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Abstract
The rural landscape has long been eroded by urban and infrastructural development that has altered the system of relationships between town and country. These phenomena, including agriculture intensification, have radically changed the rural landscape, especially in terms of land use, visual and ecological diversity and biocultural heterogeneity. However, agriculture is gradually changing, moving from an exclusively productive model (highly specialised) to one more sensitive to landscape issues. In particular, the *Common Agricultural Policy* (CAP) has many environmental aims and, theoretically, its financial tools might be used for landscape purposes. However, the CAP does not have a "landscape dimension" and does not include assessment and integration phases with landscape policies. These issues that have arisen not only appear to be influenced by a lack of clarity on the differences between environmental and landscape orientations, but also by a shortage of indicators to identify and assess the landscape dimension in the *Common Monitoring and Evaluation Framework*. Here, we attempt to show that a "landscaped role" for the CAP is possible, based upon identifying the main dimensions involved, as well as verifying the effects and induced changes of rural policies. In this scenario, this paper highlights the development and testing of landscape key indicators to support the decision-makers of rural policies. The main result, in an Italian pilot case, reveals direct and indirect relations between Rural Development Programmes (RDPs) and landscape, not only in terms of negative effects, but also in relation to the real contribution of CAP towards preserving farmland and enhancing the rural landscape. Finally, these tools may also be useful in different timescales and different situations, including the improvement of current RDP spatial targeting which often seems to be ineffective compared to the requirements of landscape character areas.

Keywords
Common Agricultural Policy (CAP); European Landscape Convention (ELC); Rural Development Program (RDP); rural landscape; landscape indicators; Landscape Character Assessment; Strategic Environmental Assessment (SEA);

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1. Introduction

Over the past few decades, the importance of rural landscape preservation has been acknowledged by several researchers (Agnoletti, 2013; Antrop, 2005; Haines-Young and Potschin, 2010; Van Zanten et al., 2013), international bodies, such as the OECD, as well as at institutional level by the *European Landscape Convention* (ELC) (CoE, 2000). In addition, the *Common Agricultural Policy* (CAP), and its second "pillar" devoted to rural development, has highlighted the vital role that agriculture plays in land management and in preserving bio-cultural values, in a broader sense, including traditional activities and local identity.

To date, the CAP is one of the most important EU sector-based policies and its budget is a hefty 34,9% of the EU's total budget (EP, 2017). The structural funds of the CAP were created in order to provide support to farmers' incomes. More recently, the CAP has changed its previous social and productive functions in favour of a dual effort to support productivity – especially in marginal or degraded areas – and to preserve the environment and the biodiversity. However, agricultural policies have rarely dealt with the topic of landscape (Gottero, 2016; Rega, 2014) and landscape is little involved in evaluations of rural development policies (see, in particular, *Commission Implementing Regulation* (EU) No 808/2014).

As a consequence, not surprisingly research has shown that several Rural Development Programmes 2007-2013 (RDPs) have been ineffective and not very sensible in terms of actions oriented towards preserving farmland and enhancing landscape (ECA, 2011; Gottero, 2016; Rega, 2014; Van Zanten et al., 2013). When assessed in terms of landscape orientation, the weakness of RDPs emerge in the kind of actions chosen (Agnoletti, 2013), in the lack of coherence between RDP territorial coverage criteria and landscape priorities (Rega e Spaziante, 2013; Spaziante et al., 2012 and 2013), and in the shortage of tools (indicators) for assessing landscape (Gottero, 2016; Van Zanten et al., 2013). In fact, among the environmental components (water, air , soil), landscape is the least tangible one (Cassatella e Peano, 2011). A lack of clarity on the differences between environment and landscape seems to be the key factor for the above mentioned weaknesses.

Landscape indicators have only recently been used in the analysis and evaluation of territorial transformations. They originated from more stable and organised environmental assessment models (see also: Defra, 2009; UNCSD, 2007) introduced in Europe in the 1990s[1]. Since then, several studies developed the rural landscape concept (Antrop, 2005; Agnoletti, 2013; Pachaki, 2003; Swanwick, 2002 and 2004; Van Zanten et al., 2013; Washer et al., 1999), as well as applied research on agricultural landscape indicators (Carvalho-Ribeiro et al., 2016; Cassatella and Peano, 2011; EEA, 2006a-2006b; Haines-Young et al., 2012; José Lima et al., 2016; OECD, 2001 and 2004; Palmieri et al., 2011; Paracchini and Capitani, 2011; Paracchini et al., 2012; Paracchini et al., 2016; Piorr, 2003; Schüpbach et al., 2016; Shimizu et al. 2017; Van Eetvelde and Antrop, 2009; Washer, 2002 and 2005). However, quantifying landscape values in rural areas is a very complex task. Existing research tends to focus on indices and indicators mainly oriented towards the ecological profile of landscape or habitat services, leaving out other crucial dimensions such as those of cultural, historical, visual and socio-economic nature (Cassatella and Peano, 2011).

[1] See, in particular, EU Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive).

Regarding the assessment system of European agricultural policies[2], rural landscape is not considered yet, although each regional authority may introduce additional indicators in the evaluation of their RDPs. For these reasons this may be the context within which experimenting with the use and introduction of specific tools. However, which indicators could be used to assess landscape dimensions of RDPs? What is the landscape context within which RDPs operate? How has it changed? Which are the effects (direct and indirect) on the landscape? This paper proposes some indicators intended to answer these questions in several applicative fields of RDPs, from context analysis to the monitoring process or from SEA to the *Common Evaluation Questions for Rural Development* (CEQ-RD).

The identification and test of a set of landscape indexes and indicators is applied to an Italian region, the Piedmont. The aim was to fill the current gap in a RDP assessment framework that, at this point in time, excludes landscape in the environmental dimensions considered. For this reason, one objective of this study was to create the technical tools for assessing the state and change of rural landscape, to understand the effects of actions fostered by sector-based policies, as well as to assess the contribution of agricultural policy to the achievement of the landscape quality objectives of the landscape plan. The research questions will be discussed in the paragraphs below through the above mentioned Italian case study.

2. Methodological approach

2.1 The core set of indicators: selection criteria and computing models

The overall structure of the study takes the form of three phases, including a literature review on landscape indicators, the identification, development and testing of some of the latter, and the selection of a core set (see: Table 1). The selection criteria of these indicators can be summarized as follows:

- they support policymaking on landscape and agriculture; landscape indicators are applied at regional scale. However, some indicators can also be used at sub-regional scale;
- the core set is designed to reflect the multidimensionality of landscape, so including not only the ecological, but also the perceptual, historical and cultural dimension (Cassatella and Peano, 2011);
- the feasibility of the core set, in other words the existence of a cognitive background and data-source;
- the replicability and transferability (especially in the European context) of the selected tools.

The result of the above mentioned criteria is a set of seven indicators (Table 1) focused upon *landscape functions* such as *keeping of territory*, *transmission of places identity and maintenance of bio-cultural diversity*, *aesthetic*, as well as *recreational value* (cultural services of landscape) (NE, 2009). Furthermore, these functions correspond to political objectives of the Region. In the paragraphs below, these tools will be outlined.

Abandoned agricultural land (I_{aal})

The abandonment of agricultural activity, particularly in peri-urban areas, encourages the advance of invading forest species and the urbanisation processes, the loss of the rural landscape, as well as the gradual reduction of biological and cultural diversity. The indicator shows the surface area of abandoned crops within the reference landscaped units. It allows for us to identify the areas that require protection and conservation interventions, as well as

[2] The *Common Monitoring and Evaluation System* referred to in Article 67 of Regulation (EU) No 1305/2013.

incentives for maintaining agricultural activity (Dramstad et al., 2002). The indicator can be calculated through Eq. (1):

$$I_{aal} = \frac{Sup_{abb}}{SUP_{Ap}} \leq 1 \quad (1)$$

where:
$SUP_{abb} = crops\ abandoned\ area\ \ in\ landscape\ unit$
$SUP_{Ap} = area\ of\ landscape\ unit$

Biocultural diversity (I_{bd})

This index expresses the traditional environmental knowledge framework (BIP, 2010; Harmon and Loh, 2005; Maffi and Woodley, 2010; Zent and Maffi, 2012). Agricultural diversity is thus to be understood both in terms of species and crops (recoverable and exploitable), and in the broad sense, in reference to all traditional agricultural practices and production, as part of cognitive and cultural heritage, as well as for its economic and social importance in traditional food supply chains. The re-processed index from Harmon and Loh (2005) can be calculated through Eq. (2):

$$I_{bd} = f(EL, DB, PT, TAR) = \frac{EL + DB + PC + CT}{4} \leq 1 \quad (2)$$

where:
$EL = \ ethnolinguistic\ diversity = \frac{nED}{nEDmax} \leq 1$
$nED = number\ of\ languages\ in\ landscape\ unit$
$nEDmax = maximum\ number\ of\ languages\ per\ landscape\ unit$
$DB = biological\ diversity = \frac{nSp}{nSpmax} \leq 1$
$nSp = number\ of\ species\ (flora\ and\ fauna)\ in\ landscape\ unit$
$nSpmax = maximum\ number\ of species\ (flora\ and\ fauna)\ per\ landscape\ unit$
$PC = richness\ of\ certified\ agricultural\ products\ = \frac{nPcert}{nPcertmax} \leq 1$
$nPcert = number\ of\ certified\ agricultural\ products\ in\ landscape\ unit$
$nPcertmax = maximum\ number\ of\ certified\ agricultural\ products\ per\ landscape\ unit$
$CT = richness\ of\ traditional\ features = \frac{nCtrad}{nCtradmax} \leq 1$
$nCtrad = number\ of\ traditional\ features\ in\ landscape\ unit$
$nCtradcmax = maximum\ number\ of\ traditional\ features\ in\ landscape\ unit$

Tourist and recreational usability of farm (I_{tr})

The indicator represents the ability of farms to offer tourist and leisure facilities such as, for example, farmhouses, recreational and social activities, as well as educational farms. The indicator can be calculated through Eq. (3):

$$I_{tr} = \ f(A, B, C) = \left(\frac{nAgri}{n\ maxAgri} + \frac{nAzRS}{n\ maxAzRS} + \frac{nFd}{n \max Fd}\right) \cdot \frac{1}{3} \leq 1 \quad (3)$$

where:
$nAgri = number\ of\ farmhouses\ in\ landscape\ unit$
$n\ maxAgri = maximum\ number\ of\ farmhouses\ per\ landscape\ unit$
$nAzRS = number\ of\ farms\ with\ recreational\ and\ social\ activities\ in\ landscape\ unit$
$n\ maxnAzRS = max\ n.\ \ of\ farms\ with\ recreational\ and\ social\ activities\ per\ landscape\ unit$

$nFd = number\ of\ educational\ farms\ in\ landscape\ unit$
$n\ maxFd = maximum\ number\ of\ educational\ farms\ per\ landscape\ unit$

Agricultural and forestry land use dynamics (I_{dus})

The indicator shows the annual change (annual rate) of agricultural and forestry land use (arable, permanent meadows, pastures, orchards, vineyards, forests, etc.) and the importance of agriculture in relation to the area of surface analysis. The re-processed indicator from EEA (2005) and Puglia Region (2010), can be calculated through Eq. (4):

$$I_{dus} = 100\ x\ \frac{A_1\ -\ A_0}{n\ x\ A_0} \tag{4}$$

where:
$A_0 = Agricultural\ and\ forestry\ area\ in\ landscape\ unit\ at\ time\ 0$
$A_1 = Agricultural\ and\ forestry\ area\ in\ landscape\ unit\ at\ time\ 1$
$n = number\ of\ years\ between\ \ two\ periods$

Areal impact of RDP on rural landscape visual diversity (I_{adv})

The areal impact index of RDPs on rural landscape visual diversity is an indicator borrowed from landscape ecology (see: Forman, 1995; Finotto, 2011) used for evaluating the change in the heterogeneity level and visual richness of agricultural landscape as a result of interventions promoted by RDPs. The indicator can be calculated through Eq. (5):

$$I_{adv} = \left(\frac{DV_1}{DV_0}\ x\ 100\right) - 100 \tag{5}$$

where:
$DV_1 = visual\ diversity\ at\ time\ 1$
$DV_0 = visual\ diversity\ at\ time\ 0$

$$DV_n = \frac{\sum_{k=1}^{s}\left(\frac{A_k}{Atot}\ log\ \frac{Ak}{Atot}\right)}{log\left(\frac{1}{s}\right)} \leq 1$$

$A_k = utilised\ agricultural\ area\ of\ class\ K$
$s = number\ of\ use\ of\ agricultural\ land\ classes$
$A_{tot} = utilised\ agricultural\ area\ in\ landscape\ unit$

Values close to 0 indicate a mosaic dominated by a single, common and interconnected element, while values close to 1 indicate a landscape characterised by many elements with similar significance. The parameters that determine landscape heterogeneity refer exclusively to the equitable distribution of agricultural land uses.

Loss of rural landscape by RDP afforestation (I_{pepr})

The indicator represents the rate of traditional landscape area covered by RDP afforestation measures. In fact, the afforestation of agricultural land may conceal negative effects in terms of the loss of traditional elements of rural landscape. The indicator can be calculated through Eq. (6):

$$I_{pepr} = \frac{A_{imp}}{A_{tot}} \leq 1 \tag{6}$$

where:
$A_{imp} = traditional\ landscape\ area\ covered\ by\ afforestation\ measures\ in\ landscape\ unit$
$A_{tot} = traditional\ landscape\ area\ in\ landscape\ unit$

Aid intensity for landscape unit (I_{ail})

Measuring the economic contribution of the CAP (pillars I and II), the indicator allows for the identification of those rural landscapes where the aid for maintaining agricultural activity and farmland is more intensive or, on the contrary, less significant. For this purpose, the contribution of the first "pillar" was also considered. The indicator can be calculated through Eq. (7):

$$I_{ail} = \frac{SP_{ap}}{SP_{tot}} \tag{7}$$

where:
$SP_{tot} = CAP\ total\ public\ expenditure\ for\ whole\ Region$
$SP_{ap} = CAP\ total\ public\ expenditure\ in\ landscape\ unit$

2.2 Description of the study area

The study area is Piedmont, region located in the northwest of Italy. The Italian landscape is configured mainly as the union of the agricultural landscapes matrix (about 55% of the national surface) and the woodland landscape matrix (equal to about 40% of the total) (Agnoletti, 2010). A variety of environmental and historic factors have created a multiplicity of rural landscapes (Agnoletti, 2013). However, especially in Piedmont, the rural landscape has been strongly transformed. Today, it maintains only a few intact fragments, but they are of undoubted value, such as the historical vineyards' landscapes of Langhe, Roero and Monferrato – recently named a UNESCO World Heritage Site (fig. 1) – the meadows (fig. 2) and wood pastures of the mountains, the oak-hornbeam woods (Cevasco and Moreno, 2013) and the paddy fields in the plain. Landscape is considered a strategic asset by regional community and government. However, Piedmont's regional public policies consist of a fragmented policy framework: a *Regional Spatial Plan* (RSP) and a *Regional Landscape Plan* (RLP). The RLP is the regional cognitive framework and regulative system on landscape, as well as a useful guidance document for multi-sector policies. It divides the region into 76 landscape units (landscape character areas), and 535 sub-units, on the basis of a synthesis of environmental and cultural features (Piedmont Region, 2015). For this reason, the RLP's landscape units were used as spatial references for applying our core set. In addition, the RLP expresses landscape quality objectives for each unit: these aims will be taken into consideration, interpreting the results of the indicators.

2.3 Data preprocessing

In order to test the indicators at regional level, an in-depth analysis has been carried out through multitemporal thematic maps and a review of existing literature. Primary data for this research was obtained from European, national and regional institutional databases, including numerical and spatial data. Table 2 includes the list of primary datasets and contains the different data type of several producers.

In general, the RLP is an important source for landscape characters, for specific landscape features and traditional rural landscape components. The reference to a regional source is not unusual, as long as data about landscape elements (and their trends) are usually collected at regional scale, as suggested by the *Recommendation CM/Rec(2008)3 of the Committee of Ministers to member states on the guidelines for the implementation of the ELC*. On this basis, the experiments conducted at regional level are primarily focused on context indicators, which are designed to verify the state and dynamics of the rural landscape and the changes attributable to regional policies. Land cover and use maps are essential for the generality of the indices and indicators: I_{aal}, I_{dus} and I_{adv} are based on the *Corine Land Cover* (2006 and 2012) or on the *Regional Forest Map* (2005). The latter map, although not very recent but more detailed than CLC, identifies abandoned crops on the whole regional territory. Unlike previous indicators, I_{bd} was built systematizing different numerical and textual information: regional datasets (number of species and certified products), the cognitive framework of RLP (at landscape unit) and a review of existing literature. Conversely, the I_{tr} has been developed through the *National Agricultural Census* dataset (2010) that periodically (every 10 years) produces municipal level information on farms and farmers. I_{adv}, and I_{pepr} have been set through the use of the regional RDP monitoring data warehouse, as well as spatial analysis of the RDP measures coverages. Lastly, I_{ail} resorts to the use of additional information of the first "pillar" of the CAP monitoring system, considering the total value of direct payments during the period 2007-2013 (only surface payments of title III).

3. Results on indicators' testing phase

The results of core set indicators are spatially referred to the landscape units identified by the RLP. The RLP is also a key reference in interpreting the results, as long as it provides landscape quality objectives. It can be compared with the values and dynamics which emerge from the assessment via indicators. This methodology, inspired by the research "Countryside Quality Counts" (Haines-Young, 2007) and by the DEFRA indicator "landscape change"[3] is meant to overcome the problem of the absence of thresholds in landscape indicators (Peano, Bottero and Cassatella, 2011).

Regarding the results of indicators at landscape unit, they represent a regional agricultural landscape very heterogeneous, especially if compared to the objectives of quality stated by the RLP. The phenomenon of abandoned crops *(I_{aal})*, particularly relevant in terms of defence and protection of soil, is strongly accentuated in the south of Piedmont, between the lowland of Alessandria and the low Apennine area (fig. 3). The indicator of "Tourist and recreational usability of farms" *(I_{tr})* shows, reasonably, that the supply of recreational farms is particularly marked around the UNESCO Site vineyards' landscapes (fig. 4). The results of the biocultural diversity index *(I_{bd})* are more complex and heterogeneous: the landscape is particularly biodiverse in the south of Piedmont and in the Alpine Occitan landscape (west), while more homogeneous are located mainly in the north Alpine landscape (fig. 5). The analysis of the rural landscape changes, highlights some significant aspects concerning the aesthetic value: the land use dynamics, in the period 2006-2012, demonstrate the increase of artificial surfaces, sometimes coinciding with the loss of traditional agricultural landscape (such as permanent grasslands). The rate of annual change of agricultural and forestry land use *(I_{dus})* confirms the attenuation of the intensifying crop phenomenon, as well as forests with a marked invasion character, particularly in areas of high agronomic and scenic interest (table 3). The indicator "Loss of rural landscape from RDP afforestation" *(I_{pepr})* highlights the

[3] See website: https://www.gov.uk/government/statistical-data-sets/agri-environment-indicators (accessed: 02/03/2017).

negative effects of agro-environmental measures (namely, measures H and 221) in some landscape units (table 4). Basically, these actions, especially in the areas of Tortona (Landscape Unit 74) and Alessandria (Landscape Unit 70), have resulted in a significant loss of traditional characteristics, such as permanent meadows, orchards and vineyards. The decrease of these elements, affecting local identity, can be derived from a cognitive deficiency of RDP which does not place emphasis on the values enshrined in RLP for each landscape unit (table 4). Finally, in relation to landscape aesthetics, the experiments conducted on the Piedmont case study have revealed some important issues. The "areal impact of RDP on rural landscape visual diversity" *(I_{adv})* is not significant or positive in most landscape units (see, in particular, Tortona and Alessandria). However, RDP – which mainly support actions to convert arable land into permanent forage crops (measure 214.4) and, in small part, crops for feeding of wildlife and buffer zones (214.7) – had negative effects, when measured in terms of visual heterogeneity and equitable distribution of crops. This phenomenon probably resulted from actions that affected crops which are not visually dominant. Once again, in this case the RDP reveals cognitive and spatial gaps that prevailed over the benefits of the interventions (table 5). The economic and financial contribution of the CAP (Pillar I and II), as well as the "maintaining service" of agricultural policies (aid intensity indicator in the period 2007-2013, *I_{ail})*, is very limited in the mountain areas, moderate in the hill systems of Langhe and Monferrato and in the arable crops of Turin, while it is high or very high in the Novara, Alessandria and Cuneo landscape unit (fig. 6), i.e., the plain, where extensive agriculture prevails. This fact is not negative per se, but it questions the efficiency of the CAP in terms of spatial targeting.

4. Discussion

The key results underlined some relationship among the rural development policies, the landscape characters and their dynamics. They also show strengths and weaknesses of the rural development policies, if compared with the landscape quality objectives stated by the regional administration (and, widely shared in the field of landscape policies). The following section deals with the transferability of the proposed set and with the general issue of the supposed impact of the rural development policy on landscape.

a) Is the proposed set transferable to other contexts? Although several datasets and sources used to populate the indicators originate from national or regional datasets, we think that the proposed core set is applicable in other European contexts. The *EU common monitoring and evaluation system*, referred to in *Article 67 of Regulation (EU) No 1305/2013*, has established that the data collection, storage and transmission of the RDP is an obligation of all Member States or administrative regions. For these reasons, each impact indicator, such as I_{adv}, I_{pepr} and I_{ail} can be built through regional datasets, while the "Touristic and recreational usability of farms indicator" (I_{tr}) can be developed through national agricultural censuses, regional or local direct surveys or, at least in part, through the European "Farm Accountancy Data Network" (FADN). In fact, the I_{tr} indicator can be calculated and represented also at sub-landscape unit scale. Biocultural diversity index (I_{bd}), based on specific datasets of regional authorities, sectoral plans and local literature, is the most difficult to replicate. Another critical aspect concerns the reliability and update of different data sources: although most indicators can be calculated with a high frequency, such as those based on CLC, one of the sources of the I_{aal} indicator is a map published in 2005. According to the most recent international debate and literature (see for example: Estel et al., 2015; Tsuchiya and Hagihara, 2017) land abandonment is very difficult to be measured, although many methods are being tested. In the Piedmont case study, the dataset under use currently is being updated through photo-interpretation of satellite images and remote sensing methods.

b) Which is the RDP impact on landscape? Our assessment reveals mostly positive but still quite weak phenomena (especially with reference to the visual dimension of landscape), particularly through agri-environment payments. The research, in particular, highlights the actions, supported by RDP, which act as pressures on the landscape: the construction of new buildings and afforestation of farmland, which may lead to loss of identity elements, change in land use and visual impact.
c) Is the proposed set significant for policy making? The research conducted on Piedmont case study showed the lack of integration among the rural policies, the landscape and spatial policies. This lack of integration is particularly clear in the relative assessment frameworks, i.e. in the absence of tangible steps of *co-assessment* based on a common and shared set of landscape indicators. For these reasons, the proposed set is intended for integrated applications among RDPs and other kinds of plans/programmes. In particular, their environmental assessment procedures may provide an appropriate field of application. The Piedmont policies framework are composed from a fragmented planning tools (RSP and RLP) that is separated from the RDP and does not provide common assessment phases and tools. This issue is further compounded by the lack of landscape indicators within the current common set of context, result and output indicators of *Commission Implementing Regulation (EU) No 808/2014* for rural development. The proposed set may also be useful in other applicative fields, such as *Annual Implementation Report* (AIR), RDP applications, support to *Good Agricultural and Environmental Conditions* (GAEC) and projects of *Ecological Focus Area* (EFA), as well as assessment of local landscape benefits of RDP instances.

5. Conclusion

The proposed landscape assessment adopts a model oriented towards fulfilling a number of demands in the fields of agricultural policy, but also some needs of spatial planning policies. In fact, the landscape concept offers a link among many sectoral policies (CoE, 2000; ESPON LIVELAND, 2014). The complexity of new and emerging demands for support tools for policymakers and decision makers, as well as landscape functions selected through the review of literature, represent the relevant aspects that distinguish the evaluation paradigm used for the Piedmont case study.

In our opinion, the proposed set can contribute to innovate the regional assessment framework in a more general way, being transferred from the assessment of the RDP to the SEA of other plans and programmes. With this regard, some innovative aspects of the presented research may be considered. The SEA of plans and territorial programmes has already produced a considerable number of landscape indices and indicators, being the landscape one of the environmental components to be assessed. Nevertheless, their dominant approach is fundamentally focused on the assessment of urban transformations and on their effects on the environment only. For these reasons the core set covers several functional and temporal dimensions of rural landscape, currently unexplored or poorly depth. To date, many studies have proposed an approach focusing mainly on biological dimension, while few researches have interpreted the rural landscape in holistic way. The proposed set provides a tool for assessing multiple dimensions of the landscape. However, the diffusion of the use/testing of these indicators also depends on the creation of an adequate knowledge system that could be supported by the landscape observatories.

Despite the significance of the tested indicators, the issue of the indicators thresholds remains problematic and still is one of the most challenging research perspective. To the extent of this research application, the results of each indicator have been compared with landscape quality objectives extracted by a regional policy document, but this operation has a

qualitative and subjective nature. The issue of landscape indicators thresholds could be valuable to develop some elaborations, especially on the inclusion of the indicators in a DPSIR framework for landscapes. The creation of a common framework and cross-sectoral evaluation and monitoring which integrates the set developed with the existing indicators for the evaluation of other sectoral policies, is a topic that needs further investigations. To date, an extremely important part of the CAP is also unexplored: the effects of the first "pillar", specifically "direct payments" and "greening payments". Currently, the impact of such tools, has a great importance. The first "pillar" covers about 80% of the total budget of the CAP and has a very significant role in terms of maintaining the agricultural activity. However, it does not have any environmental assessment system, although it constitutes a very relevant public investment. The process that assigns to landscape the same value of the other environmental components seems quite far from an inclusive process. Most probably this will be one of the most important challenges that CAP will face in the coming decades.

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Table 1. Core set of indices and indicators proposed for rural development policies (Source: authors' elaboration)

Indicators/indices	Landscape functions	Landscape dimension	Aims	Field of application	Data to be replicated
Abandoned agricultural land (I_{aal})	keeping	Land Use	state and change	Context Analysis	Land cover/use
Biocultural diversity index (I_{bd})	biocultural trasmission	Historical and Cultural	state and change	Context Analysis	biological and cultural features
Touristic and recreational usability of farms (I_{tr})	recreational	Social perception	state and change	Context Analysis	Farms features
Agricultural and forestry land uses dynamics (I_{dus})	aesthetic	Land Use	state and change	Context Analysis	Multitemporal Land cover/use
Areal impact of the RDP on rural landscape visual diversity (I_{adv})	aesthetic	Visual Perception	Effects of RDPs	Ex post assessments	Multitemporal Land cover/use, RDP coverage
Loss of rural landscape by RDP afforestation (I_{pepr})	biocultural trasmission	Historical and Cultural	Effects of RDPs	Ex post assessments	Multitemporal Land cover/use, RDP coverage
Aid intensity for landscape unit (I_{ail})	keeping	Economic	Indirect effects of RDPs	Ex post assessments	RDP coverage

Table 2. Primary datasets (Source: authors' elaboration)

Indicators/indices	Data type	Producers, year
Abandoned agricultural land (I_{aal})	Carta forestale e altre coperture del territorio (Forest Map and other land covers),	IPLA Piemonte, 2005
Biocultural diversity index (I_{bd})	map of regional languages	Rubat Borel et al., 2006 (local literature)
	n. of species (flora and fauna)	BDN Regional Dataset, 2015
	map of certified products	CSI Piemonte, 2015
	traditional features of rural landscape for landscaped unit,	Piemonte Region (RLP), 2009
Touristic and recreational usability of farms (I_{tr})	– n. of farms; – n. of farms with multifunctional activities;	ISTAT (National Agricultural Census dataset) , 2010
Agricultural and forestry land uses dynamics (I_{dus})	– Corine Land Cover, 2006, IV level; – Corine Land Cover, 2012, IV level;	ISPRA, Sinanet, 2006 and 2012
Areal impact of the RDP on rural landscape visual diversity (I_{adv})	– Cover area of Measure 214.4 (Conversion of arable land into permanent grassland); – Cover area of Measure 214.7.2 (Crops to feed wild animals); – Cover area of Measure 214.7.3 (Buffer zones);	CSI Piemonte (RDP data warehouse), 2013
	Corine Land Cover, 2006, IV level;	ISPRA, Sinanet, 2006
Loss of rural landscape by RDP afforestation (I_{pepr})	– traditional features of rural landscape for landscaped unit	Piemonte Region (RLP), 2009
	– Cover area of Measure H and Reg. 2080/92 (Afforestation of farmland); – Cover area of Measure 221 (Afforestation of farmland)	CSI Piemonte (RDP data warehouse), 2010

Aid intensity for landscape unit (I_{ail})	– Total value of amount during the period 2007-2013 - Title III - Direct payments (except art. 68-69); – Total public expenditure of RDP during the period 2007-2013	CSI Piemonte (CAP data warehouse), 2013

Table 3. Annual change rate in Corine Land Cover (2006-2012). The negative signs show a decrease of surface (Source: authors' elaboration)

CLC Classes	Landscape Unit								
	18	**23**	**28**	**30**	**48**	**52**	**64**	**70**	**74**
Artificial surface	0.23%	1.26%	0.09%	1.07%	0.50%	1.99%	1.97%	2.40%	1.71%
Agricultural Areas	-0.02%	0.06%	-0.11%	0.02%	0.09%	-1.53%	0.47%	-0.09%	-0.22%
Vineyards	—	—	0.92%	—	1.08%	—	-0.27%	0.00%	—
Fruit trees	—	—	-0.17%	—	-0.34%	—	-1.75%	—	0.00%
Permanent grassland	—	—	-3.38%	-2.36%	0.12%	-1.97%	-4.58%	0.07%	-16.67%
Rice fields	0.11%	0.29%	—	—	0.00%	—	—	5.10%	—
Arboriculture	17.64%	—	—	0.00%	-0.19%	—	-3.88%	-1.19%	—
Complex cultivation patterns	-0.40%	-0.40%	0.16%	-0.19%	-0.67%	0.13%	1.96%	-2.17%	-0.35%
Land principally occupied by agriculture with significant areas of natural vegetation	1.23%	-1.01%	0.11%	0.38%	1.48%	-1.17%	2.38%	-1.06%	0.06%
Forests	-0.18%	-1.10%	0.33%	-0.21%	-0.11%	0.07%	-2.48%	-1.16%	0.02%

Table 4. Loss of rural landscape by RDP afforestation. The negative signs show a loss of rural landscape (Source: authors' elaboration)

Landscape Unit	Name	PEpr
18	Pianura novarese	—
23	Baraggia tra Cossato e Gattinara	-4.60%
28	Eporediese	-0.52%
30	Baso Canavese	-0.49%
48	Piana tra Barge, Bagnolo e Cavour	-0.10%
52	Val Maira	-0.06%
64	Basse Langhe	-0.20%
70	Piana Alessandrina	-9.37%
74	Tortonese	-23.82%

Table 5. Areal impact of RDP 2007-2013 on the rural landscape visual diversity. The negative signs show a negative impact (Source: authors' elaboration)

Landscape Unit	Cover area by RDP measure (ha)	DV_0	DV_1	IAdv (%)
18	48.64	0.44	0.40	-9.53%
23	6.63	0.29	0.24	-16.30%
28	95.69	0.67	0.68	1.49%
30	94.95	0.77	0.78	1.30%
48	85.79	0.57	0.57	—
52	0.01	0.62	0.62	—
64	38.81	0.66	0.66	—
70	1155.77	0.29	0.32	10.34%
74	314.64	0.70	0.72	2.86%

Figure 1. The historical vineyards' landscapes of Langhe and Monferrato recently named a UNESCO World Heritage site (photo of the authors)

Figure 2. Meadows of the Po Valley, near Turin. (photo of the authors)

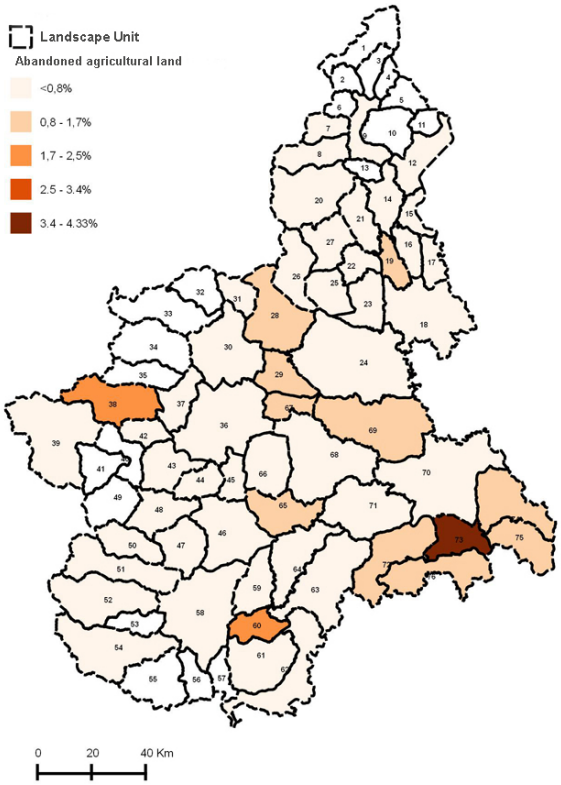

Figure 3. Spatial distribution of "Abandoned agricultural land " (Source: authors' elaboration)

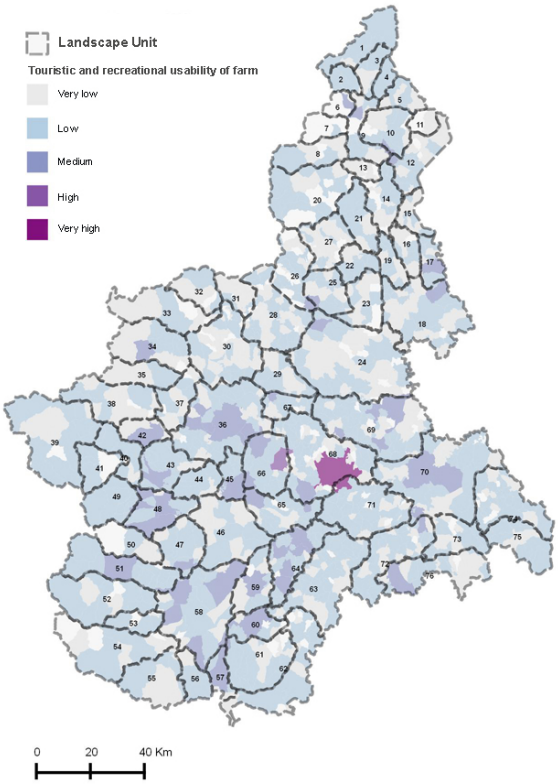

Figure 4. Spatial distribution of "Touristic and recreational usability of farm". (Source: authors' elaboration)

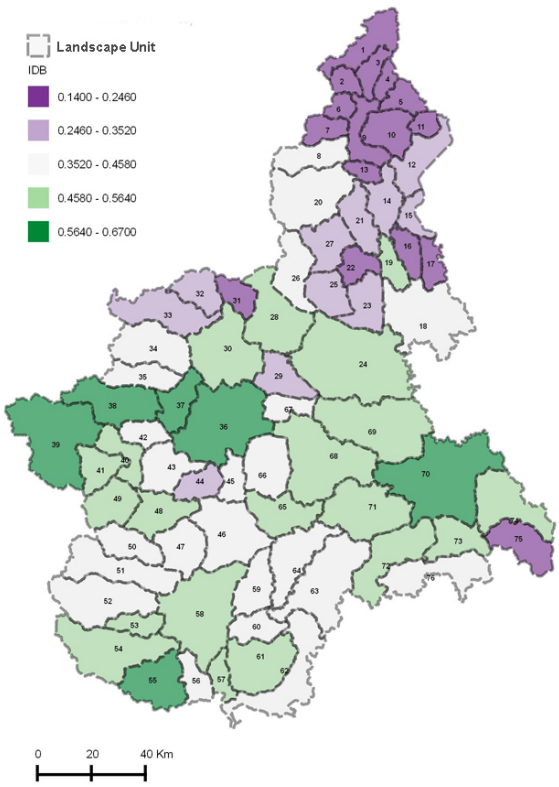

Figure 5. Spatial distribution of "biocultural diversity index" (Source: authors' elaboration)

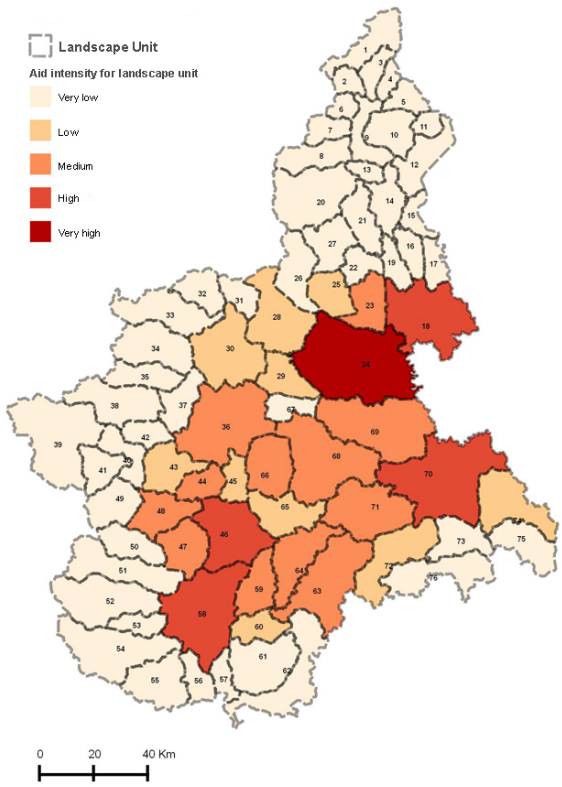

Figure 6. Spatial distribution of "aid intensity indicator" (Source: authors' elaboration)