilience theory. In fact, they reaffirm the contribution of traditional knowledge to building resilience in socio-ecological systems, stressing its potential to increase the capacity of social-ecological systems to deal with disturbances or crises. According to Otero-Rozas et al. (2013) for instance, in the case of climate crisis in transhumance pastoralism, traditional knowledge could theoretically facilitate a revisiting of past strategies that embody social and ecological memory; in the case of natural disasters, it could contribute to creating a social cohesion that allows communities to face shocks (Gómez-Baggethun et al. 2012).

Different terms have been proposed in the literature to refer to knowledge about nature. Local ecological knowledge is used to emphasize its very localness (e.g., Gilchrist et al. 2005). Indigenous knowledge is used to refer to a holistic worldview inseparable from the indigenous ways of life embedded in cultural values, spiritual beliefs, and customary legal systems (e.g., Maweu 2011). Traditional ecological knowledge (TEK) refers to all types of knowledge about the environment derived from the experience and traditions of a particular group of people transmitted from one generation to the next. It is acquired through frequent interaction with the local environment (e.g., Rist et al. 2010). In the present study, the term TEK is used because it is predominant among conservationists and is not restricted to indigenous peoples.

Hoberg et al. (2012) argue that bridging the gap between science, policy, and practice has become the most sought-after paradigm for fostering traditional ecological knowledge in order to contribute to conservation and sustainable development in Europe. The practices for halting the loss of knowledge that have been proposed in the fields of ecology and conservation have been driven by an "emergency approach" following the recommendations of international conservation rhetoric, which expresses concern for the "parallel extinction" of biological and cultural diversity (Secretariat of the Convention on Biological Diversity 2010). In practice, efforts to conserve traditional knowledge in modern rural societies have been associated with the economic development of territories through tourism and promotion of local products (Parrotta and Agnoletti 2007). Also, Gómez-Baggethun et al. (2010) have suggested that environmental policies, such as payment for traditional production, are among the few ways of protecting the remaining ecological knowledge pools in the developed world. Additionally, eco-museums and eco-tourism related to traditional practices have often been lauded as good conservation practices for marginal rural areas (Carvalho and Frazão-moreira 2011), promoted and financed by international agencies through rural development programs. However, many rural communities' livelihoods are now largely disconnected from agricultural and wild systems. As such, ecological and traditional knowledge conservation should primarily address this change and recognize that it has much to do with endogenous processes, sovereignty, and re-appropriation of territories by the communities. The present study contributes to the debate on the value and the role of ecological knowledge in modern conservation strategies via a small-scale case study of a mountain community in southern Europe.

The case study considers the community of Montagne, a small village located in the Italian Alps within the boundaries of a World Heritage Site. As in many other mountainous areas of Italy, historical changes occurred in the environment and society during the process of rural exodus and consequent land abandonment. Beginning in the first decades of the 20th century and continuing with

the transition to a global market economy initiated in the 1960s, the process increasingly disconnected communities from agricultural and wild systems. Like other rural communities in mountain areas of southern Europe, Montagne suffers from depopulation and aging due to the emigration of youth caused by a lack of economic opportunities; decreasing rural activities allow for forest densification and the afforestation of meadows and open spaces. Coppicing, slashing of ground vegetation, and grazing are promoted and supported by the local administration in selected areas.

The present study seeks (a) to understand whether ecological knowledge is still in place, and to understand the relationship between knowledge transmission and the social and land use changes that have occurred in the community in recent decades; and (b) to describe how ecological knowledge conservation could be viewed as an important part of recovering community vitality. The Montagne community was selected for three reasons: (1) Montagne is a paradigmatic example of the multiple transformations experienced by many cultural landscapes in Alpine areas; (2) The relative isolation and small scale of the community allowed for an integrated reasoning; (3) Today, some community residents are making extraordinary efforts to achieve change. In addition to offering theoretical insight on traditional knowledge, this study aims to contribute to community organization by promoting a revitalization project for the Montagne community. This should include long-term considerations regarding the future of the families affected and the development of an enduring systemic vision.

This study is organized as follows. The Study Area Section describes the study area and its socio-ecological system. Methods Section presents the methods used to analyze the vitality of ecological knowledge in the community, based on three steps: analysis of the key variables that shaped the socio-ecological system during the last century and identification of the community's future priorities; analysis of people's growing disconnection from the land, using land use changes as a proxy; and quantification of the changes in the biodiversity-related knowledge in the community by analyzing inter-generational differences in plant species recognition. Results Section presents the results, which are then discussed in Discussion and Conclusions Section by addressing the role of ecological knowledge in modern conservation strategies and in the construction of diverse, autonomous, and resilient social-ecological systems.

The Study Area

Montagne is located at 1004 m.a.s.l. in the Trentino Alto-Adige region, within the boundaries of the Adamello Brenta Natural Park, which is part of the Dolomites World Heritage Site established in 2009 (Fig. 1). Like many other mountain settlements in the Alps, the community and the landscape of Montagne have undergone a rapid transformation process during the last century due to depopulation, the aging of remaining residents, and abandonment of agricultural practices. Montagne's recent history can be described in terms of two periods: a period with a high migration rate (1920–1960) followed by a period of transition to a global economy (1960s-present). In Montagne, as in virtually all the Italian Alps, the first decades of the 20th century witnessed an impressive process of rural exodus when many peasants left Italy to seek better living conditions in Germany and Switzerland (Fig. 2). By the 1960s, as opportunities for better-paid non-farming jobs increased in nearby towns in the valleys, many peasants left their mountain villages. Due to the morphology of the territory, manual work and farm animals could not be replaced by tractors, harvesters, and power saws. Crops, pastures, and vines were gradually abandoned because the income from agricultural activities was not sufficient to sustain rural livelihoods; decreasing rural activities led to forest densification and the afforestation of meadows and open spaces (Zambelli et al. 2012). The large body of ecological knowledge that had developed in response to the demanding Alpine conditions has been gradually lost over the generations.

Today, the total number of residents in Montagne is 259, and the average household size is only two. Half of the residents are more than 45 years old and 30 % are more than 60 years old (ISTAT 2012). The territory of Montagne is included in a natural park that has centralized decision-making regarding resource management and restricted access to certain resources. There are almost no resource-dependent jobs in the community. Cattle farms and cultivated fields no longer exist and residents work in nearby towns. The historical reasons for the abandonment of mountain farming—the most important of which is the rugged terrain that limits the use of machines and requires a large input of manual labor—are still in place. Moreover, work in the forest is not attractive because it is very dangerous and accidents are frequent. However, Montagne is not a dying or "ghost" community: strong social networks are still alive. In fact, a solid cultural system of common lands—the "Regole system"—persists, voluntary collective work is regularly performed, and communitarian associations are lively. An annual cultural festival is also organized in the community. The presidents of the local associations are under 25 years old, and the borough council is composed of persons younger than 50 years. As an indicator of cultural vitality, most of the members of the community continue to use the local dialect as their first language to communicate. The dialect is unique in the area and was recently compiled and systematized in a dictionary by Grassi (2009).

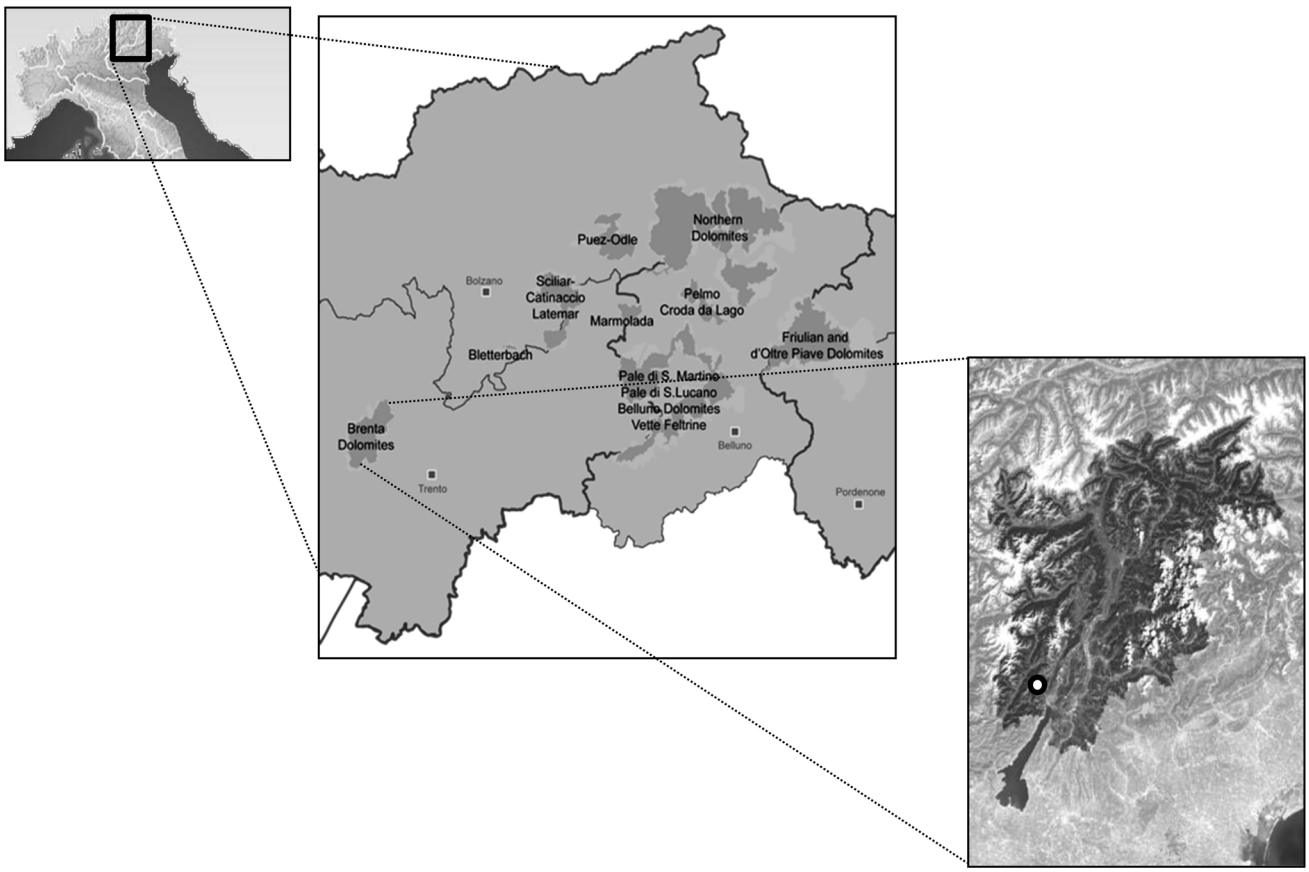

Fig. 1 The community of Montagne, located in the Brenta Dolomites, included in the Dolomites World Heritage Site

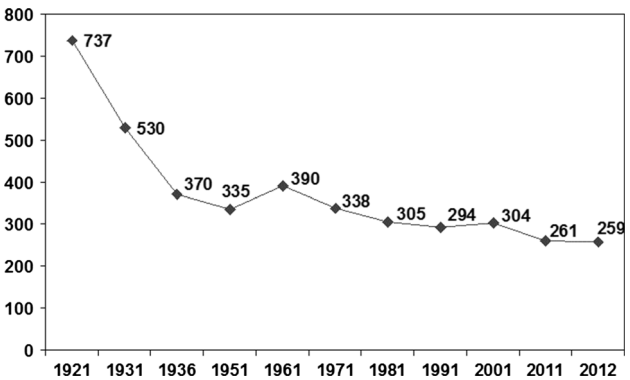

Fig. 2 Population trend in Montagne (1921–2011)

Methods

This study proxies TEK through biodiversity-based cultural knowledge. In order to establish a relationship between inter-generational TEK transmission and land use and social changes that occurred in the community, the following steps were undertaken:

1. A conceptual model of the socio-ecological system, based strongly on stakeholder inputs, was developed in order to understand historical changes in the ecosystem, society, and economy, and a range of desired future trajectories was established together with the community;
2. An in-depth analysis of the most significant change in land use of the last 60 years, namely forest expansion and a corresponding decrease in cultivated plots, was carried out;
3. The changes in biodiversity-related knowledge in the community were quantified by analyzing the inter-generational differences in plant species recognition.

As described by Walker et al. (2002), the actual trajectory that a socio-ecological system follows will be the outcome of external drivers and stakeholder interactions. For this reason, in Step 1, researchers worked with the community in order to (a) understand the historical profile of the system, the variables that are changing, and the processes and external drivers producing those changes; and (b) establish a range of possible trajectories and understand residents' preferred directions.

Step 1 entailed interviews with 12 key informants and a communitarian workshop. Key informants were persons over 65 years of age, retired, had life-long experience in

the area, and were acquainted with agricultural practices and the local farming system and culture. Interviews involved free discussions and were conducted using two guiding questions: (1) How has the landscape changed? (2) How has your life in the community changed? Then, as the interviewees talked freely, new topics were explored as they arose. Interviews were not recorded; much time was spent building a relationship based on trust and confidence between the interviewer and the respondent. Subsequently, a workshop was organized to which the entire community was invited.

The workshop was organized in collaboration with the local administration, which promoted participation through articles in the local newspaper and daily informal invitations. The aim of the workshop was threefold: (1) to encourage residents of different ages to express their feelings about the community; (2) to assess whether and in which forms concern for intergenerational knowledge transmission emerged; and (3) to envision futures scenarios of community development. The four guiding questions were (1) How do I feel in my community? (2) How do I imagine it in 20 years? (3) What factors are negatively influencing the life of the community? (4) What are the current priorities for revitalizing the community? Participants were asked, individually and in small groups, to answer the questions through drawings and/or brief sentences. These responses guided the discussions held in the plenary sessions. The workshop was held in the community hall and lasted 4 h. It was attended by 31 residents whose ages ranged from 12 to 70, and it was the first time that the community had met to jointly discuss future scenarios.

Step 2 was performed by analyzing a set of historical aerial photographs dated 1954, 1973, and 2006 with GRASS GIS version 6.4.3RC3. The photographs were orthorectified and processed at a resolution of 3 m. The analysis focused on forest expansion and on two land uses: forest and meadows. The reasons for this choice were twofold: (1) residents openly expressed the concern that the area occupied by the forest was growing too quickly; and (2) the change from forest to meadow is the most significant land use change currently occurring in the mountain areas of the region, as shown by Sitzia (2009) and Tattoni et al. (2010). An automatic supervised classification using a maximum likelihood algorithm was used to calculate the rate of forest expansion (Tattoni et al. 2011). A GIS simulation projected to 2050 was conducted using the method proposed and described in detail by Ciolli et al. (2012). The assumption underpinning the simulation is that the rate of forest expansion will not change in the coming years. The MC-CA model was validated using the 1954 and 1994 forest maps as the inputs to model 2006 coverage; then, the modeled and actual 2006 maps were compared using cross-validation and the validate module, following Tattoni et al. (2011). The model correctly predicted 93 % of the cells (overall kappa (κ) 0.93). Results were validated by comparing the output to that of a random model and providing a set of modified kappa (κ) indices that assess the accuracy in terms of errors of quantity, errors of location, and spatial resolution (Pontius et al. 2004).

Step 3 was achieved by investigating the general ecological knowledge of the population and assessing the differences between the knowledge of elders and that of younger residents. Following Berkes (1999), general ecological knowledge is understood here as the ability to name the living (i.e., plants and animals) and physical (e.g., soils, water, weather) components of the ecosystem as well as knowledge of the functions and uses of each component. A questionnaire was developed based on a list of plant species. The choice to focus only on plants and their functions and uses was based on the assumption that they are indicators of overall ecological knowledge, as suggested by Pilgrim (2006), who observed a strong positive correlation between knowledge of plants and of mammals and birds. The most common species in the area were listed on the basis of a literature review and forest surveys with the help of researchers familiar with the region.

From this preliminary list, 38 species were selected that were common and abundant, widely employed as firewood or traditionally cultivated or used for culinary and medicinal purposes. The species chosen had not undergone significant changes in their abundance levels due to processes other than land use changes. The long-term presence of the species chosen is well documented in regional floristic inventories (Marini et al. 2008). As recommended by Schunko et al. (2012), the relevant domains of knowledge were differentiated by classifying plants into three groups: trees, flowers/shrubs, and crops (Table 3). It was hypothesized that the identification rate would be high since the trees chosen are used as firewood by all the families in the community and are very characteristic of the environment, and the flowers and shrubs selected are easily found in the environment. Little difference was expected between women and men since both know well the environment: both collect mushrooms and herbs in the forest and many of the male residents are hunters. Differences in crop recognition were expected among age classes, since they are no longer cultivated in the area. Structured interviews were carried out with the residents of Montagne dividing the population according to the following age classes: 8–18 (youth), 19–35 (adults I), 36–65 (adults II), and over 65 (elders). Women represent 57 % of the population and are therefore the majority in the sample. In the younger classes, the great majority of interviewees were women, due to the high percentage of women in this age class (81 %). Interviewees were shown leaves, of the selected species, as well as photographs and drawings of the entire plant or portions

thereof, such as the leaves or the trunk, in different seasons. Crops were shown individually and cultivated in plots. The interviewees were asked four questions: (1) Do you recognize the plant? (2) Can you name it? (3) Do you know if the plant is used, and if so, which parts are used and for what purposes? (4) Do you use it? Any additional knowledge respondents added (e.g., regarding the plants' habitat and flowering season) or comments (e.g., anecdotes, feelings, and emotions upon being asked questions on this topic) were also recorded. Twenty-nine face-to-face interviews were conducted between December 2012 and March 2013, in Montagne and in Trento, the nearby town where the young people of the community (19–35 age class) study and work. Interviews lasted around 1 h, depending on the age and the information provided by respondents. Interviewers took notes but did not record interviews to keep the conversation informal. Four measures of ecological knowledge were constructed: (i) plant species recognition rate, (ii) the rate of correct identification of species names, (iii) the number of species for which at least one use is known, and (iv) the number of species actually used by the respondent. These measures were then analyzed according to gender and age class. The relatively small sample size was justified by the nature of this study, which does not aim to draw conclusions based on statistical analysis of the results, and by the population size of the study area.

Results

Step 1 generated two sets of information: (a) the principal forces that caused changes to livelihoods and TEK in the community, as described by the key interviewees and workshop participants (Table 1); and (b) the major issues of concern for residents in terms of the future of the Montagne community. The children and the youngest participants agreed on the business-as-usual trajectory and explicitly stated, "in 20 years there will be only forests and elders here." During the workshop, participants highlighted the urgent need to revitalize the community and noted two priorities: creating jobs and attracting new residents. Participants noted a collective sense of permanent crisis and heatedly discussed the exaltation of elders as the "old" as good compared with the "contemporary" as poor. They reinforced the idea that "we cannot go back," opposing to the idea of creating backward-looking scenarios about past landscapes. Rather, they were interested in the development of ideas that deal with landscape change, for instance, using wood as a renewable source of energy. A pilot project to reclaim a reforested terraced area was also suggested and agreed to in the workshop. The forward-looking capacity of people is crucial to the evolving organization of the system and the resilience of the trajectory that it will follow. This resolute attitude during the workshop is particularly relevant in our study area, considering the practice of welfare dependency generated by regional policies.

The GIS analysis of the 1954, 1973, and 2006 aerial photographs of Montagne indicates that during the 52-year period, more than 35 % of the original meadow cover was replaced by forest (Table 2). The future simulation suggests that, if no specific management action is undertaken, by 2050 meadows will cover only 5 % of the total vegetation cover (Fig. 3). This outcome is similar to what is expected in other areas in the same region (Tattoni et al. 2011).

Tables 3 and 4 outline the interview results, reporting the values of the four metrics described in Sect. 3. All respondents recognized the tree species that are widespread in Montagne, such as spruce fir and silver fir, and those that are still widely used, such as beech (used as firewood) and hazelnut (used to make walking sticks). However, unlike the groups adults II and elders, the youth and adults I did not easily recognize mugo pine, larch, and mulberry, species that are relatively uncommon in the Montagne area but common in the surrounding mountain environment (the former occurs near the tree line and the latter in sunny hills up to 800 m.a.s.l.). The three species were widely used in the past.

Table 1 Interactions of the linked social-ecological system as identified by the residents of Montagne

What variables are changing?	What processes and drivers are producing theses changes?	Effects of interactions
Forest area	Out-migration	Wood biomass accumulation in the forests
Forest density	Government regulation over land use	Decline of fields and meadows areas
Population structure	Aging	Densification of forest at higher altitudes
Communitarian social values	State and EU agricultural policy incentives to increase production, discouraging mountain farming	Centralization of decision-making about natural resources
		Weakened connection between environment and livelihoods
		Historic houses used as summer residences
	Regional policy promoting mass tourism centers	Increasing reliance on non-farming jobs and jobs outside the community
		Weakening of negotiation power of small municipalities

Table 2 Conversion between forest and meadow areas

	1954	1973	2006
Meadows (%)	61.1	47.5	24.9
Forest (%)	38.9	52.5	75.1
Total (%)	100	100	100

Mugo pine cones were widely used to perfume spirits and mugo pine branches to prepare a remedy for respiratory infections (called *mugolio*). The resin of the larch (*largà*) was widely collected and used in multiple ways, including medicinal uses. During the last century, mulberry was a common plant across the landscape because silkworm breeding was a supplementary livelihood activity for most rural families. The silk industry began to decline between the first and second world wars and then collapsed in the 1950s. It appears that the memory of that landscape has completely vanished. For example, ash, a common tree that re-colonizes open fields and used in the past for multiple purposes due to its elastic properties (to weave baskets, to feed animals, and to tie vines in vineyards) is no longer used, and today only a few elders recognize it.

All the plants in the flowers and shrubs list (Table 3) have either medicinal or culinary uses. All of the respondents in all age classes mentioned elderflower, nettle, taraxacum, and gentian as having culinary uses. These plants (at least the first three) are still widely used to prepare food and perfume spirits in both mountain and rural contexts in the Alps. The use of *arnica* and *hypericum* has been widely described in the region, and the results confirm that adults still continue to know and use them because their medical preparation is not complicated. Arnica flowers are prepared in alcohol and used for strains, sprains, and bruises. Hypericum flowers are conserved in oil and used for burns. Youth (8–18) and adults I (19–35) know that these plants can be used but cannot recognize them and have never prepared them. Contrary to expected results, yarrow, the use of which has been widely described in the adjacent areas (Cappelletti et al. 1981; Vitalini et al. 2013) no longer appears to be used. Cyclamen, gentian, edelweiss, and snowdrop are symbolic of myths and values related to the Alps and are well known to everyone. Younger people (8–18 and 19–35) know and recognize them but have completely lost all knowledge of their medicinal properties. Despite the general decline in local knowledge about plants, certain species in the study area were only named in the local dialect by the participants (e.g., the snowdrop). This is due to the fact that these species are still common to most people and, as a

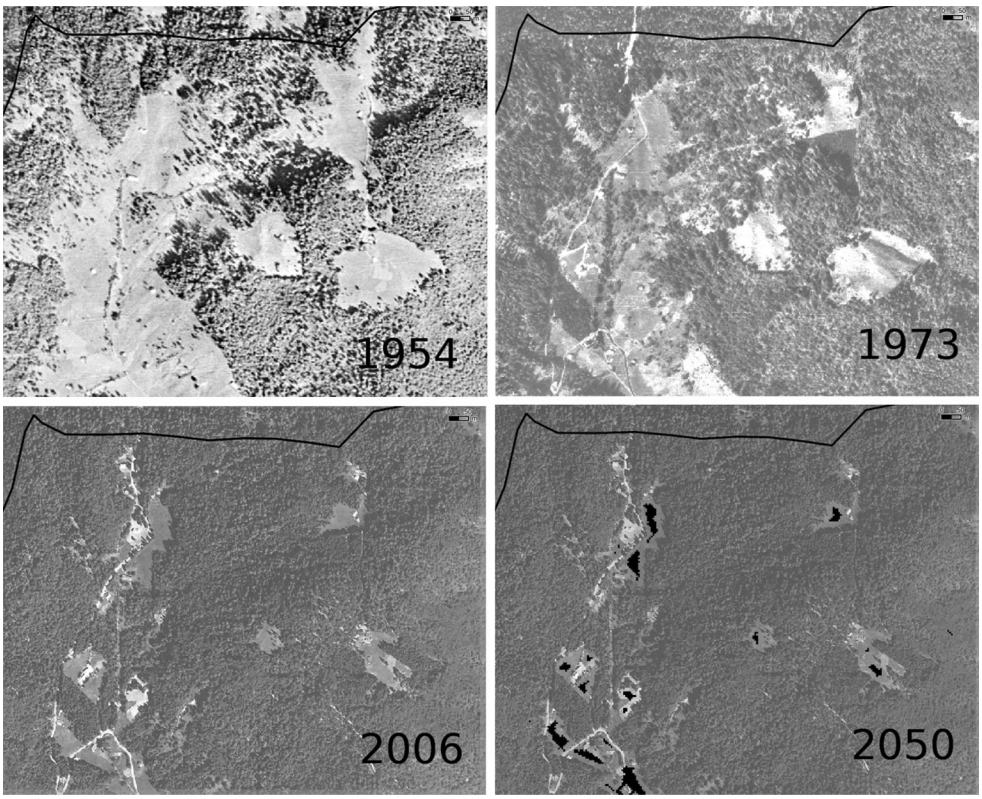

Fig. 3 1954, 1973, and 2006 orthophotos of the study area. The GIS simulation projected to 2050 was superimposed on the 2006 orthophoto; predicted residual meadows are shown in *black*

Table 3 List of plant species organized by group

	Common name	Scientific name	Local name
Trees	Spruce fir	*Picea abies*	*Pèc*
	Silver fir	*Abies alba*	*Avèz*
	Beech	*Fagus sylvatica*	*Fò*
	Hazelnut tree	*Corylus avellana*	*Golanèr*
	Mugo pine	*Pinus mugo*	*Much*
	Larch	*Larix deciduas*	*Laras*
	Silver birch	*Betula alba*	*Bedól*
	Ash	*Fraxinus excelsior*	*Frasan*
	Hornbeam	*Carpinus betulus*	*Carpan*
	Linden	*Tilia cordata*	*Tilio*
	Oak	*Quercus pubescens*	*Róar*
	Mulberry	*Morus alba*	*Morèr*
	Hickory	*Juglans regia*	*Noghèra*
	Willow	*Salix alba*	*Salghèr*
	Maple	*Acer pseudoplatanus*	*Asár*
Flowers and shrubs	Cyclamen	*Cyclamen purpurascens*	*Ciclamìn*
	Dandelion	*Taraxacum officinalis*	*Dent de cagn*
	Elderflower	*Sambucus nigra*	*Sambuc*
	Gentian	*Gentianaceae*	*Genziana*
	Edelweiss	*Leontopodium alpinum*	*Stéla alpine*
	Arnica	*Arnica Montana*	*Arnica*
	Snowdrop	*Galanthus nivalis*	*Birimbimbim*
	Mallow	*Malva sylvestris*	*Malva*
	Hypericum	*Hypericum perforatum*	*Iperico*
	Stinging nettle	*Urtica dioica*	*Ortiga*
	Orchid	*Orchidaceae*	*Orchidea*
	Balm	*Melissa officinalis*	*Melissa*
	Yarrow	*Achillea millefolium*	*Achillea*
	Wornwood	*Artemisia absinthium*	*Artemisia*
Crops	Corn	*Zea mays*	*Mais*
	Wheat	*Triticum aestivum*	*Gran*
	Hemp	*Cannabis sativa*	*Cànava*
	Oat	*Avena sativa*	*Avena*
	Millet	*Panicum miliaceum*	*Miglio*
	Buckwheat	*Fagopyrum esculentum*	*Formentón*
	Barley	*Hordeum vulgare*	*Orź*
	Rye	*Secale cereal*	*Segala*
	Flax	*Linum usitatissimum*	*Lin*

The gray scale represents ranges in the rate of identification as follows: dark grey >70 %, light grey >30 % and <70 %, white <30 %

Table 4 Mean values of the indicators of ecological knowledge by age class for the 38 plants

Number of interviews per age class	Number of species identified in the pictures (%)	Number of species name identified (%)	Number of species for which at least one use is known (excluding crops)	Number of species actually used by the respondent (excluding crops)
8–18 (9F, 3M)	8 (21)	5 (14)	7	1
19–35 (5F)	16 (42)	27 (33)	8	4
36–50 (4F, 3M)	27 (70)	20 (52)	11	6
>65 (3F, 2M)	34 (89)	29 (77)	19	7

In the first column, in parenthesis, the number of interviews and gender of interviewees

consequence, all of the interviewees recognized them by their local name. The greatest inter-generational knowledge gaps are evident in the ability to recognize crops. Although all of the elders remembered traditional agricultural crops—oats, millet, hemp, buckwheat, barley, rye, and flax—none the youth remembered them, recognizing only corn and hemp because the image of these crops was familiar to them, and not because the crops are cultivated in the area. No differences were apparent between genders. Regarding the feelings experienced by participants in response to questions, elders expressed feelings of rejection of the past and the knowledge associated with it. Elders also associated plant knowledge and use with poverty and need: "We were poor so we had to eat and use herbs. Now I do not need them, and I go to the pharmacy." However, we also observed that women were proud of their knowledge and blamed the younger generations: "Young girls currently do not know such basic things." Most of the youngest participants (youth and adults I) recalled stories of the medicinal properties that plants possess, but did not actually use the plants themselves, and most admitted they could not identify the plant in the field. Members of youth and adults I also expressed a sense of shame: "I should know these plants, I live in the mountains!"

Discussion and Conclusions

In many European regions, studies of inter-generational ecological knowledge transmission within local communities have focused extensively on the quantification of loss (a review can be found in Hernández-Morcillo et al. 2014). Efforts to conserve traditional knowledge in modern rural societies have often been associated with eco-tourism, the promotion of local products or the folk recreation of traditional practices and rituals. One of the crucial weaknesses of these initiatives is that they are rarely triggered by actual residents' needs. Furthermore, these initiatives have often been put in place with the intent (or the unexpected result) of freezing traditional practices. The main criticism of such approaches is that they do not recognize the changes occurring in many rural communities. Consequently, they do not encourage and support the adaptation of traditional knowledge to socio-economic and cultural change, particularly in terms of maintaining its dynamic connections with the practices of individuals in their daily interactions with their surroundings, as repeatedly recommended by the convention on biological diversity (CBD) documents (Secretariat of the convention on biological diversity 2003, 2007, 2010). Also, the CBD recommends the retention and use of knowledge, and the same concept is used in the World Heritage Convention (UNESCO 1972), which calls for policies aimed at giving cultural and natural heritage a function in the life of the community (art. 5). As previously highlighted by Alivizatou (2011) and Frank (2011), there is a need to rethink intangible heritage, knowledge, and practices as live cultural practices that are constantly transformed and recreated by local communities. The results that we obtained offer useful insights into the debate on the link between TEK conservation practices and the other processes occurring in communities. Below, ecological knowledge in the community of Montagne is discussed as identified by the survey, and it is argued that the understanding of intergenerational changes in TEK must necessarily be based on a reasoning that considers and integrates all relevant socioeconomic and environmental drivers affecting the communities where such changes have occurred. Furthermore, results are discussed in the context of the actual situation of Montagne, and it is proposed that the policies and actions to promote TEK protection or recovery in Europe be viewed as an important part of the recovery of community autonomy and vitality. Lastly, several concrete actions are suggested that could be implemented in this particular case study.

From a merely quantitative perspective, the results presented in Tables 3 and 4 show that general ecological knowledge in the community, proxied by the knowledge and use of common plant species, is limited. This result is consistent with the findings of other studies in comparable areas in Europe, such as Grabherr (2009) in the neighboring region of South Tyrol, and Biró et al. (2014) in rural areas of Romania and Hungary, who found that the knowledge of salient plant species (those with conspicuous flowers, large populations, and special habitats) in the

communities studied was lower than expected. Consistently with the findings of much literature, the data compiled in the present study confirm the negative trend of biodiversity-related knowledge transmission between generations. In Montagne, elders have lived through the transformation of a diverse mountain agricultural landscape in the 1950s that was gradually abandoned and occupied by forest. Previous studies, Otero et al. (2013) and Toledo et al. (2003), among others, confirm the interconnection between the changes in biodiversity and the disappearance of knowledge and cultural practices related to the use of forests, fields, and livestock in Mediterranean and tropical areas. In the present study, the increase in forest areas and the scarcity of knowledge among younger generations as regards crops and plants indicate a strong relationship between increasing disconnection (either physical or psychological) and independence of livelihood from agricultural and wild systems and significant intergenerational losses of ecological knowledge (in terms of species names and uses). These data suggest that forest encroachment is not an indicator of environmental health, but rather of people's abandonment of and distance from their surroundings, as confirmed during the interviews and the workshop. The loss of ecological knowledge among the residents of Montagne is thus an indicator of a wider phenomenon of loss of ecological control over the territory.

The analysis of the community carried out in this study allowed for integrated reasoning. Montagne's economy, similar to that of many other villages in the Italian Alps, is largely independent from locally produced environmental goods and services. The socio-ecological system that was associated with the livelihoods and agricultural practices of rural societies, as well as the accompanying knowledge of plants and crops, simply does not exist anymore because it is no longer economically viable or socially desired. People living in Montagne, as in many other villages of the Italian Alps, feel 'locked' into an undesirable state of young emigration and disadvantageous market conditions. The term 'locked' is used to refer to the situation of this and many other communities that used to have a strong connection with the land but, due to various economic and political shifts, have been forced to disconnect from nature and move toward market-dependent livelihoods. Currently, the economy is dominated almost entirely by nearby towns, and there are no signs that the emigration trend can be reversed. However, youth describe Montagne as "home" and in positive and concerned language, even if they no longer live there. The priorities that emerged in the workshop concerned strategies to revitalize the community—creating jobs and attracting new residents—not to abandon it. Montagne, like many other villages, faces the challenge of developing strategies for sustaining its future development and its conjunct of knowledge–practice–belief, in a context of decreasing populations and limited agricultural land (since much of the land has converted to forest). The processes of TEK protection or recovery should not be seen as isolated, but rather as an important part of the process that Toledo (2005) defines as "sustainable communitarian development": an endogenous process in which a community takes (or recovers) control of the six dimensions (territorial, ecological, cultural, social, economic, and political) that are shaping and affecting the community itself. Gómez-Baggethun and Reyes-García (2013) claim that the key issue related to TEK loss is not whether a specific unit of knowledge is lost or kept, but whether the society retains the ability to generate that knowledge and the role that it assumes in the new society. This implies that communities conserve autonomy and control over the process of producing and regenerating knowledge. The present research assisted and accompanied the community in the first steps toward planning strategies to move away from the current undesirable configuration and to revitalize the community. Several characteristics of Montagne could favor the implementation of actions that Pilgrim et al. (2010) termed 'revitalization projects.' These include the fact that Montagne is located in a natural park and within a World Heritage site. Ownership of the forest is collective, and natural resources are abundant; social networks are strong, and residents show a clear will to act for change. Revitalization projects could represent a step toward rethinking innovative livelihood models rooted in local knowledge and strategies for the sustainable use of ecosystem services. We add that in this case, two characteristics that are traditionally described as weaknesses should instead be viewed as strengths: the remoteness and the small scale of the community can give it the autonomy and the freedom to experiment with new models of citizenship and membership.

To conclude, we suggest some actions that could support both the implementation of a revitalization project and the conservation of TEK.

1. Conservation education for TEK transmission: a shift in the paradigm. The call for the inclusion of TEK in formal education systems is not new (McCarter and Gavin 2011). In our case, important actors in the area, such as the protected area and the park administration, have the important task of supporting the community revitalization project from outside. For instance, they should include the re-appropriation of the intangible cultural heritage (e.g., knowledge, practices, and symbols) as a key aspect of education. Cetinkaya (2009) has summarized the reasons why people consider plant knowledge important: "basic material for a good life" (e.g., food and generation of income), "development of good social relations with other

community members," "good health" (e.g., access to clean air and feeling well), and "freedom of choice and action" (e.g., religious and spiritual reasons). In Montagne, young people primarily associated plant knowledge with the knowledge of their ordinary landscape; looking at the drawings of the plants, they felt that they "should have known" them. As an illustration of the need for a paradigm change in conservation education, during our ethnobotanic fieldwork, one of the children of the community said: "We can't pick the gentian because it is protected; it is private, the park owns it!"

2. Actions for the change in Montagne: the need for continuous and collective reasoning. During our fieldwork, the following remark was often made by the elderly: "It's a pity that the youth do not know the things we know. However, I wonder: why should they know them in this changing world?" Previous investigations have found that promising conservation processes for biological and cultural diversity are those where groups envisage and discuss their own alternative development opportunities for the future, based on their own values and at their own pace, deciding when and how to create networks and growing awareness of their political responsibilities (Ianni et al. 2014). The revitalization project of the community of Montagne should be strongly based on the considerations that have emerged in this work, considering the role that perceptions of attainable futures play in shaping a collective and enduring vision for the future (Walker et al. 2002). From this perspective, as already pointed out by Yli-Pelkonen and Kohl (2005), small technical solutions, such as better visualization, could improve the chances of TEK reaching end-users; researchers and universities can play an important role, both by investigating the status of TEK and by developing visual tools that could foster discussions and support the educational process.
3. Actions to promote TEK recovery in Europe: a shift in the narrative. Traditional knowledge is often seen as a part of the extinction crisis of biological and cultural diversity, which includes species, ecosystems, languages, and cultures (Maffi 2002). In fact, TEK is not something static that belongs to remote and 'exotic' environments; it also belongs to 'normal' contemporary rural people managing 'ordinary' landscapes, for example, social groups in Europe who have played a central role in shaping local biodiversity even though their economy is no longer based on agriculture. Therefore, there is a need to define current socio-ecological heritage (i.e., the cumulative body of knowledge, practice, and beliefs) of modern rural communities in order to find strategies that could support both sustainable revitalization projects and the conservation of TEK.

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