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Landscape Economic Value for territorial scenarios of change: an application for the Unesco site of Langhe, Roero and Monferrato

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Abstract

The present paper focuses on the issues related to the economic value of landscape and the role of indicators and indices systems. The aim of the study is the definition of a synthetic index of Landscape Economic Value (LEV) through a system of economic indicators, to measure the attractiveness of Vineyard Landscape of Langhe-Roero and Monferrato (IT), recently included in the UNESCO World Heritage List (2014). Furthermore, the synthetic index is employed in a dynamic transformation model that works in a cluster system of municipalities, where the Landscape Economic Value acts as an attractor factor generating people flows. The results obtained by the evaluation model might be an innovative proposal to define development territorial scenarios in decisional making-processes.

Keywords: Indicators and indices; Dynamic model; Landscape planning and management; Complex environmental system

1. Introduction

Landscape assumes a renewed meaning in comparison with the aesthetic concept belonging to both the cultural and normative scenarios of early years of the twentieth century. The European Landscape Convention revolutionizes the landscape definition, extending it to the whole territory, as perceived by populations, “whose character derived

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from action and interaction of natural and human factors" (ELC, 2000). Nowadays, the territory is conceived as a complex entity, so the adoption of an integrated approach is required to manage sensitive territorial systems.

Literature shows many economic contributions on the subject, despite the fact that they tend not to attribute a monetary value to landscape. The economic definition of value is based on the rationality of users, who choose among a series of alternatives, according to their individual preferences. Such a choice translates into Willingness To Pay (WTP) for an improvement or Willingness To Accept (WTA) as a compensation for the degradation: both are the main measures used in the economic evaluation of landscape (Stellin & Rosato, 1998; Van der Heide & Heijman, 2012). The Economic value of landscape depends on structural components, as well as on the users' different perceptions, making the empirical measurement more difficult, even if both a multidisciplinary convergence and an integrated approach facilitate the analysis (Cassatella & Peano, 2011).

The aim of the present paper is to define the economic value of the UNESCO site "Vineyard landscape of Piedmont: Langhe-Roero and Monferrato", employing a system of economic indicators, that comes to a synthetic index of attractiveness. Such synthetic index will be employed in a dynamic transformation model that works in a cluster system of municipalities belonging to the UNESCO site, in order to investigate the trends over time of how attractiveness affects people flows. The integration of the results obtained from both evaluation models might be considered a proposal for decision making processes, aiming to the definition of territorial scenarios future developments.

2. Landscape economic indicators

The economic activities related to the territorial use and transformations generate impacts and effects on landscape. Landscape can be considered as an externality, as a result of favorable and unfavorable effects, brought about by an individual's production and consumption by the production and consumption on another individual, without any monetary transaction between them, in order to balance costs and benefits of these effects (Marangon & Tempesta, 2008).

For public goods, such as environment and landscape, market prices either do not exist or only capture a small part of the total value. It has been generally agreed that the Total Economic Value (TEV) approach is suitable to dealing with the economic valuation of environmental and landscape goods (Pearce & Turner, 1990). The Total Economic Value (TEV) is the result of the use and non-use values of a good: The use value is the sum of the direct use (revealed preferences), indirect use (stated preferences, hypothetical markets), while the non-use value is given by resources unrelated to a current, future or potential use (existence value and bequest value). Both value components produce the option value, that is the potential for a good to be available in the future (Pearce & Turner, 1990). In economic terms, landscape is a public good available to the whole society in a limited quantity, due to an inefficient resources allocation (Santos, 1998). Estimation tools establish and evaluate the economic value starting from the predictable benefits of use and transformation actions of landscape, as well as the efficiency and efficacy of the public expense for landscape interventions.

Among the methods to estimate the economic value of landscape, a very important role is performed by economic indicators systems (Bottero, 2011). Economic indicators can be divided into monetary and non-monetary: monetary indicators refer to the methods of economic evaluation such as the choice of certain categories related to the maintenance and development costs of landscape (such as costs-opportunities analysis), the demand of the same good, as well as WTP or WTA in terms of use or non-use of landscape; while non-monetary indicators are both quantitative, based on the expert opinion about tangible features of landscape, or qualitative, related to the level of satisfaction of the users about intangible aspects, encouraging the integration with the territorial policies (Marangon & Tempesta, 2008).

3. Application

3.1. Case study

"Vineyard landscapes of Piedmont: Langhe-Roero and Monferrato" is a suggestive context of Southern Piedmont, that covers a territorial surface of 10.789 hectares, between the Po river and the Ligurian Appennines, stretching across the province**s** of Alessandria, Asti and Cuneo. The site is characterized by a singular hill**y** conformation, modeled by the local communities for centuries, and by the vineyards, a symbol of the cultivation and production of the most important national and international wines; and, at the same time the culture of wine pervades all sectors, from economy to everyday life, from gastronomy to literature.

The area of Langhe-Roero and Monferrato represents a living cultural landscape. Thanks to the features of integrity and authenticity, on 22th of June 2014 it was included in the UNESCO World Heritage List (WHL). Furthermore the vineyard landscape was nominated in the category “landscapes in evolution”, that is expression of both tangible and intangible memories of an evolution process still in act. The candidacy of the Site started in the early 2000**s**, but only in 2006 were the vineyard landscape and settlements involved (UNESCO, 2014). In 2008 a protocol of agreement was signed between public and local actors, by which the candidacy dossier was produced.

The core zones represent the exceptional universal value: “Langa of Barolo” (core 1) is a singular geomorphological context, where the companies of famous wines have been developed; “Grinzane Cavour Castle” (core 2) is **a** ~~an~~ historical castle with an experimental vineyard of **E**uropean rank; “Hills of Barbaresco” (core 3) is known for social-productive companies of Barbaresco wine; “Nizza Monferrato and Barbera” (core 4) are medieval commercial settlements with strong links among winemakers associations; “Canelli and Asti spumante” (core 5) is characterized by several architectural, urban and industrial evidences about the cultivation and production of wine; “Monferrato of the Infernot” (core 6) are characterized by vernacular architectures inside geomorphologic conformations, known as *infernot,* for the storage of wine. The buffer zones consist in protection areas of the UNESCO site: the perimeter resumes Units of Landscape, that are a specification of Ambits of Landscape, both provided by the Landscape Regional Plan of Piedmont Region. There are 30 Units of Landscape in the UNESCO site, submitted to specific lines and protection provisions. So the buffer zones, following the homogeneous territory characteristics, facilitate the integration of several elements: from the viticulture to the production of wine, from the conservation to the commercialization of the product (UNESCO, 2014).

3.2. The system of indicators

The starting point of this study consists in the definition of a system of economic indicators, finalized to achieve a synthetic index of Landscape Economic Value (LEV) that measures the attractiveness of vineyard landscape. The system of indicators has been identified considering four macro-indicators, for each of which the main economic elements of landscape have been selected, namely “Agriculture”, “Tourism”, “Real estate” and “Forestry”. These also arise from the relevant literature in the domain of economic evaluation of landscape (OECD, 2001). Firstly data are collected for each municipality belonging to the UNESCO site and then they are related in a matrix with macro and micro indicators (see Table 1). Successively the municipal data are reorganized in a cluster system, resuming core and buffer zones of the UNESCO site.

Table 1. The system of economic indicators and their micro-indicators to calculate LEV for both municipalities and cluster system.

Agriculture	u	Tourism	u	Real estate	u	Forestry	u
Agricultural farms	*No.*	*Arrivals*	*No.*	*Real estate market value*	*€/m^2*	*Forest surface*	*m^2*
Bio farms	*No.*	*Presences*	*No.*	*Agricultural value*	*€/ha*	*Forest farms*	*No.*
DOP/IGP farms	*No.*	*Total beds*	*No.*				
Utilized agricultural surface	*m^2*	*Sleeps farmhouse*	*No.*				

3.3. Aggregation and results

The second step concerns the standardization of the indicators related to the different clusters in a common scale in order to aggregate non commensurable items. For the standardization, the formula (1) has been used:

$$i_i = x_i / x_{\max} \quad (1) \qquad I_j = \sum_{i=1}^{n} i_i * w_i \quad (2)$$

where i_i is the standardized value of the indicator, x_i is the original value and x_{max} is the maximum value of the indicator in the data set. The subsequent steps of the evaluation concern the weighting of the indicators and the final aggregation into a single index. The aggregation formula to reach partial indices is represented by equation (2), where I_j is the partial index of macro-indicators, i_i is the standardized value of i-th indicator and w_i is the weight of i-th indicator. The final index of the Landscape Economic Value is obtained by further aggregation of the partial indices as follows:

$$\mathrm{LEV} = \mathrm{y1} * \mathrm{A} + \mathrm{y2} * \mathrm{T} + \mathrm{y3} * \mathrm{RE} + \mathrm{y4} * \mathrm{F} \quad (3)$$

where *A*, *T*, *RE* and *F* represent the partial index of the Agriculture, Tourism, Real Estate and Forestry macro-indicators, respectively, and *y1*, *y2*, *y3* and *y4* are the relative weights.

Mention has to be made of the fact that the weights for the aggregation have been determined by the application of the Analytic Hierarchy Process (Saaty, 1980) within a panel of experts that have been questioned about the importance of the different economic elements of landscape.

Figure 1 illustrates the results of the calculations made for the Langhe-Roero and Monferrato landscape: figure 1(a) shows LEV values obtained**,** the first time**,** for core and buffer zones, figure 1(b) represents LEV values per square kilometer, considering the territorial surface of each cluster: at first the most attractive cluster is buffer 1, because of the size of the cluster, the second time only core zones are considered, so the most attractive cluster is "Canelli and Asti Spumante" (core 5) with 0,0023/km^2.

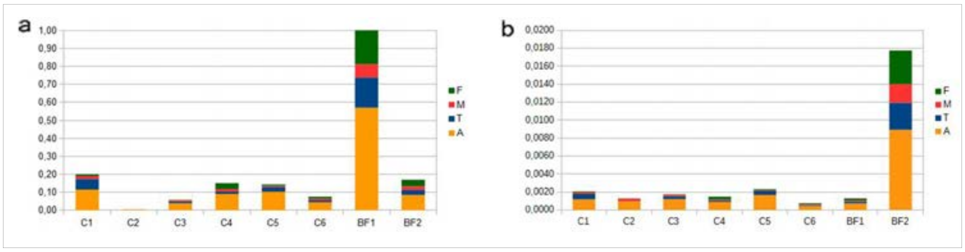

Fig. 1. (a) Original values of the LEV for core and buffer zones; (b) LEV per square kilometer for core and buffer zones

4. Model of population dynamics

4.1. Methodological framework

The mathematic models of Lotka-Volterra are systems of differential equations that study the population dynamics in a structure of territorial poles, whose interactions generate the attractiveness, which is not only expression of economic, social and cultural resources of a certain landscape, but also the mobility, in terms of distances of the territorial poles. The application of a dynamic model investigates the mobility of residents in a territorial system according to the attractiveness, considering different temporal scales that determine definitive or temporary movements (Monaco & Servente, 2006).

The p_i element indicates the number of people being in the center *i*, without considering the effective residents in the same. In the present study, the parameters of attractiveness mean the appeal that the economic value of landscape exerts on people. Supposing that the variation of the populations *i* depends by itself on a logistic law, another term will be added, considering the attractiveness perceived by populations *j* toward center *j*. Associating p'_i

with the derivative, in relation to the time of population of generic center *i*, we will have a differential system of N equations, where the index *i* changes from 1 to N. At the first member the logistic term will recognize after the equal sign that depends on the threshold value s_i to give the carrying capacity of the center $_i$. At the second member of the equation, for the population *i* will be extended to all populations $j \neq i$ from the population *i* and it will be proportional, through the coefficients of attractiveness A_{ii} at the same p_j communities.

This model has a mathematical structure of Lotka-Volterra models with the term of linear interaction of cooperative type. The model shows only one solution of stable balance.

The parameters A_{ij} can be defined as Malthusian terms and considering the logistic ones like classic models of Verlhust for every population p_i. To simplify, the terms are indicated with A_i (Monaco & Servente, 2006).

The parameter A_{ij} is the distance factor among the centers *i* and consists in an attenuation factor of the attractiveness that obstructs the mobility. A possible modeling of the parameters A_{ij} is given by:

$$A_{ij} = B_{ij} \cdot \frac{1}{1 + bd_{ij}^2} \tag{4}$$

where B_{ij} are parameters of pure attractiveness of center *i* from the population *i*, without considering the negative perception that the distance exerts on the same population, while $b>0$ is a territorial factor of scale. The determination of *b* is given by an expansion in a polynomial of Taylor, supposing both centers at the maximum distance, leading the reciprocal attractiveness to zero. This hypothesis can be considered if it is assumed to be marginal compared with the overall mobility phenomena in the territory, where the two centers are situated at the maximum distance.

Retaining this hypothesis as valid, the model takes the form of equation (5). In conclusion the coefficients A_{ij} will be determined by the following formula, where d_M is the maximum value of distance among the poles (6), while for B_{ij} coefficients the relationship between the attractiveness of pole *i* and *j* will be used (7).

$$p'_i = A_i p_i \left(1 - \frac{p_i}{s_i}\right) + \sum_{j=1, j\neq 1}^{6} \frac{A_i}{A_j}\left[1 - \left(\frac{d_{ij}}{d_M}\right)^2\right] p_j \tag{5}$$

$$A_{ij} = B_{ij} \cdot 1 - \left[\left(\frac{d_{ij}}{d_M}\right)^2\right] \quad (6) \qquad B_{ij} = \frac{A_i}{A_j} \quad (7)$$

All the coefficients of attractiveness are normalized in the interval [0,1] in order to increase the attractiveness of center *i* because of its strength. In the present study we consider the core zones of the UNESCO site as centers and the mathematical model is important to investigate about their economic attractiveness. The data used in the calculation are:

- Maximum distance (d_M): the maximum distance is between “Grinzane Cavour” (core 2) and “Rosignano Monferrato” (core 6), equal to 56,7 km;
- Threshold value: it is given by the product of territorial surface of every core and the major density in the territory, considering a density of 600 inhabitants/km^2, because the major value of density is Grinzane Cavour with 526 inhabitants/km^2;
- LEV value normalized among core zones (LEV/km^2)
- Reciprocal distances: the model includes the reciprocal distances dd (*i*,*j*)=dd (*j*,*i*)
- Observation time: it is considered with an arbitrary unity of measure (t=1,5), when the system achieves the balance;
- Fund of scale: a value for the ordinates, equal to 0,35.

4.2. Results of experimentation

The results of the dynamic model illustrate the progress of attractiveness of each territorial pole system, in terms of percentage of population movement:

- the pole 1 starts with 11% and finishes with 16%, showing a maximum;
- the pole 2 starts with 6% and ends with 16%. It presents also a maximum;
- the pole 3 has a growth of 8% and show also a maximum; while the pole 4 presents a decrease of 11%, showing a point of minimum.
- the last poles do not have maximum or minimum because they do not perceive the attractiveness. Pole 5 starts with 33% and ends with 19%, while pole 6 starts from 5% and goes to 15%.

The result is dominated by the logistic behavior being in the first term after the equal sign. Therefore the asymptotic behavior toward the balance is dominated by the effect of the dynamic**s** of the populations. The second term, after the equal sign, is dominated by attractiveness of population *j* toward the pole *i*. This effect is perceived in little periods of time. The core zones 1 – 4 show points of maximum and minimum, owing to the effect of the attractiveness. Successively the logistic effect prevails and the population accommodate to the asymptotic value. The core zones 5 and 6 do not perceive the effect of attractiveness, showing graphically a monotone curve: the first one because of the high number of inhabitants, while the second one for the low value of attractiveness.

5. Conclusions

This study presented a method of economic evaluation to estimate the value of vineyard landscape of Langhe-Roero and Monferrato, as a synthetic index of attractiveness, that is useful to define scenarios of territorial development. This method is based on the search for development of a set of economic indicators that consider tangible and intangible features of vineyard landscape. The economic value of landscape has been developed following two paths, the first one about 101 municipalities, the second one about the clusters system, favoring the identification of the most attractive components in the site, comparing, at the same time, the attractiveness of core and buffer zones. The attractiveness is not only the expression of intrinsic characteristics of landscape, but also synonymous of mobility of people, who choose a certain landscape rather than another one, so influencing the territorial dynamics. The application of the mathematical model Lotka-Volterra has allowed the evaluation and comparison of the attractiveness in the territorial system, represented by the relevant municipalities in terms of number of residents, using LEV/km^2, a threshold value and the reciprocal distances of core zones.

As a further development, to experiment the dynamic model in other territories would be of scientific interest, in order to validate the approach; moreover, a sensitivity analysis would be useful to investigat**e** the variations of answer of the model, depending on differentiated variables; finally, extra work has to be done in order to calibrate the temporal scale for the model.

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