Spatial Analysis in Multi-Value Assessment for Rural Landscapes: A Comparative Study of ES, LS, and LCA Frameworks

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Abstract. Rural landscapes, such as Italian Inner areas, hold rich cultural, ecological, and heritage values. Yet, these peculiar landscapes are characterised by isolation, demographic decline, and limited access to essential services. These conditions present a unique challenge for landscape valuation and traditional assessment methods based on their spatial characteristics. Spatial analysis provides both conceptual and operational tools to navigate the complexity of landscapes. However, current approaches still face significant methodological and theoretical challenges in effectively capturing and representing inner areas' tangible and intangible values. The heterogeneous nature of existing spatial approaches makes it difficult to directly compare results, while the integration of perceptual data remains difficult due to the limitations of current GIS tools and models. These challenges highlight the need for more comprehensive assessment frameworks capable of overcoming existing limitations and providing a holistic understanding of landscape values.

To address these gaps, this study conducts a comparative analysis of three key landscape valuation frameworks–Ecosystem Services (ES), Landscape Services (LS) and Landscape Character Assessment (LCA). Through a semi-structured literature review, this contribution explores how these frameworks assess landscape values, and examines their respective criteria. Results show that ES and LS frameworks primarily value landscapes based on the benefits they provide to people, while LCA emphasises qualitative aspects such as perception and identity, recognising the intrinsic value of landscapes beyond their functional use. The analysis highlights critical gaps in current approaches, including their predominantly anthropocentric perspective and limited integration of multiple values into decision-making processes. We need for a more inclusive and spatially explicit valuation framework that places landscapes, especially in marginalised areas, at the centre of valuation processes and recognises their multiple, interconnected values.

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1 Introduction

Over the past century, the concept of landscape has undergone a significant transformation. Once rooted in the idyllic notion of nature as a retreat, it has evolved into a more nuanced understanding of landscape as a dynamic, living system. This contemporary view recognises landscapes as complex, ever-evolving systems shaped by the continuous interplay between human activities and natural processes [1]. This evolutionary perspective highlights the ecological, social, and cultural dimensions of landscape as deeply intertwined. As living systems, landscapes are shaped by a range of interrelated factors: climatic conditions, geomorphology, the availability of natural resources, local knowledge, governance structures, and technological and economic capacities, [2]. From an ecological perspective, landscape value is often associated with ideals of natural integrity and approaches aiming at minimal human intervention [3]. In contrast, from an anthropocentric standpoint, landscape values are defined in terms of the tangible and intangible benefits they provide to society, such as ecosystem services, cultural identity, and aesthetic or recreational functions [4]. These diverse influences often give rise to competing interests and value systems that undermine landscape planning, management, and maintenance.

Emblematic is the case of Italian Inner Areas, where such tensions tend to be more pronounced.

The National Strategy for Inner Areas (SNAI), identifies inner areas as areas characterised by geographical remoteness and difficulties in accessing basic services, resulting in depopulation and economic decline [5].

On the other hand, they are reservoirs of valuable natural, economic and cultural resources [6, 7]. This strict national framing provides the conceptual foundation for the present study, guiding the identification and analysis of the rural landscapes addressed throughout the paper.

The SNAI represents a first institutional attempt to systematically define and classify these rural landscapes.

However, this approach has been the subject of debate in the literature, as it tends to highlight what these territories lack compared to urban standards, rather than highlighting their specificities and local potential.

As a result, different models for interpreting and intervening in these areas have emerged, viewing these landscapes not as something to be mapped indiscriminately and a priori, but as something to be interpreted and defined in response to emerging goals and objectives [8].

Despite the increasing momentum in theory and practice, even the most critical perspectives often remain urban-centric, falling short of grasping the unique specificities of rural landscapes. In response, a shift in perspective is required, moving beyond urban-based interpretative models toward tools that can better capture the complexity of such marginal landscapes and guide more effective planning, policymaking, and design.

In this panorama, the valorisation of rural landscapes requires integrated strategies and transdisciplinary approaches [10], capable of capturing the multidimensionality of territorial values [11, 12] and promoting actions aimed at preserving their identity and enhancing their attractiveness, while at the same time promoting sustainable development [9].

Landscape assessment plays a central role in this process: it not only identifies tangible and intangible values, but also contributes to understanding the importance of the landscape for local communities and the environment [13]. It thus becomes a strategic tool capable of mediating between perceptions, actions and policy choices, offering an articulated and participatory reading of the territory. Central to this process is the concept of "value", which demands thorough reflection on its nature and its implications for decision-making processes [14, 15].

Another key component of landscape assessment is its spatial dimension, which facilitates the translation of abstract concepts into concrete, spatially explicit representations. This spatialisation provides essential tools for informed territorial planning and management [16]. In particular, mapping techniques allow for the representation of both the supply and demand of specific landscape elements [17], enabling a comprehensive evaluation of the area that accounts for the spatial relationships—such as the distance between supply and benefiting areas—fundamental to landscape functionality and equity [18–20]. Nevertheless, despite advances in landscape planning and assessment practices, effectively capturing and spatialising the diversity of rural landscape values remains a persistent challenge. Current valuation frameworks, largely shaped by urban logics and sectoral approaches, struggle to capture the complex and multifaceted nature of these landscapes. They often neglect intangible cultural values, local ecological knowledge and multifunctional land uses, resulting in partial, fragmented and ultimately inadequate analyses. To overcome these limitations, new tools and methods are needed that can reveal the diverse landscape values of inner areas-values that are too often invisible in conventional planning processes-in order to move beyond urbanist paradigms and towards a post-anthropocentric understanding of territory.

The objective of this study is to conduct a comparative analysis of three landscape assessment frameworks—Ecosystem Services (ES), Landscape Services (LS), and Landscape Character Assessment (LCA)—to examine how each approach, through its specific criteria and methodologies, contributes to the representation, mapping, and assessment of the multiple values associated with the landscape. While not exhaustive, these frameworks are among the most widely used and show a methodological advancement from a mainly quantitative to a more qualitative assessment. Understanding how these conceptualised models translate tangible and intangible landscape values into spatial terms is essential to support informed and sustainable decision-making processes in spatial management and planning.

In the light of these considerations, this study poses the following research questions: *1) Which material and non-material aspects of the rural landscape are considered in the ES, LS and LCA frameworks? 2) What methods and tools are used to spatialise the landscape values (GIS, statistical models, perception maps, etc.) and what are the main differences in representation? 3) What are the strengths and weaknesses of each approach in supporting decision making in landscape planning?*

Through a semi-structured literature review, the study aims to highlight the conceptual and methodological specificities of these frameworks and to identify their potential and limitations in capturing landscape values complexity. It also aims to explore possible perspectives for a more integrated approach to landscape valuation, capable of taking into account different value dimensions and their spatial distribution. This perspective can contribute to the development of more effective strategies for landscape management and planning, promoting an interdisciplinary and sustainable vision of landscape.The structure of the present study is as follows. The next section provides a detailed description of three consolidated landscape valuation frameworks. Then, Sect. 3 presents the methodology used, distinguishing between the different frameworks examined and the specific ways in which the analysis was conducted. Section 4 presents the results obtained. Finally, Sect. 5 offers a critical reflection on the findings and outlines possible future research directions.

2 Landscape Assessment Framework: In Comparison

This contribution focuses on the analysis and comparison of three consolidated landscape valuation frameworks - Ecosystem Services ES, Landscape Services LS, Landscape Character Assessment LCA- which interpret the values expressed by rural landscapes in complementary - but different - ways. Each approach emphasises different dimensions of landscape. These three frameworks represent theoretical and operational models already established in the scientific literature, selected because they are particularly relevant to understanding the complexity and multidimensionality of the rural landscape. They provide a starting point for building a solid and shared knowledge base that is useful for reflecting on the different ways in which landscape can be assessed, represented and managed.

Ecosystem Services (ES): The concept of (ES) emerged in the 1980s and increased in importance with the contributions of [21] and [22]. The Millennium Ecosystem Assessment (MEA) [23], carried out to assess the consequences of ecosystem change for people, focusing on the interlinkages between nature and human well-being, and, in particular, on ES as benefits people get from ecosystems. MEA highlighted the need to value the benefits that ecosystems provide to humans, influencing follow-up initiatives such as The Economics of Ecosystems and Biodiversity [24] and the Common International Classification of Ecosystem Services [25]. Today, ES and their assessment are central to environmental policy and scientific research [19]. Spatial maps of ES support environmental governance, but diversity in mapping methods and terminologies generates in their application [26]. The MEA classified ES into four categories: supporting (core ecological processes), provisioning (material goods such as food and water), regulating (e.g. climate control) and cultural (intangible benefits). The TEEB framework took up this classification and emphasised the environmental, socio-cultural and economic value of ES to support policy decisions. CICES then refined this classification by distinguishing between provisioning, regulatory and cultural services, excluding support services, which are considered as underlying processes.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) introduced the concept of nature's contributions to people (PCNs), which

broadens the view of ES and values indigenous and local knowledge [27]. NCPs are divided into material, regulatory and non-material contributions, emphasising the relationship between nature and society. IPBES, inspired by previous frameworks such as the MEA, promotes a pluralistic approach to nature values, recognising the diversity of perspectives and the need to integrate them into decision-making processes [28].

Landscape Services (LS): The approach integrates the logic of ES with landscape aspects, taking into account social and cultural perceptions. The services provided by the landscape result from the interaction between man and the territory. In recent years, LS have gained importance in landscape planning and have deepened the issue of spatialisation of landscape characteristics [29, 30]. In contrast to ES, LS provides a more contextual view and includes man-made areas, which is crucial for participatory planning [31]. Termorshuizen and Opdam [32] distinguish landscape from ecosystem and define LSs as 'spatial human ecosystems' that generate ecological, social and economic values. This approach promotes interdisciplinary integration in the assessment of LS [33]. However, LS still lacks a systematic classification, unlike ES, which are based on models such as MEA, TEEB, CICES and IPBES. Some studies have tried to integrate them into ES [34], developing categorisations based on CICES, but these are similar to ES, highlighting the need for a specific model for LS that takes into account the relationships between services, landscape characteristics and human values. When applied at the landscape scale, ES risks losing their functionality due to an overemphasis on biophysical aspects [35]. Understanding the dynamics of LS at different scales is crucial for the analysis of spatial heterogeneity [36].

Landscape Character Assessment (LCA): A qualitative approach to analysing the identity and perceptual aspects of landscape, used in spatial planning to describe its distinctive characteristics, with a focus on cultural and historical value rather than quantifying ecosystem benefits. Understanding landscape character is essential for preserving its uniqueness and diversity, especially in rural contexts [37–39]. Traditionally, landscape valuation has used quantitative approaches to estimate its ecological, economic and cultural values. In the 1990s, the trend was reversed towards an LCA approach that focuses on mapping and analysing landscape characteristics such as soil morphology, vegetation and settlements [40]. Supported by the European Landscape Convention, it has spread across Europe as a key tool for landscape management [41]. More recently, LCA has integrated functional ecological elements and intangible cultural aspects, enriching indicators of landscape perception [42, 43]. However, landscape perception varies between local communities, which modify and value different areas according to their own needs. In recent years, there has been an increasing demand to assess preferences for multiple services, including not only ecological and regulatory aspects, but also aesthetic and cultural ones [44, 45]. This highlights the importance of a contextualised approach to landscape management.

The preliminary analysis revealed an important gap in the existing literature: no study to date has systematically addressed the three landscape assessment frameworks simultaneously and in an integrated manner. In particular, the existing literature has mainly analysed the relationship between ecosystem services (ES) and landscape services (LS) [31] or between ecosystem services (ES) and landscape character assessment

(LCA) [46], leaving partly unexplored the possibility of a broader and more structured comparison between all three conceptual frameworks.

3 Methodology

The methodology aims to build a strong comparative knowledge base to understand how different assessment frameworks propose specific interpretations of landscape.

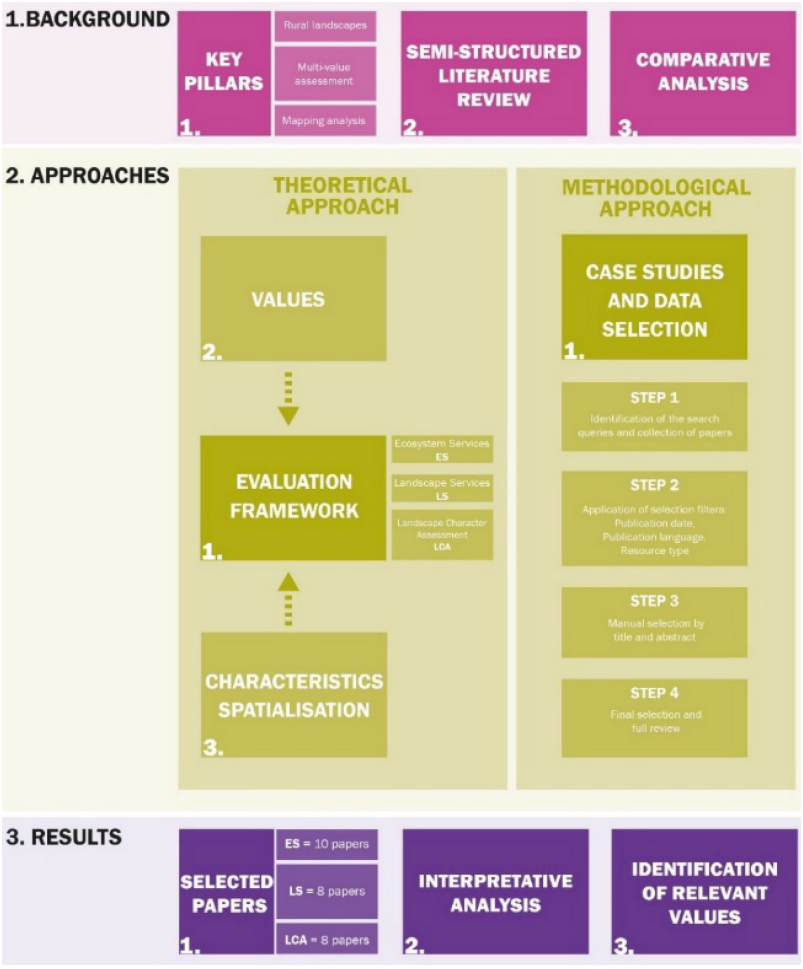

Fig. 1. Methodological framework of the research, divided into phases and operational steps.

By examining the most widely used approaches to landscape assessment, the study seeks to identify the underlying logics, values and spatial implications inherent in each framework. This analytical foundation allows for a critical examination of the landscape

through multiple lenses, highlighting the different ways in which values are defined and mapped. To this end, the methodology is structured around three key pillars-rural landscapes, multi-value assessment and mapping analysis-which are explored through a systematic literature review, allowing for a comparative reading of methodologies and conceptual perspectives, while maintaining a constant attention to the role of values and their spatialisation. (see Fig. 1) .

The proposed methodology defines a common knowledge base, developed through an in-depth analysis of the issues of the three main pillars, conducted through a semi-structured review [47, 48], and a comparative analysis.

The methodological approach adopted therefore required a rigorous selection of documents, based on specific explicit inclusion and exclusion criteria, to ensure the relevance and relevance of the sources to the research objective. The analysis of the data extracted from the selected studies was carried out in a systematic way, focusing on the comparability of the results and the possibility of integration between the different methodological approaches studied. The collection of sources was carried out through the Scopus database (2025), chosen for its wide coverage of high quality scientific publications. This first stage (Step 1) was followed by a further selection of papers, identified through analysis of bibliographies of review articles and citations of the most relevant papers. In order to achieve greater coherence and focus in the analysis, the selection of case studies was limited to rural landscapes. In order to obtain a broader and more complete vision, the research was not limited to the Italian context alone, but also included studies carried out at European and international level, where relevant, in order to identify possible methodological and applicative relationships and links. It is important to emphasize that the European and international cases considered were selected based on the characteristics defined from the perspective proposed by the Italian panorama.

Due to the high number of results obtained, filtering criteria were introduced based on Date of publication, differentiated according to the frameworks analysed; language of publication, with a preference for articles in English; type of resource, selecting only peer-reviewed scientific articles (Step 2).

After applying the filters, the resulting number of articles was subjected to a manual selection based on the relevance of the title and the reading of the abstract (Step 3).

The final selected papers were collected, organised and analysed using the *Zotero* platform, which proved to be a fundamental support for the systematic management of sources (Step 4). Only through this rigorous procedure was it possible to carry out an interpretative analysis and identify the relevant related values.

This procedure allowed the final selection of 10 case studies for ES, 8 case studies for LS and finally 8 articles for LCA.

For the comparative analysis, a systematisation table has been developed in order to collect and analyse each paper in a structured and coherent way, paying particular attention to the ways in which values are identified, interpreted and spatialised within each framework (see Table 1). The table allows for a standardised comparison, highlighting both methodological convergences and divergences, as well as the peculiarities of each approach. Specifically, each article has been examined according to a set of criteria

aimed at tracing the ways in which landscape values are conceptualised and translated into spatial representations. The structure of the table includes:

Reference framework (R.F.): the theoretical and methodological framework adopted.
Spatial Unit (S.U.): indicates the scale of application, which can vary from a local scale-focusing on smaller and more restricted areas, perhaps municipalities or hamlets, where a closer reading of the territory of the material and immaterial elements that define the identity of the place is favoured-to a territorial scale, including the set of ecological, infrastructural, cultural, economic relationships on a larger scale, often supra-municipal, where the landscape is read as a complex and interconnected system.
Highlighted Values: particular attention has been focused on the spatialization of the values considered in the various studies. The "Highlighted Value" underlines the values potentially detectable in the analysed documents. This interpretive approach allows for a nuanced understanding of how values are intertwined with spatial aspects across different research perspectives.
Spatialised Criteria: focuses on analysis of the criteria used for total landscape spatial valuation.
Evaluation Methods and Tools: identification of the methods and tools used for spatial analysis and data evaluation.
Authors.

The adoption of this approach made it possible to draw up a detailed profile of each contribution, almost like an "identikit" of the papers studied. This approach also facilitated the recognition of the potential and limitations of each framework, allowing a better understanding of the differences between approaches and the identification of the most effective strategies for evaluating spatial data.

4 Results

This paper provides a partial overview of the current approach to landscape assessment in rural areas, with reference to ES, LS, and LCA (see Table 1). Only nine of the papers selected during the literature review—three for each assessment framework—are included, as they are the most relevant and illustrative for the research under consideration.

Following the comparative study, it is interesting to note the different approaches to landscape analysis. The LCA case studies focus on a specific landscape value, such as aesthetics and perception, using innovative approaches such as social media analysis. The LS case studies highlight the importance of shared values and stakeholder conflicts in landscape management. However, their effectiveness is variable and often affected by methodological limitations, spatial scale issues and the quality of the data used. Ultimately, ES analyse the landscape in terms of services, and the main difficulty lies in the availability of the data associated with the study.

Specifically, the comparison produced the following results:

Landscape Character Assessment (LCA). Lieskovský et al. [49] attempt to assess the aesthetic value of landscapes based on the density of photos shared on Panoramio. Although the method is innovative in its ability to use user-generated big data, it introduces a clear bias: the aesthetic, intrinsic, identity, social and natural value of an area is not measured objectively, but rather based on the accessibility of the place and its popularity among photographers. Historic monuments, parks, museums, woodlands, lakes, castles, hills and places of natural interest are most often photographed, but the result is a biased analysis in which more remote or less accessible and documented landscapes

Table 1. The results of the comparative analysis.

R.F	S.U.	Highlighted Values	Spatialised criteria	Evaluation methods and tools	Authors
LCA	Territorial scale	Intrinsic value, identity value, aesthetic value, social value, local character value, naturalistic value	Urban areas Natural areas Agricultural zones Agroforesy areas	• GIS • Geolocated social media photos Google Panoramio • Land cover map CORINE Land Cover 2006 (CLC)	Lieskovský et. al. 2017
LCA	Local Scale	Intrinsic value, naturalistic value, value of local character, social value, identity value	Coherence Disturbance Historicity Visuality Complexity Naturalness	• GIS • Photos, Visual methods • Surveys of experts and the public • Multi criteria techniques for evaluation	Martín et. al. 2016
LCA	Territorial scale	Intrinsic value, local character value, identity value, social value, historical value, environmental value	Toponymic heritage Mill zones Traditional farming systems	• GIS • Interview • Strong community involvement • Historic Landscape Analysis (HLA) • Historic Landscape Characterization (HLC)	Hearn 2021

(*continued*)

Table 1. (*continued*)

R.F	S.U.	Highlighted Values	Spatialised criteria	Evaluation methods and tools	Authors
LS	Local scale	Environmental value, intrinsic value ecological value, social value	Water provision areas	• GIS • Multi-Criteria Analysis • InVEST Model • LULC map and Data • Community involvement	Darvishi et. al. 2021
			Water regulation areas		
			Pollination		
			Effectiveness of net primary production (NPPact)		
			Socio-cultural connectivity		
LS	Local scale	Environmental value, intrinsic value ecological value, social value, livability value, legacy value	Cultural identity	• GIS • Interviews • Workshops • PCA Analysis • Community involvement	Baylan. and Karadeniz. 2017
			Provisioning		
			Regulation		
LS	Local/regional scale	Environmental value, ecological value, economic value, social value, identity value	Carrier	• GIS • Multi-Criteria Analysis • ANP, Spatial weighted overly • Kernel Density Estimation (KDE): Applied to point indicators	Cerreta et. al. 2021
			Regulation		
			Information		
			Provisioning		
ES	Local scale	Environmental value, ecological value, economic value, legacy value	Marginal croplands / Low-management fields	• GIS • Analysis of satellite data • Remote sensing techniques	Longato et al. 2019
			Potentially low productivity croplands		
			Density of marginal agricultural lands		
			Wood BBES and food provision		

(*continued*)

Table 1. (*continued*)

R.F	S.U.	Highlighted Values	Spatialised criteria	Evaluation methods and tools	Authors
ES	National scale	Environmental value, ecological value, economic value, legacy value	Pollination; Regulation & maintenance	• GIS • Management analysis	Peciña et al. 2019
			Ethnobotanical areas		
			Nutrient cycling; Regulation & maintenance		
			Nutrient retention; Regulation & maintenance		
			Biomass production; Provisioning		
ES	Local scale	Environmental value, ecological value, economic value	Urbanization level (UL)	• GIS • Multi-Criteria Analysis • InVEST Model • Coupling Coordination Degree (CCD) • Hotspots analysis (Getis-Ord Gi* statistic) • GeoDetector model • Geographically Weighted Regression (GWR) model	Bi et al. 2023
			Water-related ecosystem services (WES)		
			Water provision		
			Soil conservation		
			Water purification		

may be undervalued online. Hearn [50] proposes an ethnographic approach to the characterisation of river landscapes, especially the Douro River, combining interviews, GIS and participatory mapping. These methods allow to capture the historical, cultural, ecological and social values of rural landscape. One of the limitations of this approach is that relying on collective memory carries the risk of distortions and arbitrary reconstructions, especially in contexts where the historical narrative is fragmented or politicised. Martin et al. [51] analyse the character and quality of rural landscape as seen from highways in Madrid. They use GIS, photography and multi-criteria methods to assess whether the

highway conveys the character of the landscape to which it belongs. The natural, local character, social and identity values of the area are mapped. However, the methodology used suffers from the inherent difficulty of translating the visual experience into a quantitative assessment. The quality of a landscape cannot be reduced to the sum of measurable parameters and any attempt at objectification runs the risk of being artificial.

Landscape Services (LS). Cerreta et al. [52] adopt a more structured approach, combining GIS, multi-criteria methods and public participation to assess the resilience of rural landscape services in the Partenio Regional Park (PRP). Tourist facilities, housing, transport, cultivation functions and environmental, cultural and artistic regulation are spatialised to express environmental, ecological, cultural and economic values. Although the integration of local perceptions is a positive aspect, there is a risk that the decision-making process will be influenced by strong subjectivity. The use of the Analytic Network Process (ANP) allows the weighting of different components, but the complexity of the model can make it difficult to apply in broader contexts without a wide availability of data. Baylan and Karadeniz [53] use a combination of GIS, interviews and statistical analysis to explore stakeholder conflicts in wetland management in Ekşisu, Turkey. While the interdisciplinary approach helps to capture different landscape's values-aesthetic, receptive, spiritual, intrinsic, economic, biodiversity-,it is weak in its ability to quantify and standardise the results. The difficulty of capturing intangible values, such as spirituality or cultural identity, limits the effectiveness of the method and leaves unresolved the problem of translating perceptions into concrete management actions. Darvishi et al. [54] attempt to address the issue of trade-offs between landscape services for socio-cultural functional area-based assessment through GIS analysis in the city of Qazvin, Iran. The lack of a truly interdisciplinary framework leads to a reductive vision in which the integration between environmental, social and economic dimensions remains superficial. Furthermore, the lack of active stakeholder involvement leaves open the question of the practical applicability of the results, which risk remaining at a theoretical level.

Ecosystem Services (ES). Bi et al. [55] develop a national mapping of ecosystem services in Estonian semi-natural grasslands using GIS and remote sensing. The work maps the geographical distribution of WES levels, the identification of UL and WES spatial hot and cold spots, and the spatial distribution of CCD between UL and WES. Despite the large spatial scale of the analysis, the work is weakened by the use of proxy indicators that do not always accurately reflect the complexity of ecosystem services. The over-reliance on satellite data, while making the method replicable, risks providing a distorted view that ignores local dynamics and more subtle ecological variables that cannot be captured by low resolution imagery. Longato et al. [56] address the relationship between bioenergy and ecosystem services in the municipality of Rovigo, Italy, using GIS and satellite data to classify marginal lands. Ecological, economic and environmental values are mapped. Problems encountered include the quality of satellite data - vegetation indices - which can vary significantly, and the ability to distinguish between truly marginal land and simply underutilised land. Finally, Peciña et al. [57] use the InVEST model and advanced GIS analysis to explore the links between urbanisation and water ecosystem services in China. The characteristics of living systems that enable health-promoting activities are mapped. Although the InVEST model is widely used, it is not always able to capture the complex dynamics of water services, especially in rapidly

changing urban environments. Furthermore, the analysis focuses almost exclusively on biophysical aspects, neglecting the role of socio-economic dynamics in water resource management.

5 Discussions and Conclusions

The analysis of different landscape valuation frameworks reveals a considerable diversity of methodological and theoretical approaches, each with specific strengths and limitations. One of the main observations that emerged concerns the overlap between ES and LS frameworks. Although different in their premises, these two approaches are often intertwined, making a clear conceptual separation difficult. However, LS introduce some distinctive elements, including the concept of CES and multifunctional landscapes. These aspects broaden the perspective to include not only the biophysical and economic dimensions of landscape, but also the cultural, social and identity dimensions. One element that clearly distinguishes the ES and LS frameworks from LCA is the level of theoretical structuring. While the first two refer to consolidated theoretical frameworks and relatively codified categories, the LCA appears less formalised and more difficult to fit into precise theoretical schemes. While this aspect makes it flexible and adaptable to different contexts, it also makes the standardisation of analyses and their replicability more difficult. In addition, LCA is characterised by a strong emphasis on the involvement of local communities, an element that seems almost a methodological prerequisite for understanding the specificities of the landscape. This participatory approach makes it a more democratic methodology, capable of capturing the perceptual dimension of the landscape, but at the same time introduces interpretative variability that limits its applicability on a large scale.

A key issue concerns the different values considered and mapped within the frameworks analysed.

ES, while including the ecological dimension, tend to privilege a reading of the landscape in terms of human benefits. They often focus on economic aspects, both in terms of use and non-use values, and seek to quantify the contribution of natural systems to human well-being in terms of services provided. However, this approach falls short in its ability to represent the intrinsic value of the landscape and its cultural identity. LS represent a step in this direction, attempting to capture the multidimensionality of landscape in a more articulate way. While not completely excluding an economic perspective, they also seek to integrate elements of place identity and social perception into the valuation framework. This makes their approach more comprehensive than that of ES, while maintaining some critical issues of measurement and standardisation of qualitative data. LCA, introduces a radical change in perspective, placing the perceptual and symbolic dimension of landscape at the centre, shifting the focus to characterising the landscape as perceived by people, with a strong emphasis on intrinsic values, whether anthropocentric or not. The methods used, such as social media image analysis or visual surveys, attempt to capture the collective sensibility towards landscape, without claiming to translate these values into economic terms. However, the risk of interpretation bias is high, and the reliance on data sources that are not always stable (such as digital platforms) makes this approach less reliable in the long term.

The analysis carried out shows that there is currently no landscape valuation framework capable of fully and satisfactorily capturing the multiplicity of value dimensions associated with rural landscapes. This suggests the need for a more holistic and pluralistic approach. Although some attempts to construct new, more inclusive models of environmental valuation have been explored in the literature [58], methodological and operational difficulties remain. The increasing availability of big data and the use of artificial intelligence may offer new opportunities to overcome current limitations in data collection and interpretation. However, the main challenge remains to place the landscape at the centre of decision-making processes, especially in marginal territorial contexts.

In this scenario, this paper proposes itself as a possible methodological way forward, based on the multidimensionality of landscape values. The approach does not start from what is missing, but from what exists and can be recognised as having value - be it intrinsic, utilitarian, existential, social or symbolic. The aim is to define guidelines for building a framework that can not only overcome the urban-centric paradigm, but also pave the way for a more than human vision. In this perspective, landscape should be considered as a complex relational space that includes humans and non-humans, ecological and cultural systems, temporal pluralities and alternative forms of habitability, recognising marginal landscapes as true territories of the possible.

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References

1. De L'europe, C.: European Landscape Convention and reference documents EUROPEAN LANDSCAPE CONVENTION CONVENTION EUROPÉNNE DU PAYSAGE EUROPEAN LANDSCAPE CONVENTION CONVENTION EUROPÉNNE DU PAYSAGE. www.coe.int/Conventioneuropeennedupaysage
2. Bartel, A.: Analysis of landscape pattern: towards a 'top down' indicator for evaluation of landuse (2000). www.elsevier.com/locate/ecolmodel
3. Integrating Landscape Ecology into Natural Resource Management: Cambridge University Press (2002). https://doi.org/10.1017/cbo9780511613654
4. Tempesta, T., Thiene, M.: Percezione e valore del paesaggio (2006)

5. Strategia nazionale per le Aree interne: definizione, obiettivi, strumenti e governance* *Documento tecnico collegato alla bozza di Accordo di Partenariato trasmessa alla CE il 9 dicembre 2013
6. De Toni, A., et al.: Inner peripheries: dealing with peripherality and marginality issues within the European policy framework. TERRA: Revista de Desarrollo Local **7**, 24–47 (2020). https://doi.org/10.7203/terra.7.17239
7. Wu, Y., Wang, H., Wang, Z., Zhang, B., Meyer, B.C.: Knowledge mapping analysis of rural landscape using CiteSpace MDPI (2020). https://doi.org/10.3390/SU12010066
8. Cerreta, M., D'Agostino, A., Vannelli, G., Zizzania, P.: Internet areas. A culture-led strategy of widespread projects for montagna materana (Italy). In: Smart Innovation, Systems and Technologies, Springer Science and Business Media Deutschland GmbH, pp. 188–197 (2021). https://doi.org/10.1007/978-3-030-48279-4_18
9. Cerreta, M., Poli, G.: A complex values map of marginal urban landscapes: an experiment in Naples (Italy). Int. J. Agric. Environ. Inf. Syst. **4**(3), 41–62 (2013). https://doi.org/10.4018/ijaeis.2013070103
10. Liew, A., Sundaram, D.: Flexible modelling and support of interrelated decisions. Decis. Support. Syst. **46**(4), 786–802 (2009). https://doi.org/10.1016/j.dss.2008.11.016
11. Cerreta, M.: Thinking through complex values. In: Making Strategies in Spatial Planning, Springer Netherlands, pp. 381–404 (2010). https://doi.org/10.1007/978-90-481-3106-8_21
12. Montuori, A.: Edgar Morin and Complex Thought (2013). https://www.researchgate.net/publication/260603130
13. Solecka, I.: The use of landscape value assessment in spatial planning and sustainable land management — a review. Landsc. Res. **44**(8), 966–981 (2019). https://doi.org/10.1080/01426397.2018.1520206
14. O'Brien, K.L., Wolf, J.: A values-based approach to vulnerability and adaptation to climate change. Wiley Interdiscip. Rev. Clim. Change **1**(2), 232–242 (2010). https://doi.org/10.1002/wcc.30
15. Spangenberg, J.H., Settele, J.: Value pluralism and economic valuation - defendable if well done. Ecosyst. Serv. **18**, 100–109 (2016). https://doi.org/10.1016/j.ecoser.2016.02.008
16. Wahab, N.A.A., Zakariya, K., Ibrahim, P.H., Ibrahim, I.: Mapping the Landscape Characters Along a Rural Route for Tourism. Plan. Malaysia **16**(2), 131–140 (2018). https://doi.org/10.21837/PM.V16I6.468
17. Troy, A., Wilson, M.A.: Mapping ecosystem services: practical challenges and opportunities in linking GIS and value transfer. Ecol. Econ. **60**(2), 435–449 (2006). https://doi.org/10.1016/j.ecolecon.2006.04.007
18. Crossman, N.D., et al.: A blueprint for mapping and modelling ecosystem services. Ecosyst. Serv. **4**, 4–14 (2013). https://doi.org/10.1016/j.ecoser.2013.02.001
19. Fisher, B., Turner, R.K., Morling, P.: Defining and classifying ecosystem services for decision making. Ecol. Econ. **68**(3), 643–653 (2009). https://doi.org/10.1016/j.ecolecon.2008.09.014
20. Bastian, O., Grunewald, K., Syrbe, R.U.: Space and time aspects of ecosystem services, using the example of the EU Water Framework Directive. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. **8**(1–2), 5–16 (2012). https://doi.org/10.1080/21513732.2011.631941
21. Bawa, K.S., Kaufman, L.: Nature's Services: Societal Dependence on Natural Ecosystems (1997). https://www.researchgate.net/publication/37717461
22. Costanza, R., et al.: The value of the world's ecosystem services and natural capital. Ecol. Econ. **25**(1), 3–15 (1998). https://doi.org/10.1016/s0921-8009(98)00020-2
23. "Ecosystems and Human Well-being: A Framework for Assessment."
24. Levin, S., Steiner, A.: A landmark study on one of the most pressing problems facing society, balancing economic growth and ecological protection to achieve a sustainable future
25. Haines-Young, R., Potschin, M.: Common International Classification of Ecosystem Services (CICES): 2011 Update European Environment Agency (2011)

26. Hauck, J., et al.: 'Maps have an air of authority': potential benefits and challenges of ecosystem service maps at different levels of decision making. Ecosyst. Serv. **4**, 25–32 (2013). https://doi.org/10.1016/j.ecoser.2012.11.003
27. Díaz, S., et al.: The IPBES Conceptual Framework - connecting nature and people (2015). Elsevier. https://doi.org/10.1016/j.cosust.2014.11.002
28. Pascual, U., et al.: Valuing nature's contributions to people: the IPBES approach (2017). Elsevier B.V. https://doi.org/10.1016/j.cosust.2016.12.006
29. Wu, J.: Urban ecology and sustainability: the state-of-the-science and future directions. Landsc. Urban Plan. **125**, 209–221 (2014). https://doi.org/10.1016/j.landurbplan.2014.01.018
30. Bastian, O., Grunewald, K., Syrbe, R.U., Walz, U., Wende, W.: Landscape services: the concept and its practical relevance. Landsc. Ecol. **29**(9), 1463–1479 (2014). https://doi.org/10.1007/s10980-014-0064-5
31. Zhang, S.: Applying the Landscape Services Concept in Landscape Research: A Review (2022). Grassroots Institute. https://doi.org/10.33002/nr2581.6853.050401
32. Termorshuizen, J.W., Opdam, P.: Landscape services as a bridge between landscape ecology and sustainable development. Landsc. Ecol. **24**(8), 1037–1052 (2009). https://doi.org/10.1007/s10980-008-9314-8
33. Hermann, A., Schleifer, S., Wrbka, T.: The concept of ecosystem services regarding landscape research: a review (2011). Leibniz Centre for Agricultural Landscape Research. https://doi.org/10.12942/lrlr-2011-1
34. Vallés-Planells, M., Galiana, F., Van Eetvelde, V.: A classification of landscape services to support local landscape planning. Ecol. Soc. **19**(1) (2014). https://doi.org/10.5751/ES-06251-190144
35. Costanza, R.: Ecosystem services: multiple classification systems are needed (2008). https://doi.org/10.1016/j.biocon.2007.12.020
36. Aertsen, W., Kint, V., Muys, B., Van Orshoven, J.: Effects of scale and scaling in predictive modelling of forest site productivity. Environ. Model. Softw. **31**, 19–27 (2012). https://doi.org/10.1016/j.envsoft.2011.11.012
37. Antrop, M.: Interpreting diversity in the European landscape. A comment on perspective essays by Agnoletti and Schnitzler (2014). Elsevier B.V. https://doi.org/10.1016/j.landurbplan.2014.02.013
38. Van Eetvelde, V., Antrop, M.: Indicators for assessing changing landscape character of cultural landscapes in Flanders (Belgium). Land Use Policy **26**(4), 901–910 (2009). https://doi.org/10.1016/j.landusepol.2008.11.001
39. Lu, Y., Xu, S., Liu, S., Wu, J.: An approach to urban landscape character assessment: linking urban big data and machine learning. Sustain. Cities Soc. **83** (2022). https://doi.org/10.1016/j.scs.2022.103983
40. Jellema, A., Stobbelaar, D.J., Groot, J.C.J., Rossing, W.A.H.: Landscape character assessment using region growing techniques in geographical information systems. J. Environ. Manag. **90**(SUPPL. 2) (2009). https://doi.org/10.1016/j.jenvman.2008.11.031
41. Swanwick, C.: Society's attitudes to and preferences for land and landscape. Land Use Policy **26**(SUPPL), 1 (2009). https://doi.org/10.1016/j.landusepol.2009.08.025
42. Gormus, S., Oguz, D.: Role of Landscape Character Analysis in Evaluation Interaction Between Rural Settlement and Protected Area: Kapisuyu Basin Sample. https://www.researchgate.net/publication/297440488
43. Gottero, E., Cassatella, C.: Landscape indicators for rural development policies. application of a core set in the case study of Piedmont Region. Environ. Impact Assess. Rev. **65**, 75–85 (2017). https://doi.org/10.1016/j.eiar.2017.04.002

44. Brown, G., Brabyn, L.: An analysis of the relationships between multiple values and physical landscapes at a regional scale using public participation GIS and landscape character classification. Landsc. Urban Plan. **107**(3), 317–331 (2012). https://doi.org/10.1016/j.landurbplan.2012.06.007
45. Muhamad, D., et al.: Living close to forests enhances people[U+05F3]s perception of ecosystem services in a forest-agricultural landscape of West Java, Indonesia. Ecosyst. Serv. **8**, 197–206 (2014). https://doi.org/10.1016/j.ecoser.2014.04.003
46. Morrison, R., Barker, A., Handley, J.: Systems, habitats or places: evaluating the potential role of landscape character assessment in operationalising the ecosystem approach. Landsc. Res. **43**(7), 1000–1012 (2018). https://doi.org/10.1080/01426397.2017.1415314
47. Snyder, H.: Literature review as a research methodology: an overview and guidelines. J. Bus. Res. **104**, 333–339 (2019). https://doi.org/10.1016/j.jbusres.2019.07.039
48. Wong, G., et al.: RAMESES publication standards: Meta-narrative reviews. BMC Med. **11**(1) (2013). https://doi.org/10.1186/1741-7015-11-20
49. Lieskovský, J., Rusňák, T., Klimantová, A., Izsóf, M., Gašparovičová, P.: Appreciation of landscape aesthetic values in Slovakia assessed by social media photographs. Open Geosci. **9**(1), 593–599 (2017). https://doi.org/10.1515/geo-2017-0044
50. Hearn, K.P.: Mapping the past: using ethnography and local spatial knowledge to characterize the Duero River borderlands landscape. J. Rural. Stud. **82**, 37–53 (2021). https://doi.org/10.1016/j.jrurstud.2021.01.024
51. Martín, B., Ortega, E., Otero, I., Arce, R.M.: Landscape character assessment with GIS using map-based indicators and photographs in the relationship between landscape and roads. J. Environ. Manage. **180**, 324–334 (2016). https://doi.org/10.1016/j.jenvman.2016.05.044
52. Cerreta, M., Panaro, S., Poli, G.: A spatial decision support system for multifunctional landscape assessment: a transformative resilience perspective for vulnerable inland areas. Sustainability (Switzerland) **13**(5), 1–23 (2021). https://doi.org/10.3390/su13052748
53. Baylan, E., Karadeniz, N.: Identifying landscape values and stakeholder conflicts for the protection of landscape multifunctionality: the case of ekŞisu wetlands (Turkey). Appl. Ecol. Environ. Res. **16**(1), 199–223 (2018). https://doi.org/10.15666/aeer/1601_199223
54. Darvishi, A., Yousefi, M., Dinan, N.M., Angelstam, P.: Assessing levels, trade-offs and synergies of landscape services in the Iranian province of Qazvin: towards sustainable landscapes. Landsc. Ecol. **37**(1), 305–327 (2022). https://doi.org/10.1007/s10980-021-01337-0
55. Bi, Y.: Coupling relationship between urbanization and water-related ecosystem services in China's Yangtze River economic Belt and its socio-ecological driving forces: a county-level perspective. Ecol. Indic. **146** (2023). https://doi.org/10.1016/j.ecolind.2023.109871
56. Longato, D., et al.: Bioenergy and ecosystem services trade-offs and synergies in marginal agricultural lands: a remote-sensing-based assessment method. J. Clean Prod. **237** (2019). https://doi.org/10.1016/j.jclepro.2019.117672
57. Villoslada Peciña, M., et al.: Country-scale mapping of ecosystem services provided by semi-natural grasslands. Sci. Total Environ. **661**, 212–225 (2019). https://doi.org/10.1016/j.scitotenv.2019.01.174
58. Palola, P., Bailey, R., Wedding, L.: A novel framework to operationalise value-pluralism in environmental valuation: environmental value functions. Ecol. Econ. **193** (2022). https://doi.org/10.1016/j.ecolecon.2021.107327