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Planning sustainable development o f local productive systems: A methodological approach for the analytical identification of *Ecoregions*

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A B S T R A C T

At the local and regional levels, planning for sustainable development rests on the structural peculiarities of *territories* following a development model that lays its foundations on the notion of the *Marshallian industrial district*. Recently, this form of production organization has been recognized as also featuring an organic agricultural sector, where the creation of *ecoregions* (or *bio-districts*) emphasizes the territorial dimension of sustainable development. Nevertheless, whilst ecoregions are acquiring substantial relevance at the international level, a comprehensive methodological approach for their analytical identification is still missing, thereby affecting the ability of policymakers to effectively identify territories suitable to enter an ecoregion. The few studies available on this topic adopt a narrow perspective when identifying ecoregions, considering only the dimensions that are strictly related to organic production and ignoring substantial variables that are able to capture the activities and elements that generate positive externalities and feed the economic, social and environmental life of a potential ecoregion. To fill this gap in the literature, this paper makes two innovative contributions. First, the paper discusses the notion of an ecoregion by stressing its relationship with other territorial features (i.e., environmental, social, and economic) that complement the agricultural dimensions. Second, the paper proposes a comprehensive methodological approach for the analytical identification of ecoregions considering not only the biological and agricultural features of territories but also crucial aspects related to their environmental, social and economic contexts. In this regard, the paper develops a new composite indicator – the *Ecoregional Vocation Index* (EVI) – to assess the vocation of territories to enter an ecoregion. As an illustrative example, the EVI is employed to analyse 29 municipalities belonging to the area of the Bologna Apennines (Emilia-Romagna region, Italy). The results of the analysis provide a ranking that classifies these municipalities from best to the worst in terms of their suitability to belong to an ecoregion. The results are presented and discussed to show how this methodological approach can be generally employed in sustainable territorial planning to support policymakers and other relevant stakeholders in the participatory processes concerning the creation of ecoregions.

1. Introduction

The notion of *sustainable development* (SD) is increasingly characterizing the political horizon of many governments. As a collective long-term goal, SD entails orienting economic progress, resource exploitation, investment direction and technological advancement towards trajectories fostering environmental and social well-being (WCED, 1987). While this idea is important for characterizing public interventions at various levels of government (see, e.g., Domenech and Bahn-Walkowiak, 2019), it also directly affects the organization of production at the regional and local levels, where SD policies are mostly used to interact with the specificities of the territorial dimension. In this context, planning for SD rests on the structural peculiarities of territories, such as their productive specialization, level of cooperation and competition between economic activities, habits, traditions, existence of relationships of trust and productive interdependencies between local and external actors (Loewe et al., 1997).

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While this territorial development model, which can be effectively described by referring to the notion of the *Marshallian industrial district* (Marshall, 1920), has been traditionally associated with industrial production, in the last few decades, it has been recognized as also featuring other activities, including tourism (Getz, 1993; Hjalager, 2000), food production (Brasili and Fanfani, 2016), cultural offerings (Santagata, 2002; Sacco et al., 2013) and organic agriculture (Jeong et al., 2013). In the latter context, the notion of an *ecoregion* (or a bio-district) is used exactly to emphasize the territorial dimension of SD. Indeed, ecoregions are commonly associated with geographical areas characterized by common conditions that affect the economic, social and environmental performances and opportunities of the agricultural production system.[1]

In this context, while ecoregions are acquiring substantial relevance at the international level as institutional arrangements for promoting SD, and there is a general agreement on the definition of the concept; what is missing is a comprehensive methodological approach for their analytical identification that takes into account not only the biological and agricultural features of the "organic farming" of a territory but also the dimensions that are able to animate and sustain the life of an ecoregion over time (related mainly to the environmental, social, and economic characteristics of the region). This shortcoming affects the ability of policymakers to effectively identify territories that are suitable to enter an ecoregion. Indeed, while ecoregions are formally recognized at the institutional and political levels, the academic debate in this field appears to still be in an incipient stage. To the best of our knowledge, the few studies available on the topic adopt a narrow perspective in identifying ecoregions, considering just the dimensions strictly related to organic production and ignoring substantial variables that are able to capture the activities and elements that generate positive externalities and feed the economic, social and environmental life of a potential ecoregion, including the culture and behaviours oriented to a sustainable development model, the high demand for environmentally-friendly goods and services, tourist attractions, and so on. To fill these gaps in the literature, this paper makes two innovative contributions. First, the paper discusses the notion of an ecoregion by stressing its relationship with other territorial features (i.e., environmental, social, and economic) that complement the agricultural dimensions. Second, the paper proposes a comprehensive methodological approach for the analytical identification of ecoregions considering biological and agricultural features of territories as well as crucial aspects related to their environmental, social and economic contexts. In this regard, a new composite indicator – the Ecoregional Vocation Index (EVI) – is developed to assess the vocation of territories to enter an ecoregion. As an illustrative example, the EVI is employed to analyse 29 municipalities belonging to the area of the Bologna Apennines (Emilia-Romagna Region, Italy). In line with the bottom-up approach inspiring the function of ecoregions, the EVI provides a useful informative base for supporting policymakers and other relevant stakeholders in the discussions and participatory processes concerning the creation of ecoregions.

[1] In many studies, the terms *ecoregion* and *bio-district* are used as synonyms. In this paper, we decided to use the term *ecoregion* due to its wider acceptation and because of the definition provided by INNER (see Section 2.1), which fits better with the of purpose this work. As a matter of fact, in this context, ecoregions are considered from an institutional perspective, which concerns the actions and processes oriented to help policies to formally identify those areas that meet specific requisites related to organic farming and agroecology (see, e.g., Stotten et al., 2017). This perspective differs from the one adopted by ecology studies that generally defines ecoregions as areas with characteristic flora, fauna and ecosystems.

The remainder of this paper is organized as follows. The next section discusses the literature on ecoregions, showing their peculiar features and relevance as a sustainable organizational form of a territory, as well as the issues associated with their identification. Section 3 presents the case study analysed in the paper and the methodological approach associated with the construction of the Ecoregional Vocation Index (EVI). Section 4 presents the empirical results and discusses them to highlight how the EVI-based methodological approach can generally be employed in sustainable territorial planning processes for the analytical identification of ecoregions. Section 5 concludes the paper.

2. Literature review

The aim of this section is to present the literature on ecoregions. In particular, the notion of an ecoregion is discussed by emphasizing its connection with a wide range of territorial features (related to agriculture, the environment and natural endowment, society, and the economy), that show its relevance in sustainable development dynamics and addressing the main issues associated with its analytical identification.

2.1. From industrial districts to ecoregions

Since the seminal contributions of Alfred Marshall (1920), theories of local development have largely considered the endogenous potentialities of territories. Building on the Marshallian perspective, the notion of an "industrial district" has been developed to indicate a "socio-territorial entity, characterized by the active co-presence, in an area territorially circumscribed, naturalistically and historically determined, of a community of people and a population of industrial firms" (Becattini 1990, p. 38). This form of a production organization rests on its capacity to maximize the efficiency originating from "external economies", such as the positive externalities derived from the context in which businesses arise. According to Marshall, in fact, the grouping of various sector producers in the same area can lead to advantages of economies of scale comparable to those of large companies with greater productive capacities (Brandi and Moretti, 2013). In this view, the structural peculiarities of *territories*, such as their productive specialization, level of cooperation and competition between economic activities, habits, traditions, existence of relationships of trust and productive interdependencies between local and external actors, are considered to be relevant for generating the competitive advantages of firms belonging to industrial districts. While this model has importantly characterized the economic development of some regions of central and northern Italy (see, e.g., Becattini, 1979; Piore and Sabel, 1983; Pyke et al., 1992; Becattini et al., 2003; Goodman et al., 2016; Schillirò, 2017), this "districtualization" should not be considered to be an *ad hoc* construct to explain Italian industrialization, but rather it should be considered a model of industrial organization different from the mass production system that also distinguishes the industrial reality of other countries (Sforzi, 2008; Boix and Galletto, 2005).

In the last few decades, the literature in this field has considered and recognized district dynamics as also characterizing sectors different from the secondary one, including agricultural production (see, e.g., Iacoponi, 1990; Cecchi, 1992; Lowe et al., 1995; Becattini, 2000; Fabiani, 2000; Nemes and Fazekas, 2006). In this context, however, the territorial dimension of economic development assumes typical connotations related to how agricultural production combines with other elements with various natures, including economic (i.e., craftwork production, tourism and recreation), environmental (i.e., the protection of soil, water, air, biotopes and landscape and the conservation of biodiversity) and sociocultural

(the conservation and development of local community traditions) (Sturla, 2019). In this context, as argued by Ray (2006), a socio-economic approach suitable for territorial development can be that of neo-endogenous development (Ray 1998, 1999a, 1999b), namely, a development model that not only emphasizes the participatory process of the local community in strategic planning and implementation but that also relies on the external political-administrative system (national and supranational) to increase its potential and establish the rights for actions. Building on this model, in recent years, *ecoregions* have emerged as a form of rural organization that aims to combine the aforementioned principles with the protection of natural capital and the implementation of social capital following a bottom-up development trajectory (see, e.g., Stotten et al., 2017). In this view, ecoregions describe geographical areas characterized by common conditions that affect their economic and environmental performances and opportunities. Formally, belonging to an ecoregion is accorded – through a specific certification released by the International Network of Eco Regions (INNER) association – to those areas that prove that they meet specific requisites (see below). In this context, the ecoregion, as defined by INNER, reflects "a territory naturally devoted to organic, where farmers, citizens, public authorities, realize an agreement aimed at the sustainable management of local resources, based on the principles of organic farming and agro-ecology".[2]

2.2. The increasing role of ecoregions in sustainable development dynamics

The vocation of ecoregions for the development of organic agriculture makes the promotion and growth of these ecological areas a central element of the dynamics of sustainable development. At the European level, the organic agricultural sector has been showing important growth trends, recording increases in the extension of areas, production volumes, and the number of certified companies (Willer and Lernoud, 2019).[3] In this context, the productive system – following specific *principles* for organic agriculture development[4] – is increasing its capacities to provide healthier and organoleptically valuable products while, at the same time, being more environmentally and socially sustainable (Aher et al., 2012; Reganold, 2016). This multifunctional nature makes organic agriculture a useful tool for pursuing the sustainability objectives signed by the UN member countries. A recent meta-analysis highlights the actual contribution that organic agriculture offers to eight of the seventeen Sustainable Development Goals (SDGs) indicated in the Agenda 2030 (De Schaetzen, 2019). From this perspective, organic production can also foster local development of disadvantaged rural areas (Harpa et al., 2016), where, among other factors, the use of fertilizers is generally reduced (Thøgersen, 2010). For instance, the promotion of organic agriculture as a tool for enhancing the inclusive growth of marginal rural areas has been recently highlighted by the European Union. In the next Common Agricultural Policy (CAP) plan, the European Union will increase the funds allocated to this specific purpose, while 5% of the EU funds from 2021 to 2027 will be allocated on a territorial basis to the so-called "internal areas", namely, the areas peripheral to places where basic services are provided (Mantino and Lucatelli, 2016). Similarly, the FAO and several other international institutions have recognized the important role that low impact farming, which is respectful of the environment, widespread in territories, and fairly distributes value among agricultural producers, plays in sustainable development dynamics.

In this scenario, ecoregions represent one of the various forms of organic agriculture districts, identifying a multifunctional area capable of benefiting the environment and each internal actor and user (Pugliese et al., 2015b). More specifically, an ecoregional productive system is characterized by some distinguishing dynamics. (i) Agricultural operators produce using agroecological techniques, countering the loss of biodiversity and hydrogeological instability and contributing in certain cases to the preservation of local traditions. Furthermore, belonging to an ecoregion gives agricultural operators the opportunity to increase the share of products placed in more profitable short value chains, to join multifunctionality circuits (bio-farmhouses, bio-paths, educational bio-farms, and social bio-farms) and to adopt a quality brand that promotes and enhances their products. (ii) Local consumers, through responsible and solidarity choices, are inclined towards healthy, traditional and short-chain products, guaranteeing their demand for consumption. As citizens, they benefit from the food and environmental quality that organic production and the bio-district ensure. (iii) Tour operators – who see their territory enhanced and the offering of rural tourism and eco-itineraries enriched – contribute to make marketing initiatives more effective. (iv) Public administrations coordinate the various actors of the ecoregional system, support internal activities and spread the culture of organic production through both disseminating and adopting sustainable policies. Furthermore, public administrations benefit from belonging to the ecoregion since the ecoregion promotes direct and collaborative relationships among private actors, thus increasing social cohesion.

In 2009, the first ecoregion was founded in Cilento (Salerno, Italy) because of the leading role of the Italian Association for Organic Agriculture (AIAB) (Pugliese et al., 2015a). Having become an example and a reference point at the international level (Zanasi et al., 2016), this "experiment" allowed the diffusion of the ecoregion model at the global scale. The mentioned International Network of Eco Regions (INNER) – promoted by the AIAB and founded in 2014 to facilitate the fruitful exchange of experiences between existing district realities (Pugliese et al., 2015b) – today includes over 60 ecoregions on four continents (Assaël and Orefice, 2016). Currently, approximately half of the existing ecoregions are located in Italy. This primacy is essentially attributable to a plurality of factors: first, among the countries with a substantial area of organic farming, Italy is the country with the greatest presence of small and medium-sized companies (Pancino, 2008); second, Italy has a consolidated experience gained through districts; and third, partial financial support is provided to ecoregions in the national budget.

In the future, the further expansion of the number of ecoregions can be presumed, at least within the EU, considering that among the themes of the new CAP, there is a significant emphasis on issues widely addressed by bio-districts, such as the collective approach to the agro-environment, the empowerment of local communities and the social function of agriculture (Sturla, 2019). Furthermore, the new regulation on organic production (EU Reg. 848/2018) opens up an interesting panorama regarding the possibility of reducing organic certification charges through a system of "group certifications" for groups of small farmers and agricultural operators (cons. 85 and Art. 36), which could result in additional incentives for the creation of new bio-districts.

2.3. Identifying ecoregions: the regulatory framework and issues

Despite the expansion of ecoregions, in most countries, a

[2] See https://www.ecoregion.info/.

[3] For detailed datasets, see in particular, https://ec.europa.eu/eurostat/statistics-explained/index.php/Organic_farming_statistics.

[4] See the AIFOM principles at http://organicresearchcentre.com/manage/authincludes/article_uploads/IFOAMprinciples%20.pdf.

Table 1
Summary of the criteria for identifying an ecoregion according to the current Italian regulatory framework and INNER. Source: authors.

Liguria	Tuscany	Lazio	Sardinia	INNER
Agriculture features				
➢ [organic farmers in the district/organic farmers in the region] ≥ 13%; ➢ [organic farmers in the district/total organic operators in the district] ≥ 75%; ➢ organic farm difference ≥ 4% on the regional average; ➢ biologic Utilized Agricultural Land (UAL) difference ≥ 6% on the regional average; ➢ contiguous area ≤250 Km^2 ➢ territory declared GMO free	➢ biologic Utilized Agricultural Land (UAL) ≥ 30% of total Utilized Agricultural Land (UAL)	➢ protection of traditional production and breeding		➢ biologic Utilized Agricultural Land (UAL) difference ≥ 6% on the regional average; ➢ territory declared GMO free; ➢ area formed by at least two contiguous Municipalities
Other environmental and socio-economic features				
➢ absence of environmental contaminants and sites at risk of contamination; ➢ presence of protected areas and environmental certifications	➢ presence of traditional and suitable products; ➢ solid relationships between organic sector players and other sectors (tourism, environmental protection, etc.)	➢ absence of polluted or to be reclaimed areas; ➢ integration of agricultural activities with other local activities; ➢ use of renewable resources in a non-substitute form for agriculture	➢ presence of valuable organic goods; ➢ presence of solid horizontal and vertical supply chains made by local players	➢ farmers must follow AIAB regulations (more restrictive than current European Reg.); ➢ collaboration by non-agro-food firms
Local public bodies requirements				
➢ to contribute financially; ➢ to provide the operational headquarters	➢ to be committed in land use protection policies, reduction of waste production, environmental protection, promotion of biological production and defence, and development of agro-biodiversity	➢ to be committed in reducing pesticides and to promote the environmental recovery of abandoned excavation areas; ➢ to be engaged in integrated waste management according to the "zero waste" strategy	➢ to support local players in territorial and supply chain planning	➢ to promote the territory and the short chain; ➢ to encourage the creation of organic public canteens; ➢ to carry out study and research activities useful for the consolidation of the district

specific regulatory framework for ecoregions has not yet been introduced, and thus, some relevant aspects are still open to interpretation. For example, the constitutive process, the governance, the territorial requirements for their identification, the characteristics that agriculture must have within them, and the specificities of the relations among the actors of the territory remain formally undefined for ecoregions in several countries (Pugliese et al., 2015b). At the international level, the INNER guidelines represent a common reference that, however, does not formally regulate these aspects.[5]

In this context, the Italian case offers the most comprehensive and detailed regulatory framework on the territorial requisites that an ecoregion must satisfy. As a consequence of the high number of ecoregions located in Italy, some regional administrations (EU NUTS 2) have felt the necessity to autonomously rule this phenomenon to fill the regulatory gap (see Table 1).

The regulatory framework offered by Italian regional administrations, taken as a whole, can be profitably taken into account to draw effective and formal criteria for the identification of ecoregions. In this framework, the focus is first and foremost on low-impact agriculture. In addition, other environmental and socioeconomic context-related factors have been identified, indicating the necessity to adopt a multidimensional approach to define the vocation of a territory to enter an ecoregion.

Some initial studies concerning the identification of ecoregions have been inspired by the establishment of this clear regulatory framework. However, while ecoregions are formally recognized at the institutional and political levels, the academic debate in this field appears to still be at an incipient stage. In this context, the few studies available on the topic focus on the Italian case, since in the international sphere and within the EU, Italy is a leading country. With reference to the Italian case, some research projects has been conducted in the past few years (under the patronage of the Italian Ministry of Agricultural Food and Forestry Policies – MIPAAF) to develop a method to identify the territories best suited for the establishment of an ecoregion. From 2009 to 2011, the "BIO-DISTRICT" and "BIOREG" projects were devoted to studying these exact aspects (Pancino, 2008; Monarca, 2009; Franco and Pancino, 2015).

These projects have promoted a line of research that is extremely relevant for providing regional and local administrations with appropriate analytical tools to assess the vocation of territories to enter an ecoregion and to monitor their performance over time. Nevertheless, these early studies have shown some critical aspects. In particular, the statistical indicators, mainly related to the

[5] See http://biodistretto.net/wp-content/uploads/2016/11/Newsletter_INNER_1_V2.pdf.

biological and environmental features of the territory under consideration, utilized to assess different territories describe the local agricultural productive system from a narrow perspective. This way of conceptualizing the vocation of territories to enter an ecoregion substantially ignores crucial aspects related to the ability of the potential bio-district to function effectively. As previously emphasized, the proper functioning of a bio-district is the result of a context that is able to generate positive externalities because of the embeddedness of different activities and elements strongly related to organic production within the territory, including the culture and behaviours oriented towards a sustainable development model, the high demand for environmentally-friendly goods and services, tourist attractions, and so on. In this view, the biological and environmental characteristics of the territory should not be considered in an isolated way but should be considered as being embedded in the more general economic and social context characterizing the territory. It follows that effectively assessing the vocation of territories to enter an ecoregion requires including in the analysis a wide range of variables related to biological features as well as more general aspects that can effectively feed the economic, social and environmental life of a territory and allow the potential ecoregion to work and grow in an efficient and sustainable way.

To fill the gaps in the literature, this paper proposes a methodological approach to identify potential ecoregions. Specifically, focusing on the case of the Bologna Apennines (Emilia-Romagna Region, Italy), the paper develops a composite indicator – the *Ecoregional Vocation Index* (EVI) – to assess the vocation of territories to enter an ecoregion. In the context in which ecoregions are increasing their role in fostering the dynamics of sustainable development, this methodology is useful for supporting policymakers in making strategic decisions concerning the organization of the territory.

3. Material and methods

This section aims to develop a methodology for the analytical identification of ecoregions. To achieve this purpose, the analysis relies on the illustrative case study of the *Bologna Apennines area*, which is described and discussed to highlight the elements that make it suitable to study the problem of the analytical identification of ecoregions. Subsequently, the methodological approach is developed through the construction of a new index, the *Ecoregional Vocation Index* (EVI), to assess the vocation of territories to enter an ecoregion.

3.1. The case study: Bologna Apennines area (Emilia-Romagna Region, Italy)

3.1.1. Environmental features

The area under analysis covers a territory of 2016.36 km^2 in a predominantly hilly and mountainous environment of the portion of the Tuscan-Emilian Apennines included in the area administered by the Metropolitan City of Bologna (Emilia-Romagna, Italy). There are 29 municipalities with a predominantly rural character and relatively homogeneous morphological characteristics in the territory. In this area, most of the municipalities are also recognized as "internal areas", namely, areas significantly distant from centres offering essential services (education, health and mobility) but rich in important environmental and cultural resources and highly diversified in their nature and secular anthropization processes (MIUR, 2013). These features intuitively suggest that the municipalities within the geographical area under analysis are characterized by similar environmental opportunities for the growth of organic farming and other economic activities (e.g., tourism) that could be well developed through the establishment of an ecoregion with the aim of realizing agreements for the sustainable management of local resources.

3.1.2. Economic features

From an economic standpoint, the geographical area under consideration is already partially characterized by organic production. Indeed, organic farming in this zone consists of 18,689.42 ha of organic Utilized Agricultural Land (UAL) (33% of the UAL), where 24 municipalities out of 29 exceed the 15% threshold of organic UAL (Fig. 1), the value by which the national average is measured (SINAB data, 2019). Organic production in the area seems to now be rooted in the intermediate belt of the central-eastern sector that traverses the territory and is perpendicular to its valleys. Conversely, most of the municipalities less marked by organic production are confined to the northern portion of the area, where the fertile flat land of the Po Valley favours the more intensive exploitation of resources and the proximity to the Via Emilia, the main regional road director, induces a certain degree of urbanization.

3.1.3. Social features

Beyond the environmental and economic characteristics mentioned above, social features represent important factors that define the initial geographical area under analysis. As already emphasized, the notion of an ecoregion assumed in this paper basically adopts an institutional perspective, which concerns the actions and processes oriented to formally recognize areas that prove to meet specific requisites, related to organic farming and agroecological capacities. As previously highlighted (Section 2.1), this perspective assumes a development model that emphasizes the participation of the local community in the processes constituting ecoregions. In this context, the existence of local communities predisposed to cooperate to create an ecoregion plays a crucial role in the preliminary evaluation for territorial planning, as well as in the definition of the scope of a possible ecoregion. Indeed, while the geographical area under consideration in the analysis could be potentially undefined from a technical standpoint, its initial extension (i.e., the number of municipalities included in the analysis) depends crucially on the expression of interest from the relevant stakeholders to constitute an ecoregion since this preliminary requisite that basically has to be met before a technical evaluation of the characteristics of the territories involved can be performed. In short, the initial definition of the extension of the geographical area under analysis depends on the preliminary willingness of the local communities to cooperate with each other to constitute an ecoregion, which is also a fundamental requisite for the effective functioning of the ecoregion over time. This requisite seems to be by and large met in the case of the *Bologna Apennines area*.

Overall, the environmental, economic and social attributes of the 29 municipalities considered seem to favour the genesis of a potential ecoregion, therefore providing an illustrative example for the application of the proposed methodology to a real case study.

3.2. Methodology

This paper aims to propose a methodological approach for supporting policymakers in processes concerning the identification of ecoregions. To this purpose, in this section, we build a new composite indicator – the *Ecoregional Vocation Index* (EVI) – to assess the vocation of territories to enter an ecoregion. Generally, composite indicators (or *indexes*) can be used to describe complex phenomena that are difficult to observe or measure through the adoption of a single variable (see, e.g., Saisana et al., 2005; Fayers

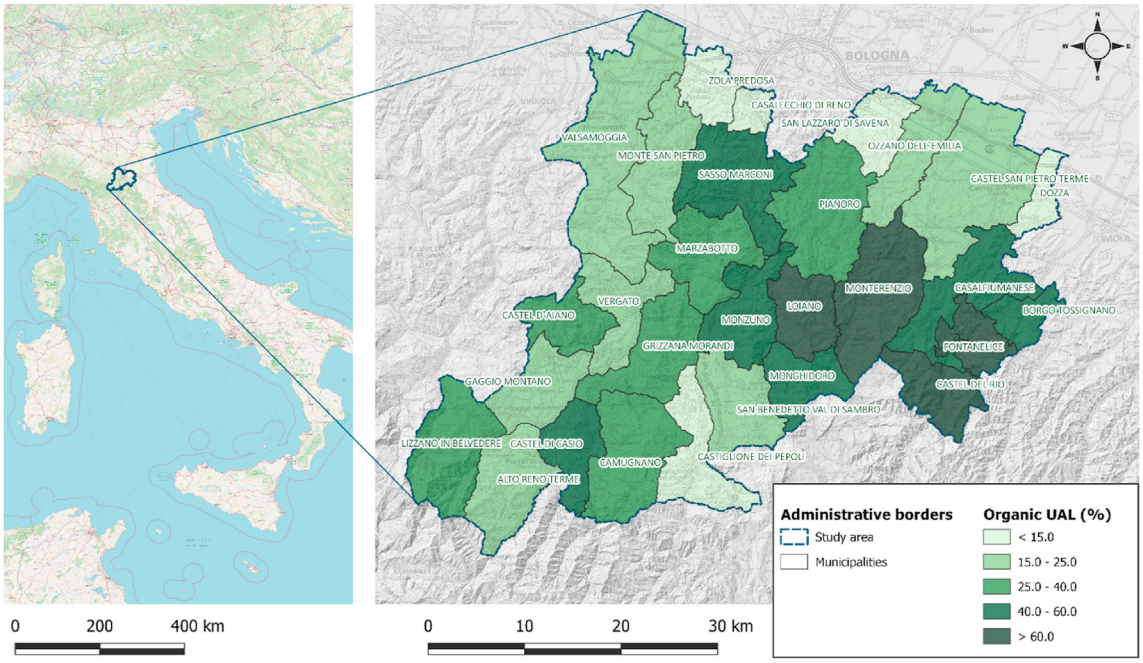

Fig. 1. Location of the study area and detail of the organic Utilized Agricultural Land (UAL) in the Municipalities.

and Hand, 2002, Silvestri et al., 2020). For example, composite indicators are commonly used to compare different countries' performances in terms of ecological footprints, social cohesion, education, health, human rights, technological innovations, competitiveness, or corruption (see, e.g., OECD, 2008). To assess the vocation of a geographical area to enter an ecoregion, we apply the notion of a composite indicator to combine a set of $K = 13$ variables referring to $J = 29$ municipalities, obtaining a ranking that classifies these municipalities from the best to the worst in terms of their suitability to belong to an ecoregion.

A general framework to compute composite indicators is reported in Marozzi (2014). The procedure is based on two main steps:

1. Normalization of the variables
2. Weighting and aggregation

In the first step of the procedure (before performing the aggregation phase), the variables are normalized since they may have different scales and dispersions. Each of the original variables is normalized in the interval (0,1) so that a transformed value tending to 1 is assigned to the best municipality, while a transformed value tending to 0 identifies the worst case. For all other municipalities, the transformed value is a number from 0 to 1. Formally, with X_{jk} representing the value of the kth variable for municipality j, the function for normalizing the kth variable is:

$$\beta\left(X_{jk}\right) = \frac{X_{jk} - \min_j\left(X_{jk}, j = 1, \ldots, J\right) + 1/J}{\max_j\left(X_{jk}, j = 1, \ldots, J\right) - \min_j\left(X_{jk}, j = 1, \ldots, J\right) + 2/J},$$

which corresponds to well-known linear scaling in the min-max range. Note that to avoid $\beta(X_{jk})$ being equal to 0 or 1, which may cause computational inconsistencies in the aggregation step, correction factors $1/J$ and $2/J$ are added to the numerator and denominator, respectively.

In the second step of the procedure, the normalized data are weighted and aggregated by applying an appropriate combination function to obtain the *EVI* for municipality j ($j = 1, \ldots J$). This phase includes the choice of weights to assign to each variable to incorporate their different degrees of importance in the composite indicator and the decision concerning the combination function to adopt. Regarding the choice of weights, we rely on a specific regulatory framework (see Table 1) providing the criteria for selecting variables and attributing them relative weights according to their importance in identifying an ecoregion (see the next section). Regarding the selection of the aggregating function, the main issue is associated with the possibility of influencing the ranking and conditioning the results provided by the composite indicator by changing the equation of the index. In other words, each combination function has pros and cons and can potentially lead to a different ranking of municipalities from best to the worst in terms of their suitability to enter an ecoregion. To control and mitigate this issue, in this analysis, we test four different combination functions to calculate the *Ecoregional Vocation Index* (EVI) to evaluate the robustness of the ranking with respect to changes in the aggregation rules and to assess the reliability of the information provided by the index.[6]

Formally, the normalized data are weighted and aggregated to obtain the *EVI* for municipality j ($j = 1, \ldots J$) according to cth aggregation rule as

[6] The methods used to evaluate the robustness of the ranking (i.e., the *uncertainty analysis*) are usually applied both to the selection of the weighting scheme and the selection of the aggregation rules (see, e.g., Saisana et al., 2005; Marozzi, 2014; Luzzati and Gucciardi, 2015). In our analysis, however, the regulatory framework provides quite clear indications of the importance that, in realty, different variables have in identifying ecoregions, inducing us to refer to those indications in assigning weights to the variables to remain consistent with current practice. At any rate, we aim to provide an evaluation of the robustness of the analysis by assessing the uncertainty associated with the ranking with respect to the change of the combination functions.

$$_c\delta\left(\beta\left(X_{jk}\right), w_k, k=1,\ldots,K\right) = {}_cEVI_j, \quad c=1,\ldots,C$$

where C denotes the number of aggregation methods and w_k denotes the weight assigned to the kth sub-indicator with $\sum_{k=1}^{K} w_k = 1$. We consider $C = 4$ rules of aggregation:

- $c = 1$, Additive rule

$$_1\delta\left(\beta\left(X_{jk}\right), w_k, k=1,\ldots,K\right) = \sum_{k=1}^{K}\beta\left(X_{jk}\right)w_k = {}_1EVI_j;$$

- $c = 2$, Fisher rule

$$_2\delta\left(\beta\left(X_{jk}\right), w_k, k=1,\ldots,K\right) = -\sum_{k=1}^{K}\log\left(1-\beta\left(X_{jk}\right)\right)w_k = {}_2EVI_j;$$

- $c = 3$, Logistic rule

$$_3\delta\left(\beta\left(X_{jk}\right), w_k, k=1,\ldots,K\right) = \sum_{k=1}^{K}\log\left(\frac{\beta\left(X_{jk}\right)}{1-\beta\left(X_{jk}\right)}\right)w_k = {}_3EVI_j;$$

- $c = 4$, Liptak rule

$$_4\delta\left(\beta\left(X_{jk}\right), w_k, k=1,\ldots,K\right) = \sum_{k=1}^{K}\Phi^{-1}\left(\beta\left(X_{jk}\right)\right)w_k = {}_4EVI_j,$$

where Φ^{-1} denotes the quantile function of a standard normal distribution.[7]

The higher the value of the composite indicator (EVI), the higher the suitability of the municipality to enter an ecoregion. The EVI value is then transformed into the corresponding *rank* for each municipality. In this manner, the results of our empirical analysis (Table 3, Section 4) are presented such that rank 1 represents the municipality with the highest EVI in terms of its suitability to enter an ecoregion, while rank 29 identifies the municipality with the lowest EVI.

3.3. Selection of variables

Considering the complex and articulated nature of ecoregions, the percentage of organic Utilized Agricultural Land (UAL) out of the total land area is certainly a significant variable, but it is not sufficient to define the vocation of a territory to enter an ecoregion. As previously highlighted (Section 2.3), to effectively evaluate the suitability of a territory to enter an ecoregion, it is necessary to consider its biological and agricultural peculiarities and the aspects related to the economic and social contexts characterizing the territory that influence the ability of the potential bio-district to work successfully. Building on the existing regulatory framework (Table 1) and relevant literature (Pancino et al., 2008; Monarca, 2009; Franco and Pancino, 2015), a set of 13 quantitative variables have been selected (Table 2) to construct the *Ecoregional Vocation Index* (EVI) as a composite measure to assess the vocation of territories to enter an ecoregion. The data have been obtained from the most updated datasets made available by regional administrations, relevant associations and national statistical agencies (ISTAT); and the data are mainly from 2018, with some exceptions (Table 2).[8]

The variables, measured in each of the 29 municipalities under analysis, take into account the four macro-categories commonly considered in analyses of agricultural districts: agriculture, the environment, society and tourism. The choice regarding the distribution of the weights among the different variables has been made based on the laws and regulations currently in force in order to align our analysis as much as possible with the actual requirements and guidelines posed for the creation of ecoregions (Table 1). Thus, the contributions of the different variables to the total value of the EVI reflect by and large the emphases of the national and international regulations on specific characteristics of ecoregions. For instance, large weights have been attributed to the measures referring to the extension (in absolute and percentage terms) of the organic UAL (accounting for 33% of the total weight), in line with the importance attached to this dimension as a fundamental requisite to create an ecoregion. In addition, the distribution of weights between the EVI variables also reflects the relative importance that can be attributed to each macro-category, of which 60% of the total value of the index is attributed to variables related to *agriculture*, 20% is attributed to *environment* variables, 13% is attributed to *society* variables and the remaining weight is attributed to *tourism* variables. In this framework, the application of the EVI to the specific case considered in this paper (i.e., the *Bologna Apennines area*) relies by and large on the regulations presented in Table 1, which constitute the main regulatory framework currently available for ecoregions. This specific application, however, has to be understood to only be illustrative example. The EVI could be applied to other contexts or countries based on different regulatory frameworks that could possibly emerge in the future. While the application of the EVI to other contexts or countries could entail some adjustments of the variables adopted and their relative weights, the logic behind the proposed methodology is not compromised, making the EVI effectively applicable to different territorial realities.[9] Table 2 shows the set of variables employed to build the EVI for the *Bologna Apennines area*, the units of measure, the sources of the data, the year in which the data were collected,

[7] For a deeper discussion of normalization and aggregation functions, see Arboretti et al. (2007) and Bonnini et al. (2009).

[8] Since the databases we use contain data collected from different temporal periods, we built the EVI by employing slightly different periods of analysis in order to deal with the limited availability of data.

[9] The choice of the variables and of their relative weights is generally an arbitrary decision in studies using composite indicators, manifesting as "a source of contention" (see OECD, 2008, p. 31). While the main advantage of using composite indicators is the possibility to simultaneously consider a wide set of variables (so that the relevance of a specific variable is replaced by the capacity of the index to, overall, describe multidimensional phenomena), there is no fully objective way to select variables and weights that define composite indicators (Saisana and Tarantola, 2002, p. 8). In our case, the weight to be assigned to the variables is by and large "subjective" in nature. This choice is essentially a *political* choice that depends on the relevance that the policy-maker attributes to the different dimensions of an ecoregion, namely, agricultural, environmental, social, and tourism. In other words, the choice of the variables' weights reflects the way in which the public regulator defines an ecoregion in concrete terms. This subjectivity affects the result of the analysis in terms of the municipalities that are suitable to enter an ecoregion, and it cannot be solved through a "technical" approach, reflecting the political nature of the actions oriented to constitute an ecoregion. Accordingly, in order to perform the empirical analysis proposed in this paper, we have chosen a distribution of the weights of the variables that seems to be by and large aligned with the orientation of the public regulator. In any case, the distribution must be understood to be a choice made merely to provide an illustrative example of the application of the methodology. Indeed, alternative weight schemes can be adopted in different analyses and contexts on the bases of the actual emphasis that the policy-maker intends to attribute to the different characteristics of an ecoregion without compromising the effectiveness of the methodological approach we propose for identifying an ecoregion. In short, the weight distribution of the variables is based on the political priorities that emerge from the referential context of the analysis, and for this reason, it is crucial that this choice takes place in a transparent and shared way among the various stakeholders (Saisana and Tarantola, 2002, p. 8).

Table 2
Summary of the variables employed to build the EVI. Source: authors.

Macro-category	ID	Variable name	Unit of measure	Source of the data	Year of data collection	Contribution	Relative weight (w)
Agriculture	a1	Organic UAL	ha	Regional	2018	(+)	0.13
	a2	Organic UAL	%	Regional	2018	(+)	0.20
	a3	Employed in agriculture	%	ISTAT	2011	(+)	0.05
	a4	U40 conductors	Absolute value	ISTAT	2010	(+)	0.06
	a5	Farmhouses	Absolute value	Regional	2018	(+)	0.08
	a6	PDO/PGI companies	Absolute value	ISTAT	2010	(+)	0.07
Environment	e1	Protected area	%	Regional	2018	(+)	0.08
	e2	Per capita waste produced	kg	Legambiente	2018	(−)	0.03
	e3	Recycling	%	Legambiente	2018	(+)	0.09
Society	s1	Per capita income	€	ISTAT and Agenzia delle entrate	2016	(+)	0.06
	s2	Old age rate	Index	ISTAT	2018	(−)	0.03
	s3	Solidarity Purchase Groups (GAS)	Absolute value	Regional	2018	(+)	0.04
Tourism	t1	Tourism rate	Index	ISTAT	2016	(+)	0.07

the contribution (positive or negative) provided by each variable to the value of the index, and the relative weight of each variable.

Since *agriculture* represents the pillar around which the system of an ecoregion must work, a large portion of the chosen variables pertains to this macro-category:

- Organic Utilized Agricultural Land (UAL) (a1 and a2), totally converted or in conversion, has been included to account for the degree of spread of organic crops, considering both relative (%) and absolute (ha) values. In this way, we intend to simultaneously evaluate both the degree of specialization towards biological production and the concrete role that the single unit can play in the entire area in terms of its production contribution;
- The number of people employed in agriculture (a3) has been chosen to account for the importance of the primary sector in creating employment;
- The presence of young farmers, approximated by the number of conductors, U40 (a4), has been chosen as a proxy for measuring the dynamism of the sector;
- The number of farmhouses (a5) has been included to account for the level of multifunctionality of the primary sector in relation to the ability of the organic district to act as a tourist enhancement tool;
- The number of PDO/PGI companies (a6) has been chosen to account for the attitude towards quality agri-food production, an issue often associated with the demand for organic products in the form of typical and short supply chain demand.

In assessing the *environment*, we wanted to assign importance not only to the purely territorial characteristics but also to the indicators of ethics and the environment, which are more subject to changes in sustainable policies and are therefore of greater interest for short-term monitoring. Accordingly, the following variables have been included:

- The protected area (e1), which summarizes the naturalistic, environmental and landscape qualities. E1 considers the share of a territory subject to protection according to the main European directives (92/43/EEC, 2009/147/EC) and the national framework law (91/394)/
- The amount of per capita waste produced (e2) accounts for the (negative) environmental impact generated by the local community.
- Recycling (e3) – representing the percentage of waste produced subject to forms of differentiation – is taken as an indicator of the commitment of the local municipal administration to reduce environmental impacts on its territory.

Among the variables that capture the *socioeconomic* characteristics of communities, the following were considered:

- per capita income (s1) is a general and all-inclusive indicator of the economic well-being of local communities;
- the old age rate (s2) – calculated as the ratio between the population over 65 years old and the population under 14 years old – is a proxy of the degree of dynamism of local communities;
- Solidarity Purchase Groups (GAS) (s3), which account for the existence of ethical consumer networks.

Finally, the *tourism* rate (t1) – calculated as the ratio between the total number of beds in accommodation facilities and the number of residents – has been included to account for the current attitudes of local communities towards welcoming tourists.

4. Results and discussion

In this section, the *Ecoregional Vocation Index* (EVI) is applied to analyse the 29 municipalities of the Bologna Apennines area and to identify the different levels of suitability of these territories to enter an ecoregion.

4.1. EVI ranking and an evaluation of its robustness

The main results of the application of the EVI to the Bologna Apennines area are exhibited in Table 3. The table shows the EVI-based rankings according to the four combination functions considered in the analysis, where rank 1 represents the municipality with the highest value in terms of its suitability to enter an ecoregion and rank 29 identifies the municipality with the lowest value. A summary measure of the suitability of each municipality to belong to an ecoregion is represented by the average ranking, which is obtained by calculating the average of the ranks realized by municipalities for each combination function. Moreover, by considering the minimum and the maximum ranks obtained by municipalities in the different aggregation functions, it possible to assess the level of robustness of the rankings obtained. Indeed, by examining the uncertainty interval corresponding to each municipality, we can understand whether the selection of a particular aggregation method will or will not affect the results regarding the suitability of a particular municipality to enter an ecoregion. Fig. 2 reproduces the uncertainty interval between the minimum value and the maximum value of the rank of each municipality, while the average rank is represented by the dot. The wider the uncertainty interval, the less robust the EVI ranking to the aggregation function of the index. The chart shows that the EVI-based ranking of

Table 3
Rankings of municipalities according to the EVI. Source: authors.

		Additive rule	Fisher rule	Logistic rule	Liptak rule	Minimum rank	Maximum rank	Average rank
High	Valsamoggia	1	3	1	1	1	3	**1.50**
	Casalfiumanese	3	1	2	2	1	3	**2.00**
	Loiano	6	2	3	3	2	6	**3.50**
	Monterenzio	2	5	7	6	2	7	**5.00**
	Monte San Pietro	8	7	4	4	4	8	**5.75**
Medium-high	Sasso Marconi	5	10	6	5	5	10	**6.50**
	Borgo Tossignano	10	4	5	7	4	10	**6.50**
	Castel del Rio	4	6	11	8	4	11	**7.25**
	Fontanelice	7	8	9	10	7	10	**8.50**
	Pianoro	9	14	8	9	8	14	**10.00**
	Marzabotto	11	11	10	11	10	11	**10.75**
Medium	Monzuno	13	13	13	14	13	14	**13.25**
	Lizzano in Belvedere	14	9	15	15	9	15	**13.25**
	Ozzano dell'Emilia	15	15	12	12	12	15	**13.50**
	Castel San Pietro Terme	12	16	14	13	12	16	**13.75**
	San Lazzaro di Savena	16	19	16	16	16	19	**16.75**
	Monghidoro	17	18	20	18	17	20	**18.25**
Medium-low	Castel di Casio	19	17	18	20	17	20	**18.50**
	Camugnano	18	21	19	19	18	21	**19.25**
	San Benedetto Val di Sambro	21	23	17	17	17	23	**19.50**
	Casalecchio di Reno	20	12	26	25	12	26	**20.75**
	Grizzana Morandi	22	22	22	21	21	22	**21.75**
	Vergato	25	25	21	22	21	25	**23.25**
Low	Zola Predosa	23	20	25	26	20	26	**23.50**
	Castel d'Aiano	24	27	23	23	23	27	**24.25**
	Gaggio Montano	26	26	24	24	24	26	**25.00**
	Dozza	27	24	29	29	24	29	**27.25**
	Alto Reno Terme	28	28	28	28	28	28	**28.00**
	Castiglione dei Pepoli	29	29	27	27	27	29	**28.00**

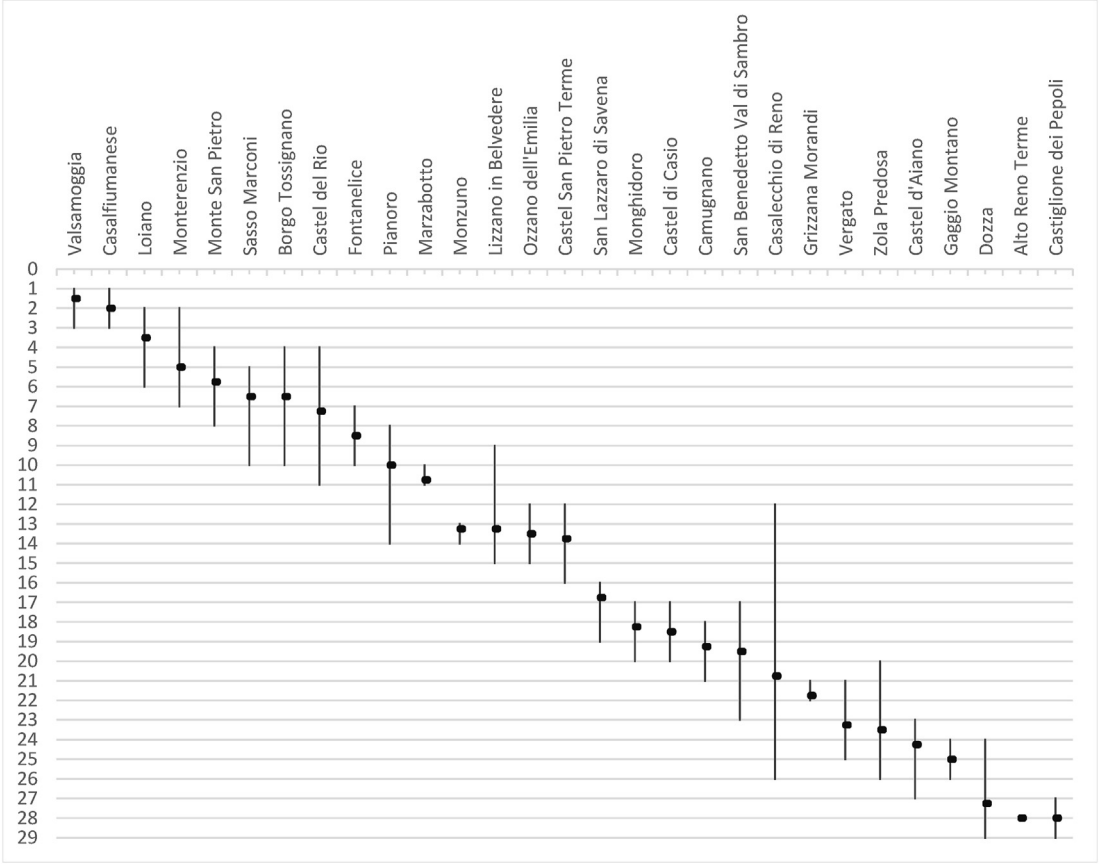

Fig. 2. Uncertainty intervals for EVI rankings. Source: authors.

municipalities is robust for several municipalities. In fact, the bands generally tend to be narrow. However, there are some exceptions, where the choice of a particular aggregation method over another substantially affects the result regarding the suitability of a particular municipality to enter an ecoregion. The most blatant example is *Casalecchio di Reno*, where the band covers 14 positions (from rank 12 to rank 26).[10]

4.2. EVI ranking and the identification of an ecoregion

By dividing the average EVI ranking into five potential categories on the basis of the quintiles of the distribution, corresponding to *high*, *medium-high*, *medium, medium-low* and *low* performances, it is possible to draw some conclusions regarding the municipalities characterized by similar conditions with respect to their vocation to constitute an ecoregion.[11] In particular, the first 11 municipalities of the ranking (i.e., those characterized by *high* and *medium-high* EVI performances) describe a relatively homogeneous territory potentially suitable for hosting an *ecoregion*.

However, the area identified by the 11 best-performing municipalities has to be considered to be an example of a potential ecoregion identified through the EVI.[12] In line with the bottom-up approach inspiring the functioning of ecoregions (Section 2.1), this methodological approach has to be understood as a preliminary informative base to inform the discussion on the effective conditions for creating an ecoregion among the relevant stakeholders. In this perspective, the EVI result appears to be extremely useful for identifying the existence (or not) of geographical areas characterized by homogeneous performances and opportunities.

To this purpose, it is useful to represent the EVI ranking in the geographical space (Fig. 3). In this way, an indication of the geographical proximity among municipalities that have similar performances can be obtained, which constitutes key information for the creation of potential ecoregions. In the specific case analysed in this paper, we consider, for instance, that the 11 best-performing municipalities – occupying the intermediate belt of the study area, running transversally from northwest to southeast –not only have the best EVI results but are also geographically contiguous (Fig. 3). In this view, the case of the Bologna Apennines provides a good example of how the EVI methodological approach can be profitably applied for the analytical identification of ecoregions and can support policymakers in the participatory process for strategic territorial planning.

As a general rule, we suggest that geographically contiguous municipalities characterized by relatively high EVIs constitute an ideal scenario for opening dialogue between relevant stakeholders to create an ecoregion. Indeed, these results reveal the existence of economic, social and environmental conditions for drawing mutual benefits from the creation of an ecoregion across different municipalities. In this perspective, the EVI framework provides information on the existence of effective rationales for creating a participatory space for different stakeholders to share their ideas and perceptions concerning the establishment of an ecoregion. This participatory space could consist, for instance, of creating appropriate focus groups expressly arranged by the government. In short, the EVI map constitutes an analytical outcome that can be used by the relevant local governments to share their views on the opportunities associated with the creation of an ecoregion within and outside the public administration. Given the multidimensional nature of the EVI, the strategic territorial planning processes can simultaneously take into account different criteria (i.e., agricultural, environmental, social, and tourist), which are all relevant from a regulatory perspective, for identifying ecoregions.

4.3. The analysis of the EVI macro-categories

As discussed above (Section 3.3), the EVI considers four different macro-categories of reference for analyses of agricultural districts: agriculture, the environment, society and tourism. Each macro-category represents a particular aspect captured by the EVI by which a municipality is evaluated regarding its suitability to enter an ecoregion. From this perspective, it is also useful to examine the information provided by each macro-category separately (Fig. 4).

First, it is interesting to note that the *agriculture* macro-category exhibits a picture in which the municipalities suitable to enter an ecoregion are slightly different from those obtained considering merely the organic Utilized Agricultural Land (UAL) (Fig. 1). Despite the weight attributed to the organic UAL in this macro-category (and more generally in the calculation of the EVI) being high, some municipalities with a high organic UAL are penalized when considering other variables that are relevant for the functioning of an ecoregion, such as the number of people employed in agriculture, young farmers, farmhouses and PDO/PGI companies. This result essentially shows how adopting a complex measure for identifying ecoregions allows one to better consider the potential of municipalities that would otherwise be ignored. For instance, *Valsamoggia* exhibits a quite high performance in agriculture despite the organic UAL of this municipality being low. Generally, the results obtained considering the *agriculture* macro-category in an isolated way do not differ substantially from the results of the EVI, mainly due to the high relative weight that this macro-category has in the calculation of the EVI (accounting for almost 60% of the total value of the index). There are, however, some exceptions that reflect additional dimensions that go beyond agriculture that the EVI considers to be relevant for evaluating the suitability of a territory to enter an ecoregion. These exceptions are specifically the cases of *Monte San Pietro* and *Marzabotto*, where the high EVI performances seem to be attributable, in particular, to the *environment* and *society* macro-categories.

With respect to the *environment* macro-category, it is interesting to highlight that the best results tend to be reached in the northern part of the study area, namely, the area next to the Po Valley, which includes some of the most urbanized municipalities, such as *San Lazzaro di Savena*, *Casalecchio di Reno*, and *Zola Predosa*. This trend

[10] The uncertainty of the result when using different combining functions is a rather common issue in analyses adopting composite indicators. This uncertainty can mislead decisions concerning the affiliation of a municipality to an ecoregion (as in the case of *Casalecchio di Reno* in our analysis). However, this uncertainty does exist, and we believe that it cannot be ignored. A prime advantage of using different combining functions is to make this kind of uncertainty transparent, allowing us to show the possible spaces to manipulate the indexes' results, which can be preferred over ignoring the problem. Furthermore, using different combining functions allows us to obtain a final ranking that is the average of the results of different combining functions, which, given the uncertainty, can be preferred over relying on only one formula. In light of these arguments, the uncertainty generated from using different combining functions does not generally compromise the use of the results, as confirmed in a number of studies adopting the methodology to analyse the uncertainty generated from using different combining functions (see, e.g., Luzzati and Gucciardi, 2015; Di Tommaso et al., 2017; Di Tommaso et al., 2020).

[11] Note that by dividing the distribution based on the quintiles, each performance category includes six municipalities, with the exception of the first quintile corresponding to *high* performance, which includes only five municipalities because the total number of municipalities cannot be divided equally.

[12] From a technical standpoint, there is no formal rule to categorize the ranking based on the different performances (e.g., we could adopt quartiles instead of quintiles) and to define what performance threshold is suitable for determining municipalities within and outside an ecoregion (e.g., we could include medium performance municipalities instead of considering only municipalities with high- and medium-high performances suitable for inclusion in the ecoregion). Since choices related to the performance threshold affect the definition of the municipalities included and excluded from the ecoregion, the EVI ranking cannot be interpreted as a methodological tool providing a "ready-to-use solution" for identifying the borders of an ecoregion.

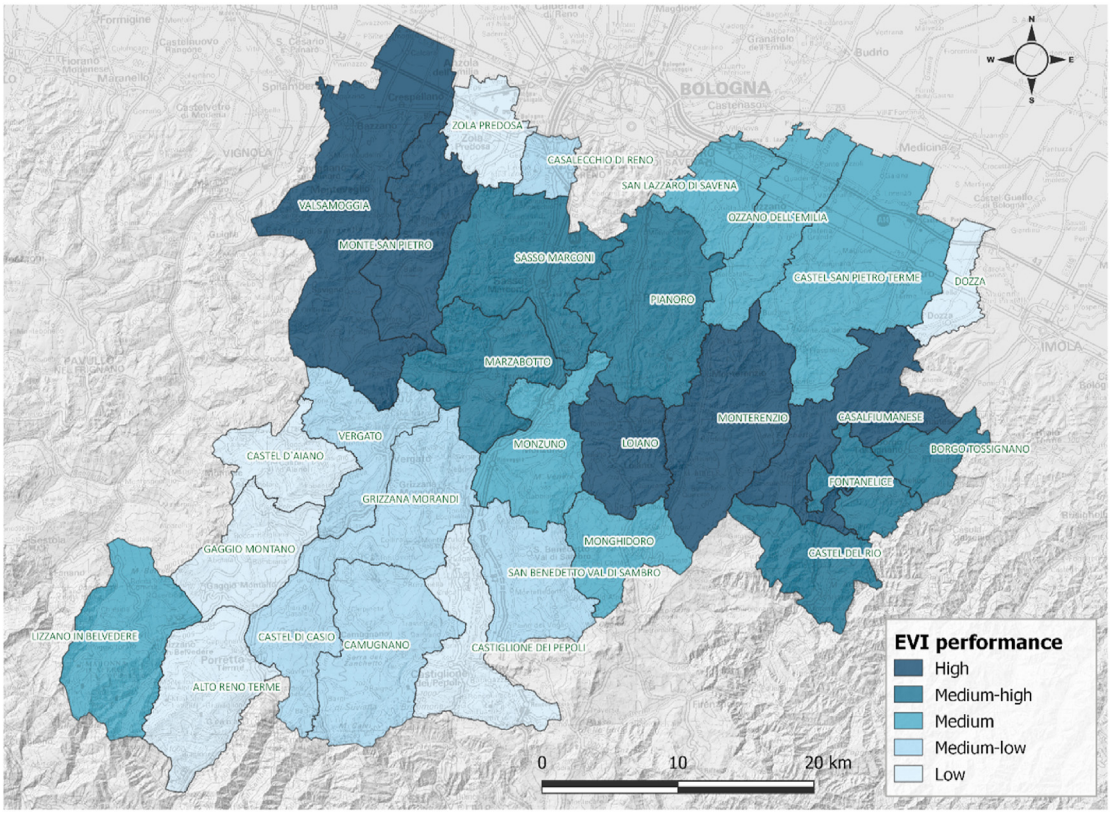

Fig. 3. Map of the Bologna Apennines Municipalities according to the EVI performances. Source: authors.

indicates that even though this macro-category includes variables that take purely naturalistic aspects into account (such as the percentage of protected area), this sub-index seems to not ignore virtuous urban dynamics (such as the percentage of recycling). Comparing the results of the *environment* with the EVI results, it is interesting to note that the municipalities with high performances in this specific macro-category are not necessarily included in the set of municipalities with EVI high and medium-high performances, signalling that *environment* is important but does not determine *per se* the overall EVI results.

The *society* macro-category shows significant differences in the performances of northern and southern areas, with the latter, which is mainly mountainous, characterized by the poorest results. Also, in this case, the results obtained by considering the macro-category in an isolated way differ from the EVI results for some municipalities. For instance, *Zola Predosa*, *Casalecchio di Reno*, and *Ozzano dell'Emilia* exhibit high performances in *society* but are not included in the best performing municipalities according to the EVI.

Conversely, regarding the main trends generally exhibited by the other macro-categories, the *tourism* sub-index indicates that the mountainous area includes the municipalities with the best tourism performances. In these municipalities, tourism is evidently more developed than in the northern area, making the map related to *tourism* rather different from that formed using the EVI.

Generally, the results of the EVI differ from the results obtained for each macro-category separately considered, which reveals the effectiveness of the EVI approach in providing a more comprehensive evaluation of the suitability of territories to enter an ecoregion considering its biological and environmental features, as well as the crucial aspects related to the economic and social contexts characterizing the municipalities that influence the ability of the potential bio-district to work successfully. In addition, the separate analysis of the EVI macro-categories allows also one to identify the potential divergence in the necessities faced by the municipalities in meeting the requisite for creating an ecoregion. For instance, though a particular area under analysis could be overall identified as suitable to enter an ecoregion, some municipalities within this area could have weaknesses in specific macro-categories, which could be targeted by policymakers as possible priorities for increasing the general performance of the potential ecoregion.

5. Final remarks

Ecoregions, or bio-districts, have received growing interest in recent years as an instrument for sustainable and rural development. Ecoregions have been implemented in 60 countries, and other countries, such as Albania, Senegal and Morocco, have made recent requests for technical assistance (Assaël and Orefice, 2016).

In Italy, four NUTS 2 regions have deliberated on local regulations for the identification of ecoregions, in some cases referring to the inspiring guidelines published by INNER. In all these regulatory frameworks, the focus is on low-impact agriculture, accompanied by other environmental requirements. In addition, other context-related factors have been identified as crucial for the functioning of an ecoregion. This perspective is consistent with a large body of literature on industrial districts, which highlights that a key for successful productive areas is the bulk of the habits and traditions and the existence of relationships of trust among local actors (Brandi and Moretti, 2013), which means that the analyses concerning the identification of an ecoregion must involve further elements related to the socio-economic features of the territories.

Following this line of research, we propose the calculation of a composite indicator (EVI) to comprehensively assess the vocation

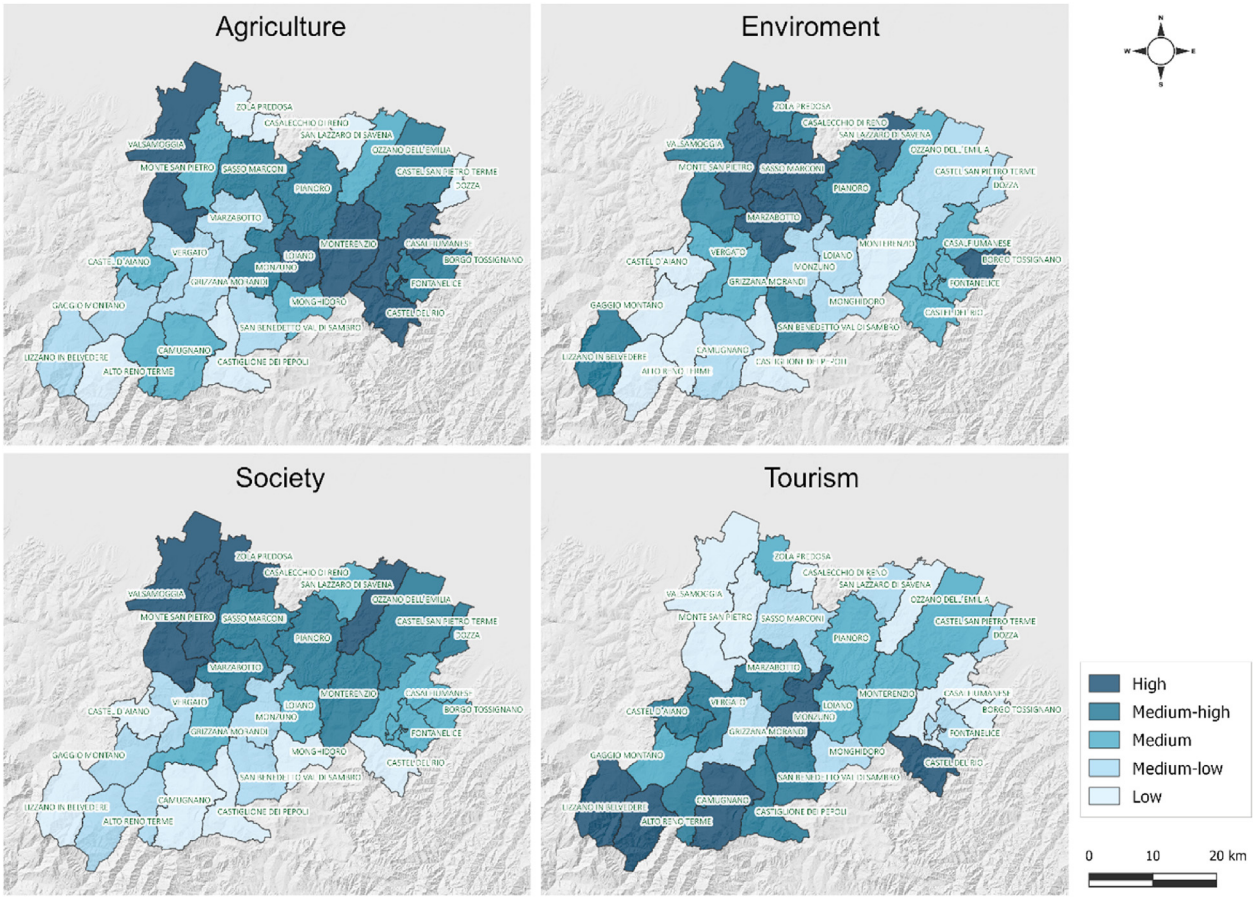

Fig. 4. Map of the Bologna Apennines Municipalities according to the different EVI components. Source: authors.

of territories to enter an ecoregion. As an illustrative example, the EVI has been employed to identify a potential ecoregion in the Italian North-Eastern Apennines. Our analysis has shown that the most suitable area for establishing a new ecoregion is not established merely by the set of municipalities with the highest percentages of organic UAL. By reflecting not only the primary productive sector issues but also the environmental, social and other production variables, such as tourism, the proposed EVI seems to be a more complete instrument for policymakers.

In short, there are two main policy implications behind the adoption of the EVI framework. First, it stresses that the discussion and choice concerning the creation of ecoregions should start by considering a rigorous informative basis regarding the characteristics of the territories that is able to determine the effective suitability of the territories to enter an ecoregion. Second, the adoption of the EVI framework assumes that conditions for establishing ecoregions should be assessed from a comprehensive perspective that considers the agricultural features of territories, as well as other environmental, social and economic attributes. From this perspective, the EVI seems to provide a useful informative base for supporting policymakers and other relevant stakeholders in the discussions and participatory processes concerning the creation of ecoregions.

Further explorations in this field could be devoted to testing the EVI on other relevant case studies to additionally test the effectiveness of this methodological approach. Moreover, future research could be performed to apply the EVI for different purposes, including evaluating the performance of different territories in terms of their achievement of SD goals over time. This seems to be a promising way to further develop the methodological tools available to policymakers for monitoring and planning the sustainable development of territories.

CRediT authorship contribution statement

Marco Assiri: Conceptualization, Writing - original draft, Visualization. **Vincenzo Barone:** Conceptualization, Data curation, Writing - original draft. **Francesco Silvestri:** Conceptualization, Project administration, Supervision, Writing - original draft, Writing - review & editing. **Mattia Tassinari:** Conceptualization, Writing - original draft, Data curation, Formal analysis, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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