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Biophysical and Monetary Ecosystem Service Valuation in Local Planning: Bridging Economic Assessment and Spatial Governance to Prevent Soil Sealing

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Abstract

Soil sealing is a major driver of urban transformation, generating significant environmental impacts through the loss of soil functions and Ecosystem Services (ES). In this context, economic valuation of ES has emerged as an effective tool for communicating the importance of soil within decision-making processes largely influenced by market dynamics. Despite extensive research on ES, reviews focusing on how economic valuation can support local planning remain limited. As a consequence, this study presents a semi-systematic literature review addressing two research questions: (1) how ES assessment can be integrated into local planning tools and practices, and (2) which monetary metrics can ethically and effectively represent ES values within planning frameworks. Conducted in RStudio, the review combined automated screening of 2500 records with further manual selection and an analytical framework to examine ES definitions, valuation methods, spatial assessment units, and planning applications. The findings indicate that the rigor, methods, and level of detail of ES assessments should be adapted to planning objectives, available resources, territorial context, and stakeholders involved, supporting site-specific decisions. A cross-scale approach emerges as the most suitable for integrating ecological processes with administrative planning, while robust, flexible, and participatory governance across administrative levels is essential. Finally, despite the need for a shared methodological framework, standardized approaches such as the System of Environmental Economic Accounting–Ecosystem Accounting (SEEA EA) are still rarely adopted, particularly for local-scale and monetary ES assessments. Overall, the review provides a transparent and operational approach for integrating ES into spatial planning through interdisciplinary and participatory approaches and strengthening planning systems to prevent soil sealing and promote long-term community benefits.

Keywords: land planning; local planning; soil value; land value; ES monetary valuation; ecosystem accounting

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1. Introduction

1.1. The Role of Soil and Land in Shaping Urban Forms

As analyzed by Richiedei et al., in the literature, the concept of "land" assumes a broader meaning than "soil", with the former encompassing a range of dimensions such as the physical environment, climate, vegetation, hydrology, and soil itself. However, the same analysis shows that the assessment of "land quality", conversely, is much more limited than that of "soil quality", being largely confined to productive, economic aspects and market-related dynamics [1]. A similar interpretation characterizes "land value", traditionally used to refer to economic aspects and defined by the International Valuation Standard Company (IVSC) as synonymous with real estate value, as closely linked to market dynamics [2].

The concept of "soil value", in contrast, recalls the function of soil as the medium that sustains numerous ecosystems and living beings, along with their interactions both internally and with the surrounding environment. Even if the concept of soil value should be described in broader and more complete terms (including elements and indicators of soil properties and threats and not only soil services, as in [1]), the notion of ecosystem services (ES) can help describe this contribution in the most intuitive way, capturing how soil supports human life and activities. From this perspective, soil value encompasses all ecosystem-related values associated with land that may be threatened by changes in land use and land cover and need to be integrated within planning instruments to gain greater economic and social recognition. The assessment of ES provided by a given land parcel subject to development pressures and, consequently, to soil sealing represents an opportunity to evaluate whether urban expansion—driven not only by private initiatives but also by public action—actually benefits the community in the medium and long term, or whether, by depriving it of natural resources and essential services, it ultimately constitutes more of a detriment than an advantage.

However, traditionally, the role of soil in urban planning has focused on urban functionalities: as a physical support for buildings and infrastructure, for geothermal uses, or for archaeological protection. On the other hand, current knowledge clearly shows that most urban and peri-urban functions directly depend on ES and therefore on soil quality [3]. Botticini and Auzins attribute to land value (although not explicitly defined as such) the role of a primary driver in territorial transformations, as land is considered a potential source of profit through real estate operations, often of a speculative nature. Such operations are clearly market-driven and therefore influenced by the economic value of the land, generating horizontal transactions among private actors based on the pursuit of real estate rent. Vertical transactions, in contrast, concern the relationship between the public and private sectors, including cadastral value and taxation, as well as the private surplus value generated by planning decisions and the possibility of capturing this value through land value capture mechanisms [2].

Within this interplay between public and private actors, a key question emerges: whether soil value can similarly act as a decision making factor in shaping urban development, serving as a primary tool for limiting land consumption and protecting natural resources. This should be pursued through both quantitative and qualitative approaches, grounded in the multi-dimensional nature of the concept of soil value already introduced while also incorporating an effort to monetize these values in order to provide a common and comparable benchmark against land value. In this sense, ES valuation research could provide a comprehensive and comparable value framework for guiding planning decisions alongside the maps, charts, and indicators already required by national land use planning regulations. Likewise, ES valuation can pave the way for the development of new planning tools, as the Discussion section will clarify.

In this context, this topic clearly warrants further investigation, particularly following a literature review aimed at assessing its current level of maturity and consolidation.

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1.2. Ecosystem Services Valuation and Monetization: The Status Quo

Recent EU policies, such as the Nature Restoration Law, the Soil Monitoring Law, and the revision of Environmental Accounts, require ecosystem and ES assessment at different scales, with the local level corresponding, within the European NUTS classification, to NUTS3 and LAUs. This highlights a key challenge for spatial planning: soil quality and soil ES are often insufficiently integrated into local planning frameworks through systematic mapping and assessment. Given the importance of local-level land use decisions, fostering the evaluation of soil quality and ES at this scale is both a technical and a cultural priority.

Beyond legal constraints, the integration of ecosystem-based approaches into spatial planning is increasingly recognized but remains at a relatively early stage of implementation. In many cases, their application is largely confined to the mapping and assessment of ecological and socio-cultural ES values, such as risk mitigation, recreation, and cultural benefits. Although planning frameworks often provide the institutional and technical capacity to incorporate measures for the conservation and enhancement of ES, the translation of these opportunities into systematic assessment and concrete planning actions remains limited. However, the authors highlight that the ES considered are a little niche, and there is general incongruity and weakness regarding the methods, the scale, and the potential of such assessments. Similarly, Urban Green Plans (now Urban Nature Plans), promoted by the EU Biodiversity Strategy 2030 for cities with more than 20,000 inhabitants, are becoming a relevant instrument, particularly when integrated with ordinary planning, for enhancing and protecting ES.

Inside of this frame and considering the restless expansion of soil sealing and degradation [4], it is clear that regulation and planning alone are not sufficient to protect soil and its services, especially at the local scale of small and medium-sized municipalities [5]. This is due to financial, fiscal, and competence constraints, as well as limitations in vision and because these municipalities are often not subject to the environmental requirements applied to larger cities (e.g., Urban Green Plans). It is precisely at this scale that a greater "soil literacy" deficit can be observed, as well as difficulties in implementing effective urban planning that integrates soil value and ES protection [6].

The literature also shows a strong consensus: in a decision making context, monetary metrics are among the most effective ways to communicate environmental value, including soil value, and their use is increasingly widespread in scientific research. This is reflected in the graph from a paper by Robert Costanza, a leading pioneer in ES valuation, where the orange line represents the number of publications addressing economic valuation of ES, accounting for approximately half of all studies in this field across different disciplines (Figure 1). Despite the fact that the monetary valuation of environmental goods remains a highly contested issue within the scientific community (see, in this regard, the position Douglas J. McCauley in his renowned "Selling out Nature" [7]), Robert Costanza recently clarified that "(monetary) valuation is not commodification or privatization", thereby taking a position that contrasts with approaches that assess environmental goods through market prices, evaluating them through exchange value metrics [8]. However, this immediately raises a central ethical and methodological question underpinning this research: which monetary metric should be used, and what exactly does it represent? This constitutes one of the main research questions guiding this literature review.

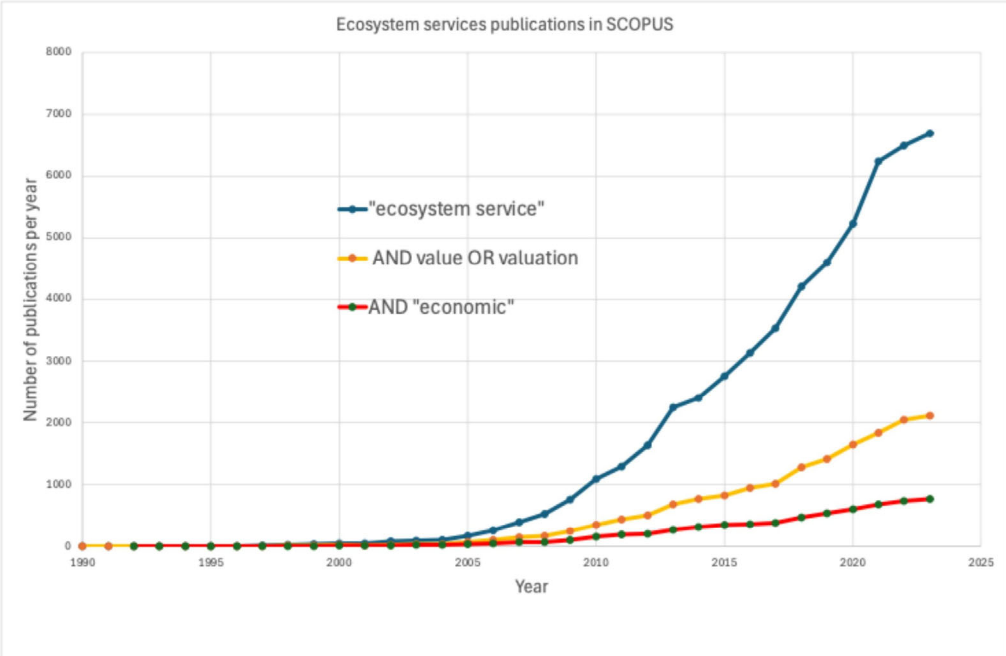

Figure 1. The number of academic publications (as of 2 September 2024) with "ecosystem service" (top line), plus "value" or "valuation" (middle line), plus "economic" (low line) in the title or abstract. Source: [8].

1.3. A New Potential Framework for Planning

All of the questions arising about the best valuation context, mechanisms, and monetization metrics, together with the objectives and the limitations of an ES assessment, could benefit from awareness that an overarching framework currently exists to which reference can potentially be made, including in the field of urban planning. It is the System of Environmental Economic Accounting—Ecosystem Accounting (SEEA EA). The SEEA EA approach, developed by the United Nations in its current form in 2021, represents a standardized methodological framework for the assessment and monetization of ecosystems and their services. The adoption of the SEEA EA was preceded by a series of influential international initiatives that progressively contributed to the development of shared conceptual and operational frameworks for ES assessment, including the Millennium Ecosystem Assessment (MA, 2005), The Economics of Ecosystems and Biodiversity (TEEB, 2010), the establishment of the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2012), and the biodiversity commitments embedded in the Aichi Targets and the Sustainable Development Goals. At present, ES valuation is conducted in two steps: first through a biophysical measurement [9], now recognized as an international statistical standard, and subsequently through a monetary estimation [10]. SEEA EA currently represents the official methodological framework for integrating environmental accounts into national accounting systems, as required by the European Union starting from 2024 (Amendment to Regulation (EU) No 691/2011). Its adoption is regarded by many scholars as an effective strategy to counteract the economic invisibility of nature. However, this framework remains largely unfamiliar to planners. At this point, the central question concerns the advantages of adopting the SEEA EA method compared to other ES assessment approaches, such as those traditionally used by ISPRA in Italy in soil consumption reports, within the EU LIFE+ MGN project for protected areas, in various Urban Green Plans, or within the planning literature. Among the main strengths of SEEA EA are the high level of precision required through the use of site-specific parameters, the methodological rigor aimed at avoiding double counting, and the clear distinction between ecosystem contributions and other production factors. Another distinctive feature is the focus on the actual use of services rather than their potential supply, thereby explicitly integrating the relationship between demand and supply. But, most of all, SEEA EA is rigorous and coherent in the economic metric considered, which is exchange value; in other terms, ES are valued with respect to the value they assume in a real or hypothetical market. This is a metric aligned with National Accounts, consistent with the objective for the building of the SEEA EA scheme within the Environmental Accounting universe, to have a country-shared framework to integrate ecosystem assets and ES into national accounting frameworks. However, as anticipated in the last paragraph, exchange value is considered unable to capture the actual comprehensive value of ES, and this raises questions about whether and how SEEA EA should be used within planning practice. This literature review will therefore introduce SEEA EA applications within the planning field in order to discuss its potential and prospects for use.

1.4. Objective of the Literature Research

This contribution tries to identify, through a semi-systemic literature review, which are the tools, methods, and most widely adopted and appropriate approaches for the assessment of ES at the local planning scale. At this stage, referring to the "local scale" remains somewhat ambiguous; however, this will be clarified in the methodological phase through the selection of filtering criteria, as well as in the Section 3, specifically in the part devoted to the scale choices of the analyzed papers. More generally, the perspective is not intended to be solely administrative. Nevertheless, if interpreted in such terms, the local scale would correspond to a sub-regional level (as in [1]), and thus, within a European context, to the NUTS3 and LAU levels. From an ecological and socio-economic standpoint, however, the definition is inherently complex and flexible and largely depends on the ES under consideration.

The literature review also involves examining how such ES assessment can be integrated into planning instruments, taking into account the technical and cultural barriers that limit its implementation. These barriers are primarily economic in nature: first, because economic development acts as the main driver of land consumption; second, because there is a strong lack of awareness of the key role that the conservation of ES plays in fostering not only environmental but also economic and social improvement. Conceptualizing soil value beyond conventional notions of land value has significant potential to open up new decision making pathways.

This leads to investigations into the economic valuation of ES and, in particular, the methods and monetary metrics employed, which reflect different value systems. Consequently, these approaches must comply with both ethical and effectiveness criteria in order to be integrated into, or used alongside, urban planning instruments.

Accordingly, this review is structured around four interconnected themes: (1) the conceptualization of soil value through ES; (2) methods and metrics for ES valuation and monetization; (3) barriers and pathways for integrating these approaches into local planning practice; and (4) the potential role of SEEA EA as an operational framework for planning.

In the Section 2, the methodology that led to the final sample of papers analyzed will be described in detail. In the Section 3, a statistical overview of certain aspects will be provided, alongside a narrative presentation of other findings, addressing the research questions that guided the analysis. Finally, the Section 4 will aim to synthesize the results and complete the overall picture by integrating insights from previous literature, as well as by offering reflections and suggesting directions for future research.

2. Materials and Methods

The first phase of the analysis involved defining a method for reviewing the literature. In this regard, the focus was immediately placed on the research objective: as explained by Snyder, the objectives of systematic reviews differ greatly from those of semi-systematic and integrative reviews [11]. While the former are more rigid and rigorous in their research techniques, screening, and analysis of results (usually with statistical and quantitative surveys), semi-systematic reviews are applied to investigate the state of the art on a certain topic, typically multidisciplinary, in a qualitative–quantitative manner, while integrative reviews are generally qualitative and aim to combine different theoretical and methodological perspectives. For the present analysis, a semi-qualitative or semi-systematic review immediately seemed the optimal choice, representing a useful tool for identifying potential research and analysis traditions that have implications for the study, as well as gaps in knowledge within the literature [11]. This type of review is designed to ensure a certain degree of rigor and systematicity in the research and selection phase, as well as transparency and reproducibility; however, a certain degree of flexibility is guaranteed in the interpretative analysis and in the construction of a narrative based on the interpretation of the results [12–14], which is exactly the rationale followed in the Section 3. The research framework used is partially inspired by that reported in Zunder, which conceptually differs little from that of the (systematic) PRISMA method, but it has been largely personally adapted, as shown in Figure 2 [12].

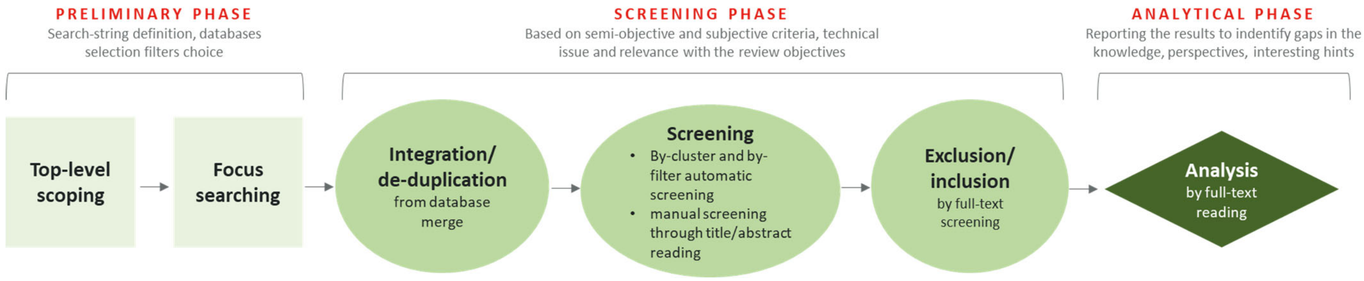

Figure 2. Semi-qualitative and self-constructed review process of the literature review. Source: own elaboration by authors.

Each phase presented in the diagram in Figure 2 will be described and illustrated in the following sub-sections (Sections 2.1–2.5). To follow the overall flow of the paper, Supplementary Materials S1 hosts more detailed information about the most complex phases of the review design.

2.1. Top-Level Scoping

As indicated, the top-level scoping phase involved an exploratory effort to understand the breadth of the field by consulting available sources, mainly policy documents and institutional guidelines (UN, EC), which helped steer the research towards specific temporal frameworks and terminology. Again, already known milestones, such as the publications of De Groot, Costanza, Daily, Ruhl, and, more recently, La Notte, Barton, Gomez-Baggethun (for the Environmental Economics field), and Geneletti (for urban planning), were taken into account in order to orient the literature review inside of specialized and less explored thematic areas.

2.2. Focus Searching

Starting from two initially defined research questions—(1) how can ES assessment be performed and integrated into local planning tools or practices and (2) which monetary metric can ethically and effectively reflect the economic value of ES within planning frameworks—two main sub-themes were subsequently identified and explored through targeted search strings. The first sub-theme concerns operational and strategic assessment experiences within the broader domain of decision making and policy development across different scales. It primarily relates to Environmental Economics and requires outputs that are spatially explicit and quantifiable in order to be applicable within planning contexts. The second sub-theme addresses more comprehensive assessment approaches, specifically those already integrated into planning processes.

Given the complexity of terminology characterized by multiple variants, declensions, and synonyms, the search queries were deliberately formulated to be as inclusive as possible. The resulting search string is presented in Figure 3.

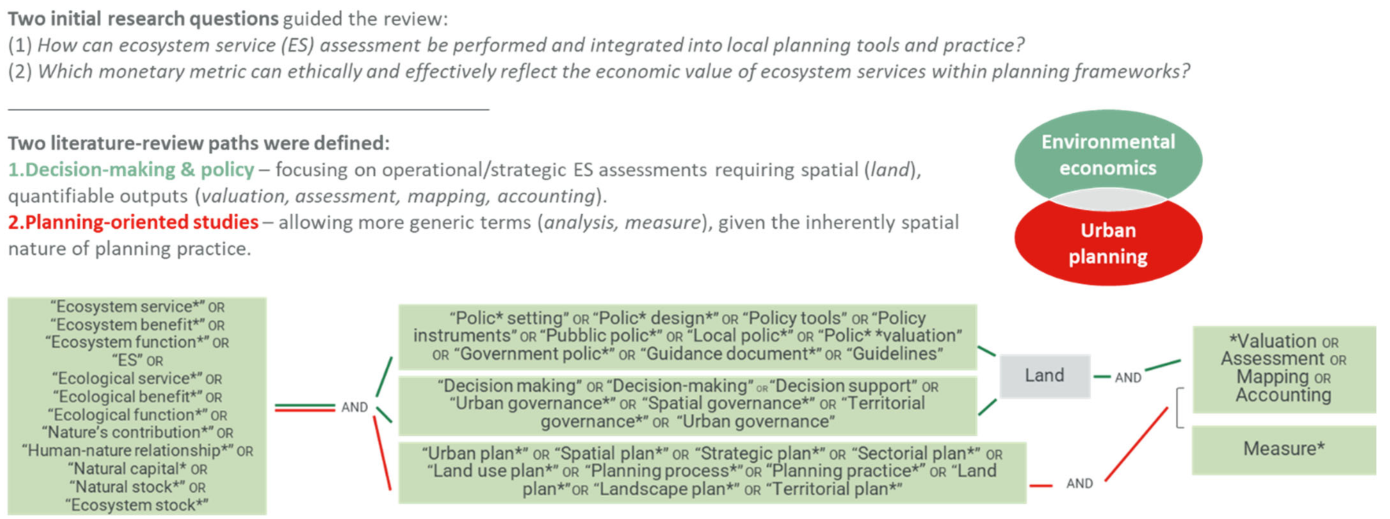

Figure 3. Research workflow and terminological and syntactic choices for the construction of search strings. Note that the symbol * indicates omitted caracters, suffixes or endings that may vary. Source: own elaboration by authors.

The inclusion of disciplinary fields not strictly related to urban planning is justified by the novelty of ES assessment, which is historically rooted in Environmental Economics, itself closely linked to Ecological Economics (associated with Robert Costanza) and the newer domain of Environmental Accounting-see [15] for a comprehensive description of Environmental Economics' development and its link to the Environmental Accounting field (from which SEEA EA originated). These fields are accustomed to developing and applying methods for the biophysical and monetary valuation of ES at different scales, typically within defined and closed system boundaries, an aspect they share to a significant extent with urban planning, which tends to operate inside of administrative extents.

At this stage, the results were filtered using the tools available within the selected databases. The filtering choices within each database are reported in Supplementary Materials S1.

These operations finally led to a number of 2319 records from Scopus and 236 records from WoS.

2.3. Integration/De-Duplication

The subsequent steps were carried out in an R environment using RStudio (version 4.5.1). The first operation consisted of merging and deduplicating the datasets, resulting in an initial comprehensive database of 2497 records. Each record corresponds to a row containing information such as the publication title, DOI, authors, keywords, abstract, publication type, corresponding author status, and other metadata typically exported from Scopus and WoS.

2.4. Screening

2.4.1. Automatic Screening

By-Cluster Automatic Screening

Starting from this initial dataset, a multi-step filtering procedure was applied to structure the literature according to the analytical focus of the research. All of the details about this clustering procedure are reported in Supplementary Materials S1.

These steps enabled identification of three clusters: “Operational_monetary_results” (OM, comprising 417 records), “Operational_non_monetary_results” (OnM, resulting in a subgroup of 437 records), and “Theoretical_monetary_results” (TM, consisting of 323 records).

The rationale underlying this clustering is grounded in the need to represent the different analytical dimensions of ES research captured by the applied filters. This, in turn, ensures that the final sample is methodologically consistent and thematically coherent within the broader domain of ES assessment. In particular, a first filter (“planning terms” in Figure 4) focused the analysis on studies addressing ES within planning theory or practice, rather than purely ecological or environmental management domains. A second filter (“market terms” in Figure 4) was applied to sketch the economic dimension of ES within the literature, selecting studies that address monetary valuation or adopt market-based approaches, but theoretical results would be appreciated, too. In parallel, a third filter (“valuation terms” in Figure 4) enhances the operational dimension of ES assessment, capturing contributions that provide quantitative or spatially explicit evaluations. Within this operational subset, further refinement (by “local terms” and “multiple terms” filters in Figure 4) was introduced by restricting the analysis to studies that consider multiple ES and are conducted at spatial scales relevant for planning practice, ensuring consistency with the research focus.

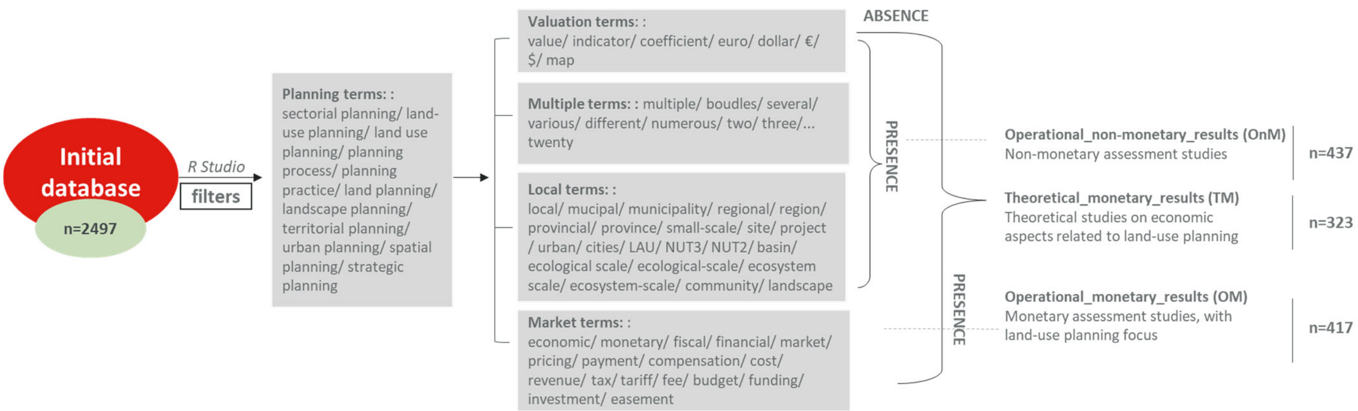

Figure 4. Automatic filtering conducted in R studio for cluster generation—with explicit terminology. Source: own elaboration by authors.

In Figure 4, a more comprehensive scheme is reported, together with the full list of words used within each filtering criterion.

By-Filter Automatic Screening

After clustering the records, additional automatic screening was applied at the cluster level in order to further refine the dataset.

In particular, a temporal filter was applied to the subsets containing operational outputs (OnM and OM), with the aim of selecting assessment experiences characterized by more rigorous and widely shared ES valuation approaches. From an operational perspective, key milestones in ES accounting (identified precisely thanks to the initial top-level scoping phase) can be identified; they are reported and summarized in Supplementary Materials S1.

From this perspective, the 2021–2025 timeframe was considered. In both the subsets, more than 50% of the results were maintained after filter application.

For theoretical monetary results (TM), investigated primarily to obtain insights into strategies and approaches for integrating the monetary or market value of ES into planning, the screening filter must be spatially coherent and applied in particular to European states that comply with the same directives, regulations, and guidelines, with direct implications for planning practice (such as the aforementioned Biodiversity Strategies and Nature Restoration Law). In addition, results produced in Australia and Canada have been included, as they are considered highly mature in this field [1]. Details about this filtering procedure are reported in Supplementary Materials S1.

Finally, automatic exclusion was performed based on purely technical aspects of the publications: results falling into the categories of conference papers, proceedings papers, short reviews, errata, editorials, and notes, as well as those not in English, were excluded from all three records.

An overview of the last two processes of automatic screening is presented by cluster in Table 1.

Table 1. Overview of automatic by-cluster screening and automated exclusion (note that exclusion was not performed by cluster, despite being presented as such in the table). Source: own elaboration by authors.

	Initial Subset	Subset After Screening by Cluster		Subset After Automatic Exclusion
TM	323	Spatial screening	213	187
OM	417	Temporal screening	211	195
OnM	437	Temporal screening	243	226

2.4.2. Manual Screening

Screening by Reading

At this stage, full-text reading of titles and abstracts was undertaken in order to further refine the results obtained. After manual cluster adjustment to better fit the categories, selection was based on a combination of two criteria:

- Semi-objective criteria. These involve the characterization of papers through objective labels, each assigned different implicit weights: context (rural/urban); single-service or multi-service evaluation; European or non-European case study; scale choice (“wrong” when referring to spatial units that are either too large or too small and conceptually distant from NUTS3/LAU levels); focus on monetization; economic–ecological link; participatory approaches; presence of technical contributions, such as benefit transfer methods; etc. Some of these criteria may appear redundant with respect to the filters previously applied; however, they reinforce the selection process and help reduce errors. It should be noted that as this was a semi-systematic review, the decision to include or exclude an article was primarily guided by a set of criteria that did not all carry equal weights; for instance, the geographical criterion was considered less important than others (but nonetheless would become decisive when papers were selected for technical reasons). Conversely, the incorrect scale (WS) criterion was consistently dominant for exclusion purposes, as was the specific field (SF) criterion.
- Subjective criteria. Papers were grouped into three broad categories according to their usefulness for the analysis: “conceptual”, when they included new elements, both operational and non-operational, in terms of novel lines of reasoning, potential

applications, or avenues for further development; "citation useful", when their results, although not fully replicable, were relevant and useful in comparative terms; and "technical", when they contained operational aspects useful for an ex novo ES assessment.

For the purposes of the present paper, and in line with a semi-systematic literature analysis aimed at assessing, as initially stated, the state of the art on a given topic and emerging perspectives, only papers considered conceptually relevant were included. These were selected provided that they did not meet any semi-objective or subjective exclusion criteria. This manual screening process thus allowed the isolation of conceptual papers, namely those providing insights into the integration of ES assessment within urban planning, economic instruments for ES conservation, landscape integration, and relevant scale choices. Inclusion, on the other hand, was justified by the simultaneous presence of "conceptual" subjective criteria and at least one the corresponding semi-objective criteria (see Figure 5). This led to the selection of 93 papers.

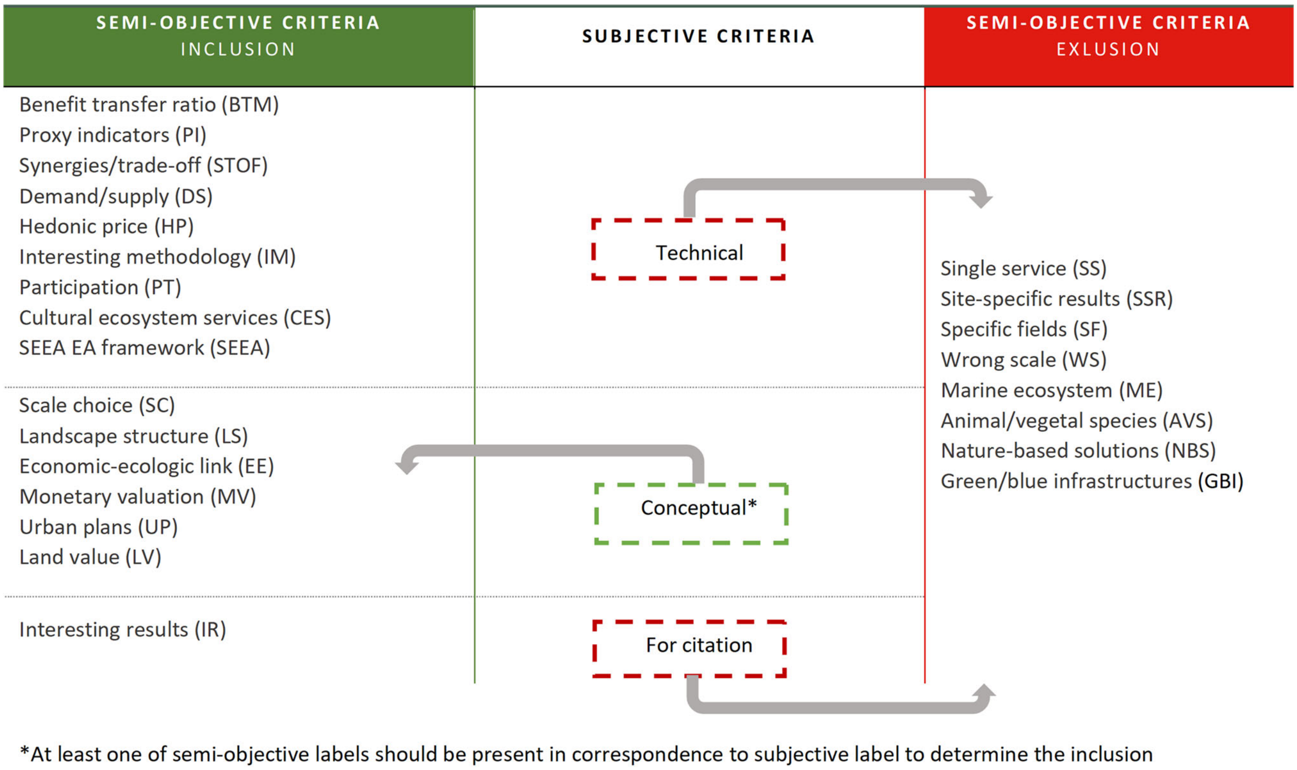

Figure 5. Manual screening rationale. Source: own elaboration by authors.

The decisions taken are presented in Figure 5. Certainly, the other papers not excluded through semi-objective criteria but addressing more technical aspects or reporting particularly relevant results (citation-oriented papers) may prove useful and valuable in future and more mature stages of the research beyond the present phase, which is intended to be more exploratory. In total, 62 papers were selected for technical purposes and 53 for citational insights. However, these are not the focus of the present literature review.

2.5. Exclusion/Inclusion

The last phase involved full-text screening of the selected documents, which allowed for further exclusion due to their unsuitability for the research objectives or lack of accessibility. In addition, some papers from the initial pool of 2497 were included ex officio because they explicitly addressed SEEA EA; of these, only one passed all selection stages "on its own", while a further five were added due to their indispensable relevance for the full-text screening phase.

Figure 6 illustrates the flow of manual screening, exclusion, and final inclusion that led to the definition of the final set of papers to be analyzed in order to address the research questions. As shown in the Figure, the papers included in the final set are reasonably representative of each of the clusters previously defined, which in turn capture relevant aspects of the research investigated through the literature review. Although limited in size, the final set can therefore be considered a representative sample. Supplementary Materials S2 reports the exhaustive list of records analyzed (Table S2).

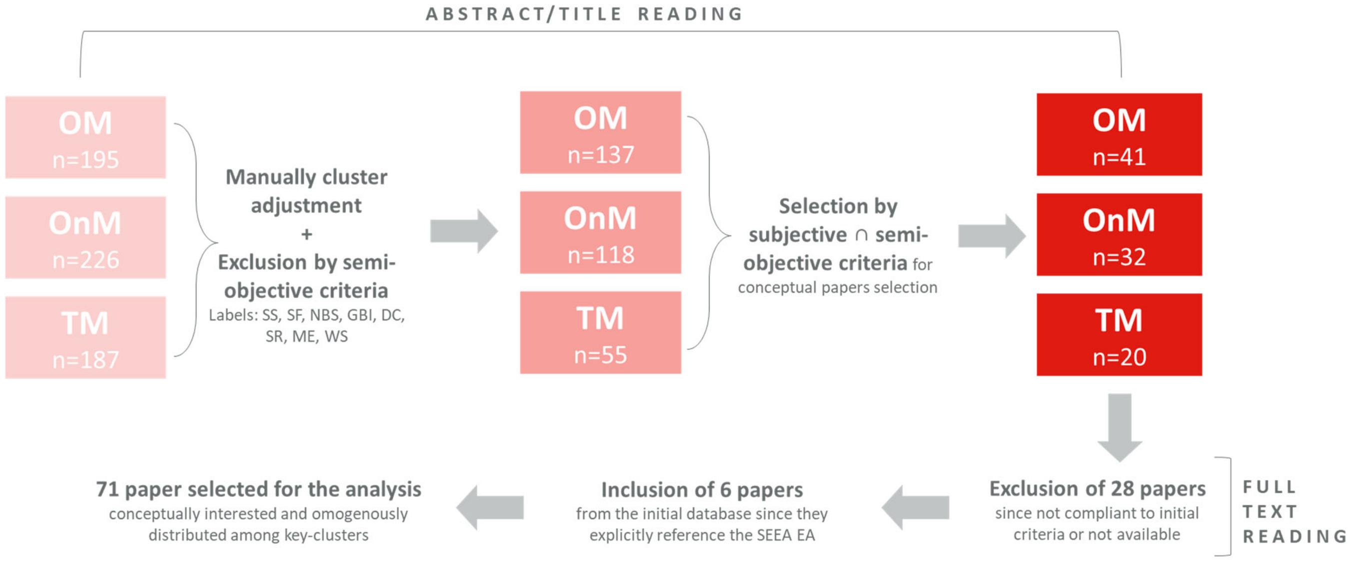

Figure 6. Flow of manual screening, exclusion, and final inclusion of papers to obtain the final sample for analysis. These passages correspond to manual screening and exclusion/inclusion in the screening phase in Figure 2. Source: own elaboration by authors.

2.6. Development of the Analytical Reading Grid

In order to organize all the contributions to the research, a reading grid was developed to present the papers according to shared criteria (see Section 2.4), while still allowing, through full-text reading, space for general and narrative comments. The reading grid is reported in Figure 7. As shown, it was constructed in order to organize for each record General information as author, title, year and journal of publication. A specific section was dedicated to the Definition of ES and landscape, with the aim to highlight eventual links and insights about the optimal assessment scale and perspective, while also providing a picture of the already fragmented nature of the field, even at the level of the conceptual definitions within which ES valuation attempts are embedded in planning frameworks.

For the Assessment aspects, information collected regards: the geographic context; whether an ES assessment was conducted, on which services and with which method; whether a monetary ES assessment was conducted, on which services and with which method; additional notes about novel/useful aspects.

Please note that some of this information are collected for completeness but are not significant: in particular, year/place information are hugely biased by the screening conducted in the previous phase and consequently are not systematically object of discussion in the following paragraphs.

The definition of the reading grid also provided an opportunity to further refine and operationalize the research questions, which were initially formulated in broader terms. In this phase, each research question was articulated into more specific analytical sub-dimensions in order to guide the systematic reading and comparison of the selected papers.

STATISTICAL ANALYSIS OF THE RECORDS			NARRATIVE ANALISYS OF THE RECORDS	
RECORD METADATA	**DEFINITIONS**	**ASSESSMENT**	**PLANNING UTILITY**	**ENVIRONMENT - ECONOMY LINK**
General information on the record	*Is there a* ***definition*** *provided?*	*Which* ***frameworks and valuation techniques*** *for ES are proposed?*	*Research question n.1:* *How can* ***ES evaluation*** *be integrated into* ***planning tools****?*	*Research question n.2:* *Which* ***monetary metric*** *can ethically and effectively reflect the* ***economic value*** *of ES within planning frameworks?*
Authors **Title** **Year** **Journal**	**Ecosystem services** **Landscape**	**Geographic context** **ES valuation** Yes/No, which ES and with which method **Monetary valuation** Yes/No, which ES and with which method Additional notes on innovative/useful aspects	**Scale of analysis** (administrative, ecological,...) **Utility explicitly for planning** Yes/No and in which way Additional notes on innovative, useful aspects	**Explicit link** with the economy Yes/No and in which way **Soil value** and **economic metrics treated** Additional notes on innovative, useful, and applicable aspects

Figure 7. Reading grid explicating criteria against which papers were fully read and analyzed. Source: own elaboration by authors.

- Planning utility—How can ES valuation be integrated into planning instruments, and which valuation frameworks and techniques have been proposed within the scientific literature?
  The research question was detailed into two analytical subgroups. The first concerns scale choices and planning instruments to determine at which spatial scales the ES assessment is conducted and which planning tools are considered (e.g., sectoral plans, master plans, regional plans, etc.). The second subgroup addresses more conceptually the explicit linkage with planning theory and practice, investigating whether and how the literature promotes or operationalizes the integration of ES valuation within formal planning tools. Also, in this case, information collected could appear redundant with respect to the previous screening passages (which, for example, preventively excluded "wrong scale" results) but instead ensures consistency and enables manually correcting errors thanks to the full-text reading.
- Environmental–economic link—According to past academic research, which monetary metric can ethically and effectively reflect the economic value of ES within planning frameworks?
  The research question was articulated into two subgroups. The first examines the explicit relationship between economics and the environment, assessing whether such a relationship is explicitly addressed in the studies and through which conceptual or methodological tools (e.g., ES monetization). The second focuses on the soil value/land value distinction, exploring whether the literature explicitly acknowledges the gap between the economic value of soil grounded in ecosystem functions and the conventional real estate value attributed to land within property markets. This distinction would directly identify reasoning around the most appropriate metric for ES monetary assessment.

Through this structured articulation, the reading grid enabled a more consistent and comparable analysis of the selected literature (statistical analysis of the records) while preserving the possibility of integrating qualitative and interpretative observations emerging from the full-text reading of the papers (Figure 7).

3. Results

The results of the literature review are presented through an analytical framework based on a structured reading grid (see Section 2.6), which served as the main tool for organizing and synthesizing the findings. Through this grid, it was possible to conduct a statistical analysis of metadata, as well as to examine definitions of ES and the landscape, the typologies of ES, and the techniques used for their assessment. In addition, a narrative analysis of the records was carried out, with particular attention to their planning utility and the environment–economy link. These results are presented in detail in the following sections.

3.1. Statistical Analysis of the Records

3.1.1. Record Metadata

Chronological analysis of the records is not indicative, as a chronological filter has been partially applied in the previous steps. However, it could be useful to detail the wideness of the sample. As shown in Figure S4 in Supplementary Materials S1, a peak in publications occurred in 2021–2023, which were the years of the Global Biodiversity Framework, SEEA EA's publication, and the EU Soil Strategy.

Author occurrence analyses do not reveal interesting results: only two papers share a number of common authors [16,17].

In terms of publications, the most popular journal within the sample is *Land* (12 publications), followed by *Science of the Total Environment* (8) and the *Journal of Environmental Management* (6). Another 24 records registered single journal publications. These results, together with the chronological analysis of the publications, are reported in Figure 8.

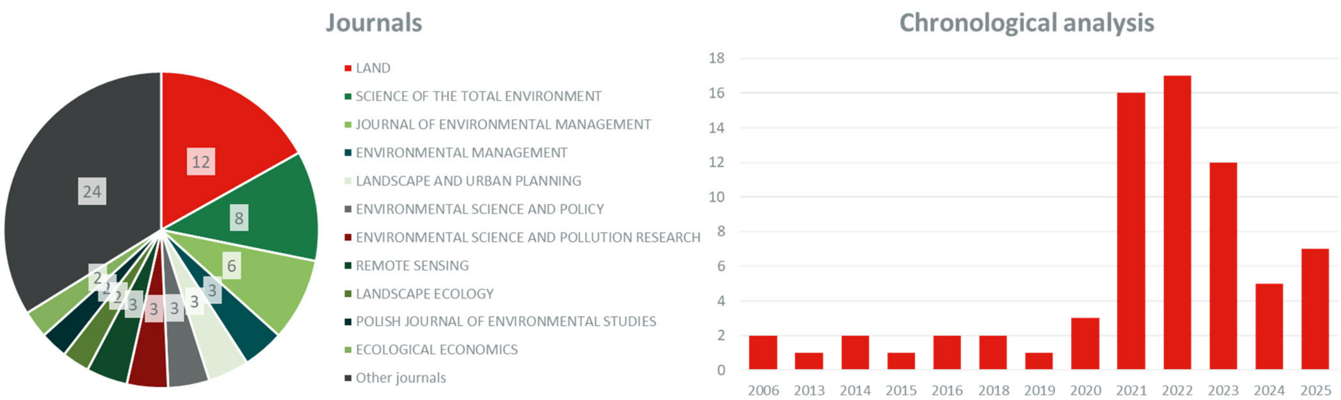

Figure 8. Journal publication frequency and chronological analysis. Source: own elaboration by authors.

3.1.2. Definitions

The definition of ES is attributed to Costanza et al. [18] and Daily [19], but it was acknowledged only after the publication of the Millenium Ecosystem Assessment (MA) in 2005. Several authors emphasize that the concept is much older and rooted in the very ancestral relationship between humans and nature. An explicit reference can be found about 160 years ago, when in his Report on the Artificial Propagation of Fishes George Perkins Marsh criticized members of his community for their misguided prejudices against animals, reptiles, and birds due to the fact that they were perceived as harmful to crops. On the contrary, Marsh highlighted their invaluable benefits for the ecosystem and for agriculture itself.

In this work, the concept of ES has been analyzed from a planning perspective in order to understand which aspect emerges most clearly: its instrumental and anthropocentric nature, the potential of its assessment in consideration of sustainable urban planning, and its spatial nature. The results are presented in the following table (Table 2).

Table 2. Definitions of ecosystem services derived from the full-text review of the papers included in the sample. The reference definition in the scientific literature is reported at the top, as it is frequently cited across the analyzed studies. Source: own elaboration by authors.

Reference	ES Definition
Costanza et al., 1997 [18], **MA, 2005** [20]	Ecosystem services are the benefits that humans derive from ecosystems
Daily, 1997 [19]	Ecosystem services represent the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life
Termorshuizen and Opdam, 2009 [21]	Ecosystem services represent a link between sustainable landscape management and ecology
Caldarice and Salata, 2019 [22]	Ecosystem services are the benefits that the soil provides to communities
Gao et al., 2022 [23]	Ecosystem services are essential for human society, and maintaining harmony between ecosystems and humanity to mitigate ES degradation is the fundamental basis for achieving a sustainable state
Slootweg, 2016 [24]	Ecosystem services have been promoted as an effective concept to translate biodiversity into understandable language for planners, decision makers, and the public at large
Aryal at el., 2023 [25]	Ecosystem services are a fundamental component of well-being and sustainable urban development with tremendous potential to enhance urban planning
Fisher et al., 2009 [26]	Understanding the processes that determine the benefits people obtain from nature, so-called ecosystem services, is crucial for the planning of sustainable, resilient, and multifunctional landscapes

Although not included in the table, as it does not constitute a formal definition, it is worth recalling the definition provided by Zepp et al., which conceptualizes ES as a common language—defined as "the Esperanto of planning"—making biodiversity and ecological functions more understandable to planners, policymakers, and the public [27]. At the same time, ES emerges as a bridge between ecological processes and the sustainable management of landscapes and urban systems.

A review of the definitions of the concept of the landscape is presented in Table 3, with the aim of outlining its connections with the concept of ES. Starting from the European Landscape Convention (2000, ETS No. 176, amended by the 2016 Protocol) definition, it is evident that landscape is the result of human action and interaction with the natural environment to the extent that it determines changes in its configuration, structure, and form. The provision of ES depends on these processes, as well as ecosystem degradation, and is in turn influenced, facilitated, or disrupted by landscape forms and dynamics.

Therefore, in urban planning, land use shapes landscapes, and landscapes in turn determine the supply of ES. This is a further confirmation that planning must integrate both spatial patterns (the landscape) and functional benefits (ES) to foster sustainable and resilient urban and rural systems.

From these considerations, it can already be stated that the landscape scale is the most suitable for capturing synergies and trade-offs among different land uses and functions.

Table 3. Definitions of the landscape derived from the full-text review of the papers included in the sample. The reference definition in the scientific literature is reported at the top, as it is frequently cited across the analyzed studies. Source: own elaboration by authors.

Reference	Landscape Definition
European Landscape Convention, 2000	Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.
Morán-Ordóñez, 2022 [28]	Landscapes are defined by the natural features and ecology of an area, as well as the local context, including cultural and historical land use patterns, consisting of multiple functions and dynamic physical, biological, and social rules.
Blaschke, 2006 [29]	Landscape refers to a common perceivable part of the Earth's surface, from which land use is the most dynamic aspect. Landscape change does happen when gradually the land cover transforms to a new dominant type, causes structural change and demands larger fields, special treatment of the soil, terrain leveling, removal of hedgerows, and new, enlarged roads.
Gonzàlez-Garcìa et al., 2022 [30]	Depending on context, the terms landscape and territory are indistinctly applied to refer to the same concept. Nevertheless, the term territory better fits the purpose of planning based on policy instruments because it refers to the management–administrative power space.
Metzget et al., 2021 [31]	Landscape is an heterogeneous areas composed of various land use and cover classes.

3.1.3. Assessment

Assessment of ES was analyzed considering two sub-questions:

1. Does the paper perform an ES assessment?
2. Does the paper perform a monetary valuation?

From the analysis of ES assessment methods, it emerges that only half of the planning-related papers perform an ES assessment. In other cases, only ecological functions were identified rather than ES themselves; this is the case, for example, of Blaschke, who proposes "functional" landscape indicators, that is, indicators capable of describing not only the physical structure of the landscape but also its ecological functioning and its connection to human land use [29].

In total, 54 papers focus on a case study, and, among these, only 38 conduct an ES assessment. In other cases, the discussion is merely theoretical or a literature review.

For SEEA papers, only two perform an ES assessment, with no monetary valuation.

Monetary valuation remains in general a specific niche when linked to planning; in total, only 14 out of 71 records perform it.

Table 4 quantitively presents the results of this first assessment analysis.

Table 4. ES assessment, both biophysical and monetary, exercises within the sample analyzed. Source: own elaboration by authors.

SEEA Records + Other Records = Total			
	Monetary Valuation: YES	Monetary Valuation: NO	**Total**
ES assessment: YES	0 + 14 = 14	2 + 22 = 24	**2 + 36 = 38**
ES assessment: NO	0 + 0 = 0	4 + 29 = 33	**4 + 29 = 33**
Total	**0 + 14 = 14**	**6 + 51 = 57**	**6 + 65 = 71**

Regarding the types of services analyzed, several clarifications are necessary. As outlined in the Section 1, multiple classification frameworks for ES exist, primarily referring to the Millennium Ecosystem Assessment (MA), The Economics of Ecosystems and Biodiversity (TEEB), and Common International Classification of Ecosystem Services (CICES) systems. In 2021, the SEEA EA introduced its own classification list of ecosystem services, with particular attention to clearly distinguishing services in order to avoid both conceptual and valuation overlaps, as well as double counting. However, in the papers analyzed, classifications—and, consequently, the naming of ES—are highly heterogeneous, making comparison challenging. In some cases, studies rely on established classification systems, while in others they adopt lists derived from seminal contributions, such as Costanza et al. [18] and Xie et al. [32,33], often also sharing their valuation approaches. At the same time, this lack of standardization further highlights the need for a common institutional framework to ensure a shared language when addressing ES and their valuation. In this respect, the SEEA EA represents a significant step toward meeting this need. This comparison in terms of classification and denominations is fully reported in Table 5.

Table 5. Comparison between SEEA EA ecosystem services classification and ES heterogenous denominations within the papers. Source: own elaboration by authors.

SEEA EA Service *	ES Nomination Inside of Papers
Crop provisioning services	Food production; Food supply; Provision of food; Crop provision; Crop production; Agricultural production; Food
Grazed biomass provisioning services	Pasture yield; Forage provision for livestock
Livestock provisioning services	Livestock; Animals reared for nutritional purposes
Aquaculture provisioning services	Animals reared by in-situ aquaculture for nutritional purposes
Wood provisioning services	Wood provision; Timber production; Fuelwood; Wood production
Water supply	Water supply; Fresh water provision; Water provisioning; Clean water; Water provision; Water resource supply; Surface water used as a material; Ground water used as a material; water yield; water conservation;
Other provisioning services, genetic material services, wild animals, etc.	Raw material production; Raw material supply; Raw materials; Energy crops, agriculture, forestry, nature management; Energy, food and feed, materials, medicinal, biochemical, and genetic resources; Fuel, wood, fiber, fodder, fertilizer and medicine; marketable products
Global climate regulation services	Carbon sequestration; Carbon storage; Carbon stock; Carbon fixation; Carbon in biomass; Carbon in the soil; Climate regulation; Regulation on global climate; carbon fixation; greenhouse gas emission; C storage
Local climate regulation services	Microclimate regulation; Cooling; Cooling effect from green agriculture; Regulation of temperature and humidity; Regulation of global climate
Air filtration services	Air quality; Air purification; Air protection; Dust retention; Air quality regulation; Regulation of air quality; Gas regulation
Soil quality regulation services	Soil formation; Soil quality; Soil quality regulation; Nutrient cycling; Nutrient storage in the soil; Decomposition and fixing processes; Soil formation and retention; Formation, permeability, and decontamination of soils; Transformation of biochemical or physical inputs of ecosystems; Moisture preservation; Pollution from fertilizer use; P storage; N storage; Environmental purification; purifying environment; Cycling; Maintenance of nutrient circulation; Nutrient regulation
Soil and sediment retention services	Soil conservation; Soil protection; Soil retention; Sediment retention; Erosion control; Anti-soil erosion; Erosion prevention; Erosion; Soil Erosion; Soil conservation supply; Sediment regulation

Table 5. *Cont.*

SEEA EA Service *	ES Nomination Inside of Papers
Water purification services	Water purification; Water purification and waste treatment; Aquatic purification; Regulation of chemical condition of freshwaters; water use/filtration; water protection
Water flow regulation services	Hydrological regulation; Water regulation; Water retention; Water infiltration; Hydrological cycle and water flow regulation; water use/filtration; Run-off mitigation; Annual and seasonal water yield
Flood mitigation services	Flood control; Regulation of hazards and extreme events
Storm mitigation services	Mitigation of natural disasters
Noise attenuation services	Noise reduction; Noise attenuation; Noise mitigation; Disturbance regulation
Pollination services	Pollination; Pollinators and dispersal of seeds; Seed dispersal
Biological control services	Biological control
Nursery population and habitat maintenance services	Habitat quality; Habitat protection; Habitat maintenance; Habitat provision; Habitat/refugia; Animal habitat; Maintaining nursery populations and habitats; Biodiversity protection Biodiversity; Biodiversity conservation
Solid waste remediation	Waste treatment
Other regulating and maintenance services	Ecological connectivity; Oxygen production; Biophysical processes
Recreation-related services	Recreation; Recreation and tourism; Outdoor recreation; Tourism and entertainment; Ecotourism; Recreation and culture; Ecotourism linked to birdwatching; Recreation/Ecotourism; Physical and mental health; Characteristics of living systems that enable activities promoting health (active); Health effects of nature
Visual amenity services	Aesthetic value; Aesthetic landscape; Natural scenery; Design aesthetics; Aesthetics; Characteristics of living systems that enable aesthetic experiences; Characteristics of living systems that enable activities promoting health (observational); Added value to houses due to a green environment
Education, scientific, and research services	Education and training; Educational activities; Characteristics of living systems that enable scientific investigation; Education and knowledge; Physical and psychological experiences; Characteristics of living systems that enable education and training
Spiritual, artistic, and symbolic services	Cultural and spiritual values; Cultural identity; Sense of peace; cultural heritage; Heritage values; Identity, sense of place; Natural and cultural heritage; Culture; Cultural services
Ecosystem and species appreciation services	Species diversity; Nature itself (green space); Individual organisms; Eco-diversity

* for biomass provisioning services, SEEA subtypes were considered.

The effort undertaken in this phase of the analysis led to the quantification of both biophysical and monetary assessments of ES identified within the analyzed sample, subsequently reclassified according to SEEA EA categories. The results, presented in Figure 9, show a clear predominance of biophysical assessments for services such as global climate regulation, water supply, soil quality regulation, nursery population and habitat maintenance (often referred to as habitat quality in the literature), and crop production. Monetary valuation exercises, which are considerably fewer, are dominated by soil quality regulation, global climate regulation, and crop provisioning services. These findings can be explained both by the fact that these services have historically been the most studied and benefit from well-established valuation methods and by the widespread use—among the analyzed studies—of rapid assessment approaches rather than model-based evaluations. These approaches often draw on the previously mentioned work of Costanza et al. [18] and Xie et al. [32,33], particularly in relation to the Ecosystem Service Value (ESV) method and the comprehensive lists of ES they propose, which will be briefly discussed below.

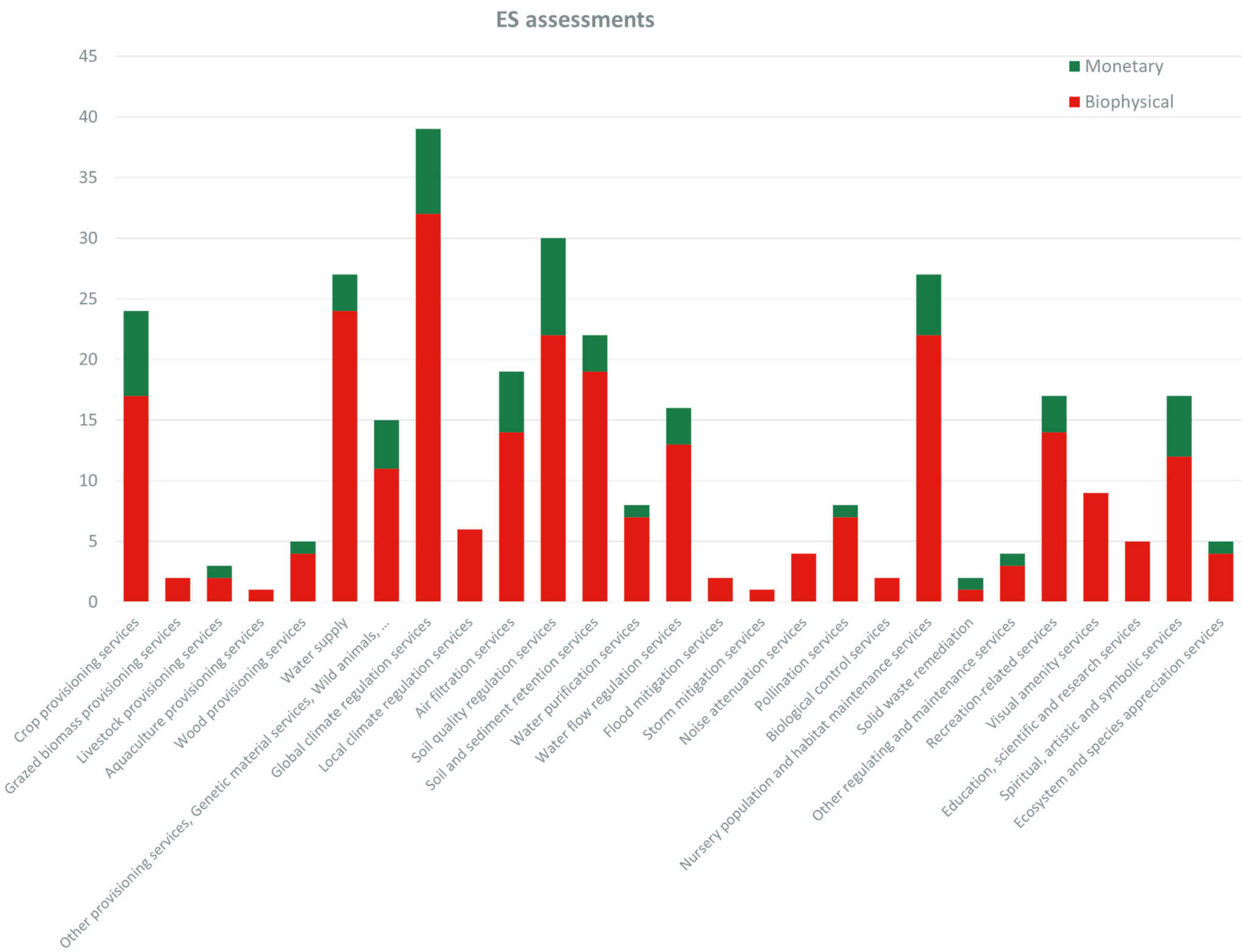

Figure 9. ES assessed through the papers analyzed both biophysically and monetary, with the relative occurrence within the sample. Source: own elaboration by authors.

Finally, in four cases, no ES are assessed, but general categories (provision services, regulatory services, cultural services, supporting services) are mentioned. This happens in Peck and Khirfan [34], Lee [35], Jin et al. [36], and Bekri et al. [37], who perform, respectively, an expert-based valuation, the value transfer method from Xie and Costanza, and a more accurate evaluation based on an EU-wide framework for mapping and assessment.

For what concerns the methods, as anticipated, among the sample, there is a predominance of rapid, no-site-specific assessments, which are scarcely rigorous. They consist, for example, of the ecosystem service value (ESV) method, based on Xie or Costanza-type coefficients, which belong to the value transfer methods. The value transfer method refers to the practice of estimating the economic value of ES in a given study area by transferring existing valuation estimates (or functions) derived from previous studies conducted in similar contexts [38]. This is the case, for example, of Wei et al. [39] and Jin et al. [36], who took values from other primary studies. Rapid assessments also comprise evaluation based on LULC factor tables and ES matrices (as in [40], in which parameters are based on the literature and successful projects in similar study regions) or other parameters from the literature [41,42].

Similarly, qualitative approaches use expert ranking, participatory ES matrices, and surveys to assign a value to ES; this is the case for Thiensen et al., in which indicators are evaluated qualitatively based on direct observations, interviews and unstructured questionnaires, literature reviews, and data provided by stakeholders using scores ranging from 0 to 1 [43]. Weights are assigned according to the frequency and relevance of each ES in the scientific literature and further refined through participatory weighting.

Biophysical or model-based assessments were conducted in only 15 out of 38 cases. They consist of the use of software such as InVEST 3.14.2 (e.g., in [22,30,44,45]), service/context-specific software like OpeNoise and ESTIMAP [46], or ECOPLAN-SE [47] and VITO [48] for multiple ES valuation. In these cases, the valuation is more site-specific and ecologically based, and it is not automatically followed by a monetary ES assessment.

Although they do not conduct a full ES assessment, it is worth noting that some papers (three) carry out a rapid assessment of ecosystem activity or ecological indices through remote sensing, using, for example, NDVI, RSEI, or the ESSI index. ESSI, in particular, is a composite indicator that estimates and maps supporting and regulating ES, primarily related to carbon and water dynamics. It is based on vegetation indices derived from satellite data, specifically the NDVI (Normalized Difference Vegetation Index); its application is discussed in [16].

Table 6 reports statistics regarding the ES assessment methods within the analyzed sample.

Table 6. ES assessment methods within the analyzed sample. Source: own elaboration by authors.

		*SEEA Records + Other Records = **Total***
Accurate biophysical modeling	Quantitative and ecologically robust approaches; InVEST, RUSLE, OpeNoise/ESTIMAP, ECOPLAN-SE	1 + 17 = **18**
Rapid assessment	Methods that transfer values from other studies, often based on LULC; Xie and Costanza-type coefficients, ES Matrix, parameters from the literature	1 + 13 = **14**
Qualitative/ participative assessment	Perception-based and expert judgment approaches (surveys, expert ranking, participatory ES Matrix)	0 + 6 = **6**
Total		2 + 36 = **38**

An important insight emerges from Albert et al.: no single assessment format is sufficient, but a combination is preferable. Indeed, semi-quantitative formats, typical of landscape planning, are easy to integrate and understand and are appreciated by planners but are often considered insufficiently rigorous by experts; biophysical numerical formats are useful for comparing scenarios and conducting technical analyses but less effective for political communication; monetary formats are effective in political and public debates but can be risky when applied to environmental planning [49].

3.2. Narrative Analysis of the Records

The narrative account, as is typical of semi-systematic literature reviews, is built on the selection of papers identified during the manual screening phase as conceptually relevant and containing elements useful for addressing the research questions. This allows the review to bring forward the most relevant cases and the most innovative approaches in relation to the questions that motivated and justified the analysis while also opening up further lines of reasoning to be developed in the discussion phase.

The following sections on the interpretative narrative are structured around two main thematic axes: "planning utility", which includes scale and context as well as explicit utility for planning purposes, and the "environment–economy link", which explores both the explicit relationship with the economy and the treatment of soil value and economic metrics.

3.2.1. Planning Utility

Scale and Context

For what concerns the scale of the context of the assessment, most of the papers focus on rural contexts (24 over 54), 17 on urban contexts, and 16 on mixed environments.

As expected, there is a predominance of studies at local scale: NUTS3/LAU from an administrative point of view or small catchments, specific forests, or ecological basins from a more environmental point of view; farm activities are considered from a more socio-economic perspective. This raises interest about scale typology: the majority of the papers (24 over 54) focus on an administrative scale, namely, the analysis is conducted entirely within a single administrative boundary (e.g., "Municipal" or LAU). In 13 cases, the analysis uses a pure functional or ecological boundary as the study unit, such as, for example, the catchment or a lagoon, as in Ruoso et al. [50]. The study adopts a "territorial lens" approach, which emphasizes the importance of place-based interactions by integrating physical, functional, and symbolic dimensions of the territory. In doing so, it aligns with an ecological (rather than administrative) scale, capturing how ES emerge from localized human–environment relationships.

As anticipated, in some papers, the landscape perspective is explicitly targeted as the most suitable, as it comprises conflicts and solutions: Brown [51] states that "a landscape approach (...) could provide a framework for allocating and managing land to achieve social, economic, and environmental objectives, recognizing that landscapes are characterized by a diversity of interest groups and multiple drivers of change". Similarly, Morán-Ordóñez et al. [28] declare that "integrating spatially-explicit planning tools and forest conservation policies and incentives can prove key to planning landscape-scale forest restoration across areas where conflicts between ecosystem recovery and socioeconomic development might arise".

Cross-scale options appear spread and offer a comprehensive vision: in some papers, cross-scaling is administrative (e.g., national/regional policies also evaluated at the local level), while in others it is ecological–administrative (e.g., analyzing a catchment ecological status across multiple administrative boundaries). The first one is the case for Tian et al. [52], who link provincial and national levels to assess how urbanization dynamics affect ES loss, identifying spatial patterns, interactions, and cumulative contributions. Even if the nature of ecosystem processes evidently transcends administrative boundaries, governance and policies operates within them and with different instruments and effectiveness with respect to the level considered. The second case, presented by Zheng et al. [53], adopts a multi-scalar ecological–administrative approach. In this framework, a locally defined administrative unit (the urban agglomeration) is identified based on ecological priorities embedded in national policies. By connecting city-level conditions with the broader territorial context, the approach enables targeted interventions and promotes synergies consistent with ecological objectives.

When the analysis focuses on units within socio-economics contexts, such as neighborhoods, companies, or projects, scale can be defined as socio-economic; this is the case for 7 papers out of 54, such as Lerounge at al. [48], where different ES are economically evaluated within a farm to identify their contribution to the activity.

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Finally, scale typology can be mixed and include multiple scales or case studies with ecological–economic relevance assessed within an administrative boundary.

Table 7 reports statistics regarding scale typologies for ES assessment of the analyzed sample.

Table 7. Scale typologies for ES assessment of the analyzed sample. Source: own elaboration by authors.

		With ES Assessment *SEEA records + other records = **total***	Without ES Assessment	**Total**
Administrative	The analysis is conducted entirely within a single administrative boundary (e.g., regional or municipal).	0 + 15 = **15**	9	**24**
Ecological/ Landscape	The analysis uses a purely functional or ecological boundary as the study unit (e.g., an entire catchment).	1 + 7 = **8**	5	**13**
Cross-Scale Administrative	The analysis explicitly links multiple administrative levels (e.g., a national/regional policy also evaluated at the local level).	1 + 4 = **5**	3	**8**
Cross-Scale Ecological–Administrative	The analysis examines an ecological boundary (e.g., a catchment) across multiple administrative boundaries (e.g., municipalities).	0 + 4 = **4**	1	**5**
Socio-Economic	The analysis focuses on units within socio-economics contexts, such as neighborhoods, companies, or projects.	0 + 5 = **5**	2	**7**
Mixed	Multiple scales or case studies with ecological–economic relevance are assessed within an administrative boundary.	0 + 1 = **1**	2	**3**

Utility Explicitly for Planning

The analyzed sample, although partially restricted to European theoretical cases through cluster-based selection—reflecting the focus of this literature review—also includes empirical cases from overseas, which, due to the applied selection criteria, tend to represent more practical and less theoretical experiences. In the following sections, the most relevant and significant cases emerging from the analysis of the papers are presented, with the geographical context specified where appropriate.

As an overall comment, it emerges clearly that ES can be theoretically integrated into planning instruments at different stages of the planning process. Ex ante, ES assessment supports decision making and enhances public acceptance by making the benefits of planning options more visible and understandable. In parallel, ES can be evaluated through Strategic Environmental Assessment (SEA) when conceived as a proactive and concurrent process with plan-making rather than as a purely regulatory step. This enables ES considerations to inform planning choices as they are developed [22,24]. Ex post, ES assessment supports the monitoring of outcomes, the adjustment of management and planning strategies, and the identification of areas where the provision or accessibility of ES can be improved. Further considerations will be provided in the Discussion.

However, from the analyzed records, the effort to integrate ecosystem-related knowledge into local planning instruments can still be considered immature. The reasons largely reflect those identified by Slootweg [24] and can primarily be attributed to a limited willingness to acknowledge, by decision makers as local administrators, the environmental damage caused by unbalanced land transformations. The case of Italian municipalities provides a relevant example: these are responsible for regulating land use regimes, where land take—when driven by public projects—is seen as an opportunity to provide services to citizens, and—when driven by private initiatives—to generate economic growth as well as revenue for the municipal treasury.

In any case, education about ES in the context of global and local crises in which we live (see [54]) is crucial. Within this context, the literature highlights how acknowledging and understanding the damages caused by urbanization represents a preliminary step toward strengthening planning awareness, particularly among decision makers. As stated by Albert et al. [49], the selection of information sources for planners is crucial: planners do not typically read scientific articles but rather rely on landscape plans, technical reports, and expert assessments. Therefore, information on ES must be translated into these practical tools, rather than remaining confined to academic publications, and should preferably be supported by workshops and meetings that help clarify the relationship between landscape and ES. An important and useful aspect concerns the governance of the science–policy interface: if science does not speak the language of planning, ES assessment results become ineffective [49].

A further limitation to the use of ES assessment in decision making concerns the difficulty of making information on ES values and damages understandable and assessable by non-experts, who at the municipal scale are primarily decision makers. In this respect, monetary metrics are identified in the literature as a potentially effective and universal language of communication, as will be further detailed in the following paragraph.

Several analyzed records propose the integration of ES assessments, and of this broader perspective, directly into planning instruments. This is done, for example, by suggesting ecological zoning (eco-zoning), namely dividing territories into areas characterized by different ecosystem–urbanization gradients [52,55] or by overlaying zoning with ecosystem performance indices [22].

For ex ante planning, ES valuation can be used to set a minimum ecological space threshold as a technical parameter within urban plans to support sustainable urban development [56]; for ex post planning, a spatial response index can serve to map territorial responses in terms of ES provisions for urbanization [57], such as the Productive–Living–Ecological Space (PLES) indicator and its variants [58,59]. The literature suggests that such awareness remains difficult to achieve in contexts (typically European) where planning is guided by a “siloed” approach. In these cases, ES assessment, when integrated into planning decisions, is primarily used for environmental protection purposes and appears both culturally disconnected from economic growth and subordinated to it [24].

In more general terms, Cortinovis et al. [60] distinguish three levels at which ES assessment can be used to support urban planning decisions: (1) strategic planning, referring to large-scale urban development and macro-level interactions between biophysical and socio-economic components; (2) local planning and zoning, aimed at regulating land use and urban functional allocation; and (3) detailed, site-specific planning at the scale of buildings and individual open spaces.

This gradient of detail also affects the selection of appropriate ES assessment techniques; in this regard, Vrebos et al. [47] indicates that only when methods directly respond to policy needs and follow transparent, common frameworks can large-scale implementation be considered. In this sense, they suggest moving away from voluntary and ad hoc systems toward legally binding or government-endorsed frameworks. At the same time, at the local scale, ES assessment would benefit from site-specific models, sampled data, and detailed knowledge of territorial dynamics, allowing for more precise analyses [47]. However, complexity and accuracy must be balanced with applicability, as highlighted by Olander et al.: "Most tools tend to be too resource-intensive for routine use in public- and private-sector decision-making. Therefore, the accuracy and complexity of research methods must match the needs of the particular decision context" [61]. As scale changes, the involvement of public and private actors varies, as do the resources available for conducting site-specific assessments. For instance, soil sealing near a watershed may have significant hydrological impacts, particularly under climate change conditions, even in the absence of strict building constraints. Site-specific ES assessments for private developers—particularly those estimating monetary losses associated with soil sealing—could potentially translate into local adjustments in construction costs or, alternatively, into administrative decisions to forgo short-term development revenues in favor of long-term ES provisions. Regulation ES generally tend to be resources and data. Assessments of this kind, given their significant modeling complexity and data requirements, particularly for water-related regulating services, are generally beyond the technical capacity of municipal administrations. Nevertheless, from a regulatory standpoint, they could be mandated through implementation planning procedures and assigned to private developers as part of development requirements. Again, these concepts will be further explored in the Discussion.

Strong emphasis is placed, in line with the scale-dependent considerations of the analysis, on the relationship between ecosystem and landscape variables. According to Tran et al. [45], these should represent the starting point for mapping ES provision. Ideally, a spatial sensitivity map should be defined, identifying where specific landscape elements most strongly enhance or hinder ES provision in a spatially heterogeneous manner. By acting on the enhancement of such landscape elements, it is therefore possible to increase ES provisions in a synergistic way. However, ES assessment exercises rarely take into account landscape components and processes. This limitation is largely due to a lack of familiarity among planners and decision makers, as well as insufficient data and indicators to simulate the full ecosystem service cascade, which is inherently spatially explicit and closely intertwined with landscape elements and components [31]. Metzger highlights the need to identify and map both ES supply and demand, to integrate multiple spatial and temporal scales in order to account for interactions and landscape processes, and to consider the connections (flows) between areas [31].

When such a level of precision cannot be achieved, Metzger et al. suggest that at least spatially explicit methods based on landscape composition should be adopted. These approaches typically associate the capacity for provision, demand, or actual provision of a service directly with land use or land cover classes. While simpler to apply, they do not require advanced familiarity with landscape ecology theories linking spatial patterns to ecological processes, which are often not accessible to practitioners. However, by neglecting factors such as proximity, edge effects, and connectivity, these methods do not allow for identification of cost-effective landscape management strategies, such as maintaining supply areas close to demand areas to enhance pollination services. Again, similar in-depth landscape and ecological assessments should be placed under the responsibility of private developers, potentially within compensation mechanisms, with the aim of explicitly and dynamically defining the ecosystem damage generated by their land use transformations. Nevertheless, spatial explicit methods based on landscape composition provide a rapid, integrable, and improvable starting point, particularly in contexts where sectoral ("siloed") approaches still prevail. A representation of these dynamics and their simplifications is provided in Figure 10, taken from [31].

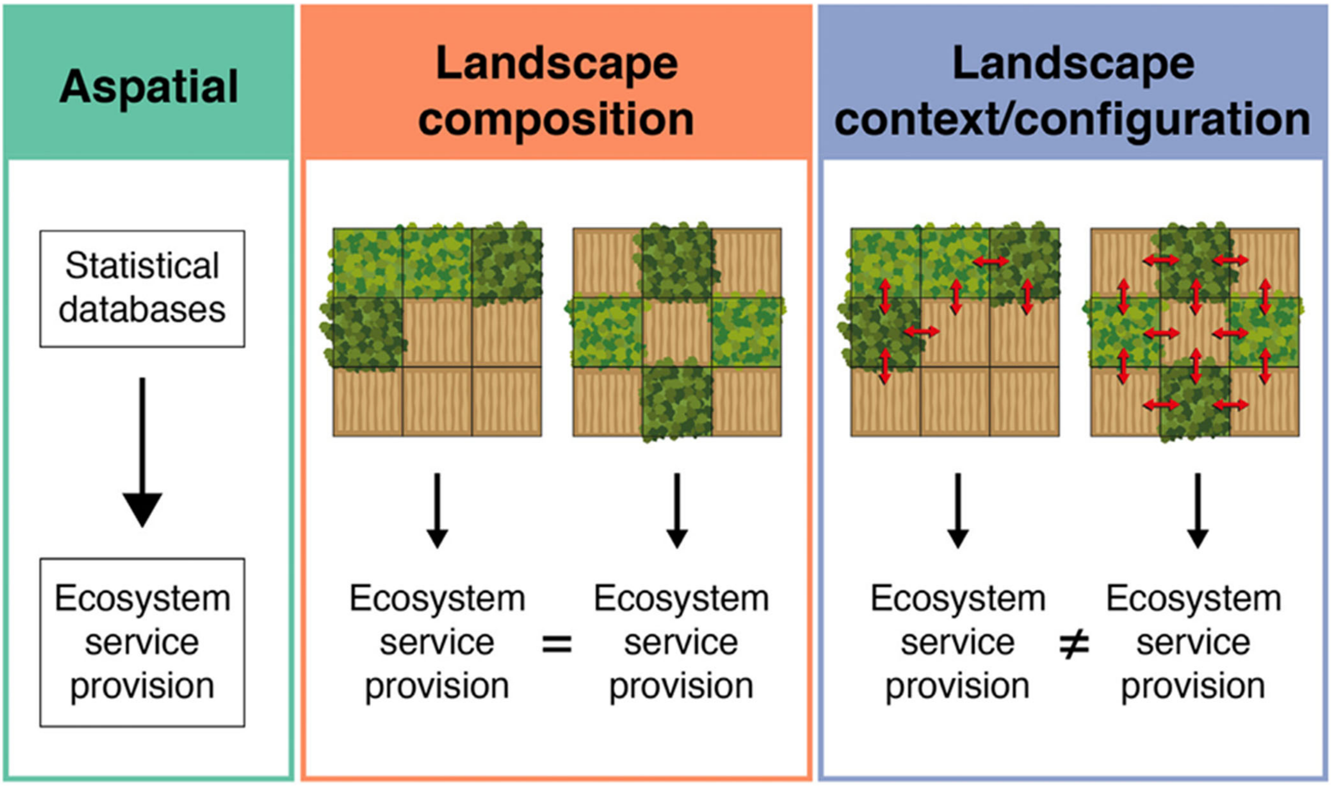

Figure 10. Different levels of landscape dynamic considerations when assessing ES. Source: [31].

In Albert et al. [49], the comparison between ordinary planning and sectoral planning shows that the former is more structured and binding and therefore more resistant to the introduction of new tools, such as ES, which tend to increase complexity. Landscape planning (and other sectoral planning instruments) can benefit more from the ES concept to make its objectives understandable and socially acceptable, highlighting synergies between economic and environmental interests.

In any case, other scholars stress that protected area management and ordinary urban planning should not operate separately. Instead, they must be integrated; otherwise, conservation policies risk being ineffective, while traditional planning remains short-sighted [30]. The same authors jointly analyzed municipal Spanish planning instruments and the planning of protected areas within the same territory. Their findings indicate that territories are often managed as a clear dichotomy between protected areas and surrounding landscapes, rather than as a gradient of protection in which human activities and nature conservation can coexist. Consequently, areas outside of protected zones are more vulnerable to continuous urban expansion.

An additional aspect is highlighted by Job et al. [62], who point to the need for strong, supra-municipal public planning, as individual municipal or private decisions do not automatically lead to sustainable land use. This includes the need for transboundary coordination in contexts such as alpine landscapes, which extend beyond administrative borders. From this perspective, institutional frameworks such as the SEEA EA are identified as essential to ensure shared reference systems and to support more targeted evaluations. However, the analyzed literature reveals very limited adoption of this approach: out of an initial 2497 contributions, only 9 refer to SEEA. Among these, only one includes a proper ES assessment, conducted at the national scale. The absence of applications at the local scale is therefore evident, as in the near-total lack of monetary valuation, which is identified as a potentially key element for integration into decision making processes.

The analysis of the reviewed papers also highlights the need not only for the integration and harmonization of different planning instruments but also for the development of broader and more effective governance systems. This is further emphasized by several case studies included in the review, which highlight the need for cooperation and for a regional or sub-regional perspective. Such an approach entails the development of inter-municipal ecological networks, the assessment of territorial ecological balances and leakage effects across administrative boundaries, and coordination at the metropolitan or watershed scale [30,42]. Regarding governance structures, the review process enhances the importance of collaboration between governments and communities, emphasizing the role of public participation in promoting sustainable change, integrating their local perspective into decision making process but also in developing rapid ecosystem assessment systems and participatory spatial mapping [35,63,64].

Community engagement is particularly valuable with reference to Cultural Ecosystem Services (CES); however, the review reveals that references to CES in planning instruments tend to be fragmented, implicit, or non-systematic, and there is no consistent language recognizing them as ES integrated into urban management (e.g., [65]). Those authors propose integrating CES bundles into zoning plans by defining sub-zones based on combinations of CES and landscape characteristics. Finally, and summing up, as highlighted by Bastiansen et al. [66], future research on spatial optimization is expected to integrate macro and micro scales, propose methods and approaches, incorporate human dimensions (policies, institutions, public interests), overcome administrative boundaries, and strengthen regional connectivity. Albert et al. [49] recommend that ES research should be more user-oriented by considering decision contexts and requirements. Key suggestions include identifying target users, understanding decision making contexts, assessing the added value of ES information, ensuring compatibility with existing planning systems, and providing methods that are both user-friendly and robust for land use decisions.

3.2.2. Environment–Economy Link

Explicit Link with the Economy

The analysis of the reviewed papers aimed to investigate whether, and how, the economic lever can support local planning in promoting soil, ecosystem, and ES conservation through tools capable of demonstrating how environmental sustainability can also translate into economic sustainability in this field.

In particular, as anticipated in the Introduction, the analysis aimed to investigate the level of awareness of the economic value of soil and its services (soil value), in contrast to the real estate value of land (land value), which in urban planning influences land transformations. It also sought to understand how economic valuation is carried out and the level of depth at which reasoning on the adopted metric is developed. Within the SEEA EA framework, as will be discussed further in the Discussion, this metric is explicitly defined as exchange value; such consistency in valuation and measurement, even if ethically discussed, enables coherent and informed decisions in the management of environmental resources.

In the analyzed records, however, the economic dimension of soil is not explicitly addressed; rather, what is generally explicit is the economic damage resulting from its unconsidered consumption, including within sectors that drive such processes for economic development purposes.

However, different papers recognize the multifunctionality of soil, understood in its role in supporting economic development, social life, and ecological balance [42,67].

In particular, Estoque and Murayama [42] analyze the trade-off between economic development and sustainability through the Triple Bottom Line of Sustainability (TBLS). Coined by John Elkington in 1994, it refers to three interconnected dimensions, economic, social, and environmental, that together reshape the framework of corporate responsibility and performance, and it is commonly summarized through the "three Ps": people, planet, and profit [68]. It is focused on sustainable urbanization and considers economic, social, and environmental dimensions, measured through composite indicators, EF, and urban growth rates.

The common thread running through several of the analyzed records is that the trade-off between economic development and nature conservation is encapsulated in the very concept of ES: in particular, the demand for ES by the population—an object of planning instruments—is associated with a supply that requires protection and regulation [30]. Even in cases where ES are not assessed, neither economically nor on a biophysical basis, the valorization of land and environmental resources becomes a strategic lever for safeguarding not only ecosystems but also the economy [69]. This recognition can pass through spatialization of opportune indicators of human activity, ecological surface condition, ecological health status, and urbanization, such as the Ecological Security Index (ESI) [70]. In one case, the idea of planning that promotes an equitable distribution of ES is advanced, framing it as an opportunity to foster equality and rebalance services and well-being across territories [52]; in this case, ecological compensation instruments are ultimately proposed to reward those who maintain or enhance ES.

In general terms, a significant gap persists between theoretical potential and practical application. The integration of ES into economic systems still requires methodological, institutional, and cultural development, as well as stronger alignment between scientific knowledge and decision making processes. In other words, there is a need to build governance systems that are aware, balanced, and capable of producing conservation-oriented outcomes that enhance soil and ecosystem health. PES mechanisms represent relevant experimentation in this regard: although legally recognized in Italy since 2015 (see the Discussion), they have not yet been effectively implemented. Examples at the global scale include South Korea [35], Costa Rica [28], and Vietnam [71]. The last study, in particular, proposes a qualitative and participatory approach to ES assessment to co-produce local land use plans; in essence, the approach promotes more inclusive and sustainable governance capable of integrating sustainable development objectives, as well as guiding the implementation of ES markets that reflect the full range of social and environmental values. In this context, Brown [51] offers an additional perspective: although not an ES assessment, it proposes a land use planning approach for Cameroon based on the concept of the landscape as a mosaic of elements and interests, encompassing both synergistic and competing land uses, starting from biodiversity conservation. The institutional, landscape, and agro-economic context of Central Africa is not directly comparable to the European one. As highlighted in Brown [51], Cameroon is characterized by a dynamic rural mosaic partly based on shifting cultivation and composed of socio-ecological systems that are strongly interconnected, with a direct relationship between local populations, production systems, and ES, and more immediate integration of economic, ecological, and cultural dimensions. Institutional control is hybrid and relatively weak, with norms often customary rather than formal, and subject to pressures such as land grabbing. In such contexts, the development of effective, multi-actor governance systems serves not only ecological but also social purposes, namely the protection of local livelihoods intrinsically linked to ecosystems. In European or developed contexts, in contrast, threats to ES are largely institutionalized and primarily economic and social in nature, being linked to territorial development and a limited awareness of ecosystem importance. Here, PES schemes can primarily reintroduce ecological considerations into decision making processes [48], even if a culture of measurement is needed to demonstrate that ecological and cultural services have real and quantifiable value. For instance, Australia's Carbon Farming Initiative (CFI) provides financial incentives for sustainable agricultural practices through a cap-and-trade system. In non-European contexts, institutional design is needed, allowing for more flexible, participatory, and adaptive frameworks. Here, public intervention can also play a decisive role. In Jin et al. [36], the use of an expropriation indicator (in some sense, a land value) supports the definition of governmental development strategies; land value thus becomes the lever through which conservative or non-conservative land use decisions are implemented. In China, as a communist system, higher land values may favor conservation, as the state, being the sole entity authorized to acquire land, faces greater constraints on expropriation and transformation. In capitalist systems based on free markets, the mechanism is reversed: higher land values increase the likelihood of land conversion through private investment. It should also be noted that this expropriation value (LEPA), although coinciding with land value, does not represent a market price in the Chinese context, whereas it does in capitalist systems.

Soil Value and Economic Metrics Treated

Several studies employ monetary valuation of ecosystem services to support planning and management decisions by explicitly integrating ecological benefits into economic analyses. Monetized ES are used to calibrate cost–benefit functions for conservation interventions [28,72], compare alternative planning scenarios balancing ecological and economic objectives [39], and evaluate the economic performance of different land management strategies, including the identification of positive and negative environmental externalities [73].

Even if monetary assessment of ES appears widespread, ethical concerns remain. In this regard, Peck and Khirfan [34] stand out as the only contribution questioning the validity of monetary valuation methods for ecological values, arguing that they fail to capture transcendental, non-utilitarian, social, and inherently non-individualistic dimensions. The authors propose instead a socio-cultural valuation that remains quantitative but more democratic, as it accounts for the plurality of values attributed by different individuals within a shared deliberative context. Although difficult to implement in real planning contexts, this approach is valuable for building governance networks in which the value of natural resources is not only made explicit but also collectively discussed and evaluated (as in [50]).

In contrast, Vatitsi et al. [74] conceptually and theoretically support the monetization of ES as a means to inform more balanced planning decisions, adopting the Ecosystem Services Value (ESV) method. As previously discussed, this involves assigning an economic value per hectare or per square meter to an ecosystem (or more commonly to a Land Use/Land Cover (LULC) unit), typically derived through value transfer techniques or literature references. In Wei et al. [39], as in similar studies, ESV is estimated by combining land cover extent with value factors differentiated by ES and adjusted to the characteristics of the study area. In this case, the adjustment is operationalized by anchoring it to agricultural productivity, defined as one-seventh of the agricultural value, thereby grounding the estimation in exchange value and subsequently extending this basis to other ES. As a result, services provided by natural ecosystems (which do not produce market goods) are assigned at least one-seventh of the value of services provided by one hectare of cultivated land. This represents a strong ethical assumption, albeit technically debatable and imprecise; rather than commodifying nature, the method translates it into an economic scale useful for planning, where ecological value acts as a reference but the monetary value is based on the pure economic (agricultural) dimension. Different variations of this approach can be proposed (e.g., [23], who advances a dynamic version of ESV or [53], who used NDVI to adjust the value locally), but what emerges clearly is that ESV is the preferred monetary metric to integrate ecological and economic considerations into planning and management decisions. Rather than serving solely as a valuation tool, ESV supports the assessment of ecological supply and demand and the design of compensation mechanisms [53]. In addition, ESV provides the basis for translating ecosystem benefits into tangible economic incentives, such as Payments for Ecosystem Services (PES), thereby enhancing the long-term economic viability of conservation and sustainable land-use practices [43]. It must be noted that from the economic valuation point of view, no paper explicitly discusses the ideal metric, which is implicitly the exchange value only when based on agricultural basis—namely on marketable products. This evidence represents the most important gap which emerges from this literature review and will be accurately discussed in the Discussion phase.

Furthermore, within the sample analyzed, no study clearly distinguishes between land value—rooted in real estate markets and human uses—and soil value, which reflects ecosystem functions once monetized. However, in some cases, the two concepts are implicitly discussed. In one case, this is done by connecting, on the one hand, soil (even if referred to as land) to ES and sustainable land management, as it is a non-renewable resource of high environmental value, or by describing land as the "most important input of production" and a key source of income for economic growth. The sale and purchase of land are recognized as the main drivers of land use, and therefore its value is even more fundamental: although the monetization of ES is not explicitly addressed in the paper, it is implicitly suggested by the fact that the market value of land does not reflect the environmental costs of its conversion [63]. Interestingly, some claim the necessity of a combination of participatory planning and institutional support for enabling "soil value" to compete with "economically destructive activities" driven by land markets that still predominantly treat land as a mere building resource, particularly in rapidly transforming regions [71].

Another study reflects on land value and contextually highlights the dominance of market forces over ecological considerations, calling for stronger conservation safeguards, improved ecological valuation procedures, and incentive-based mechanisms, as forms of value capture, to internalize ESV within planning processes [75]. Similarly, other authors move beyond the opposition between ecological value and market value by treating them as complementary components of a unified land use evaluation framework; in the Land Use Ecological Efficiency (LUEE) framework, the monetary ESV is treated as a desirable output alongside GDP and local public fiscal revenue [76]. Here, soil value is no longer external or subordinate to land value but placed on the same level as part of the economic, ecological, and social value generated by land use. From this perspective, ecological protection is not a constraint on development but can become a driver of differentiated and intelligent development.

4. Discussion and Conclusions

4.1. Integrating Ecosystem Services into Spatial Planning: From Regulatory Instruments to Market-Based Approaches

The analysis conducted in this contribution highlights several recurring patterns and gaps in the literature and confirms some of the assumptions discussed in the Introduction.

An emerging theme concerns the level of rigor, methods, and detail in the ES assessment, which in many cases asks for flexibility depending on the objectives of the analysis, the available resources, the territorial context, and the actors involved. While regulating ES are generally more complex to assess and require site-specific data and biophysically based models, they are also receiving increasing attention in the context of climate change (e.g., hydrogeological risk, urban heat island effects), and they significantly influence residents' quality of life. Therefore, assessments of this kind could be assigned to private actors and integrated into building permits in a way that captures the value of soil (i.e., ES, thus monetized) through a mechanism similar to "land value capture" [77].

This concept has been theoretically developed by Gomez-Baggethun and Barton [78], who clarified that the types of decision determine the types of valuation in urban planning, together with the costs involved, the spatial scale, and the resolution at which ES quantification is required. Figure 11 clarifies this concept.

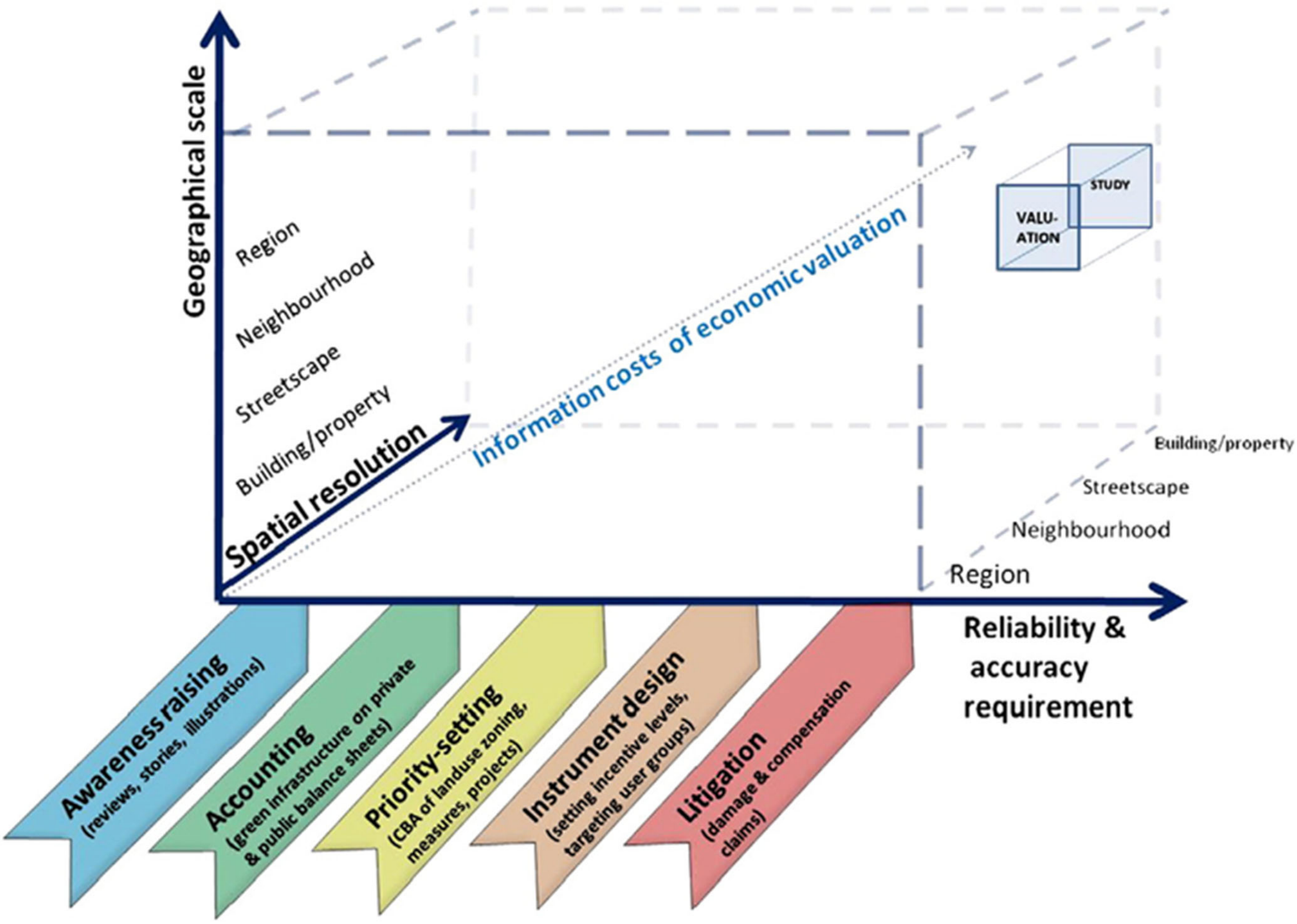

Figure 11. Economic valuation of ecosystem services in different urban planning contexts. Source: [78].

Interestingly, because these decision making contexts represent the rationale for conducting ES assessments within a planning process, and because such a process can be reasonably interpreted as a form of public policy formulation (following the Lasswell Policy Cycle [79]), the two pathways can be meaningfully compared, as illustrated in Figure 12.

The conceptual framework effectively combines the policy cycle with ES valuation decision contexts, linking the temporal dimension of planning (when valuation can intervene) with its functional dimension (for what purpose it is used). This integration is particularly useful because it shows how ES assessment can support different phases of planning, from agenda setting to evaluation. The framework also benefits from placing core assessment functions—such as identifying actions, comparing alternatives, baseline analysis, and impact assessment—at the center as cross-cutting analytical functions. In alignment with previous statements, ES assessment may interact with multiple stages, from (aspatial) accounting (see Figure 10) to an assessment requiring more accuracy, such as litigation (which may sit somewhat outside of the standard evaluation phase and could be represented as a more external or exceptional application).

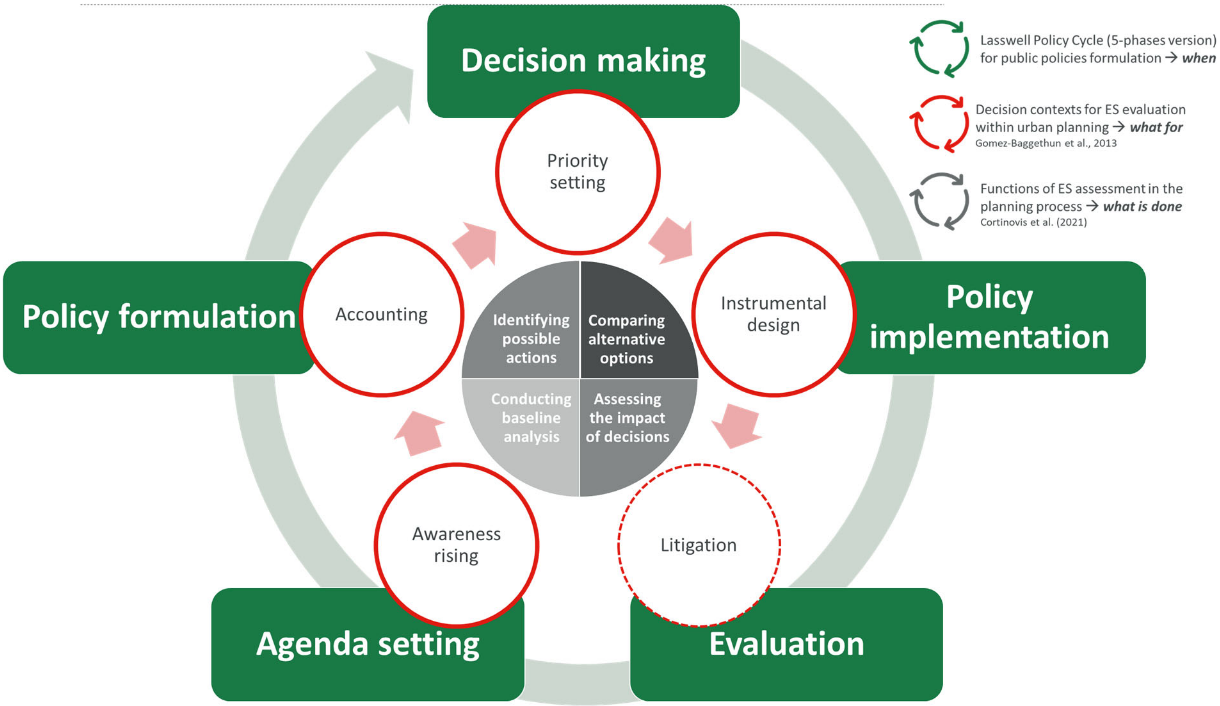

Figure 12. Policy cycle and decision contexts for ES assessment within the planning process, which highlight the functions of the assessment at each stage. Litigation is reported within a dotted circle because it's not a standard evaluation, but external or exceptional element among typical decision contexts elements of urban planning. Source: [60,78,79], self-elaborated.

Therefore, as the diagram clearly illustrates and as the analyzed sample has thoroughly detailed, the technical and theoretical possibilities for implementing an ES assessment within the planning process (and, as already anticipated in the Introduction, as noted by [80]) are numerous and promising. However, in practice, they are rarely applied or, in any case, are certainly not very effective. Local planning instruments appear generally weak at the global scale and, even in institutional contexts where ES assessment is formally associated with planning processes, they are often based on incomplete or inaccurate evaluations that do not adequately account for ecosystem functions and services. This limitation is partly attributed to an intentional avoidance of environmental knowledge ("government or business explicitly does not want to know") and the persistent separation of ES within environmental planning rather than their integration in economic and development planning.

The Italian context (e.g., Lombardy) reflects a different but equally critical situation: although regional regulations on soil consumption formally require assessment of ecological quality, such evaluations remain fragmented and largely based on agronomic data rather than explicit ES analysis. Even in the context of the still-debated national law on soil consumption [81], it remains evident that regulation alone may no longer be sufficient to achieve conservation and enhancement objectives for soil and its ES. Without a cultural shift and, potentially, a corresponding legislative change, technical efforts for ES assessment within planning are likely to remain weak and fragmented. Crucially, economic valuations should not remain theoretical exercises but must be effectively integrated into decision making processes to guide public policies and promote sustainable soil management. These concepts appear relatively recent and are still only marginally applied, at least within the European context. In general terms, the use of market-based financing instruments to support environmentally aware planning has been extensively discussed in the urban planning literature [5,82–85].

And, albeit to a limited extent, also adopted in planning practice. Among these instruments are, for instance, Transfer of Development Rights (TDR), which provides economic compensation to landowners for transferring development rights associated with their land parcels (sending areas) to actors interested in using them in designated urban expansion zones (receiving areas). However, it is important to underline that TDR schemes invariably involve new construction in receiving areas, which may generate significant environmental impacts, reduce the availability of ES, and hinder the achievement of environmental objectives [84]. In this sense, the operator is compensated for renouncing land development or for the loss of land value due to restricted land use designation; this essentially implies assigning an economic value to undeveloped land based on land value. There is a substantial distinction between the compensatory use of such instruments and the actual development of soil-value-oriented mechanisms in the valuation of ES, which in the current field seems quite new and little investigated. Indeed, in the planning practices analyzed, while some approaches implicitly integrate economic and ecological dimensions (e.g., “bioproductive land” or composite indices combining ecological, social, and economic aspects), the economic dimension of ES (namely, the soil value) is generally treated indirectly. Moreover, there is no explicit definition of soil value, nor any systematic comparison with land (real estate) value.

Instead, land value is widely recognized as the primary driver of land use change, while green areas are often valued mainly for their capacity to generate real estate benefits. In the Introduction, vertical and horizontal transactions were discussed in the context of land-value-driven urban transformation, and open questions emerged regarding the potential role of soil value as a driving force. Potentially, within the same vertical public–private relationship, soil value can enter planning decisions in preserving areas of strategic ecological, natural, and environmental value while concentrating development in already degraded or underutilized areas. The ecological and socio-cultural values associated with ES could thus be integrated into planning through existing instruments, thereby contributing to a more comprehensive and sustainable approach to territorial management. In a further reversal of perspective, the increase in soil value—and thus in the provision of ES—resulting from private actions of environmental conservation (urban regeneration, de-sealing, etc.) could become an opportunity for private value capture recognized by the public, followed by redistribution or compensation. Within horizontal relationships among private actors, soil value and the monetization of ES may also foster the creation of exchange mechanisms based on the preservation of environmental resources while allowing for the redistribution of economic benefits generated by conserved or enhanced ES to those who assume responsibility for managing the land (PES mechanisms, also recalled in some of the records analyzed). This would represent an additional layer with respect to what planning currently does or is able to do, an effort consistent with international and national trends (for Italy, see Law 221/2015), and a potential driver to increase ES provisions, whether through voluntary initiatives or through public regulation and control [86].

4.2. The SEEA EA Framework and the Limits of Monetary Valuation in Ecosystem Service Accounting

Finally, despite the recognized need for a shared and rigorous framework, adoption of standardized approaches such as the SEEA EA remains extremely limited: only nine papers mention it, only one applies it to ES assessment, and none conducts a monetary valuation or applies the framework at the local scale. As in the Introduction, the use of SEEA EA brings many advantages, but there are concerns linked to the monetary metric of the evaluation, which is strictly related to the value sphere of the environmental resource. Although this is now widely acknowledged and almost self-evident (e.g., [87]), the literature review conducted in this contribution clearly highlights the growing recognition of the contribution of ES to the economy, society, and, of course, the environment and human well-being in a broad sense; in other words, it reflects an awareness of the multi-dimensional value of their essence. The issue, which clearly emerges from this review, becomes at which scale, with which resources, and through which instruments policy-makers are truly willing to make this contribution explicit and to forgo, within an unsustainable approach, immediate economic gains in favor of more intangible yet equally certain benefits that would be derived from planning strategies based on the conservation and enhancement of ES and of soil more generally. Typically, the articulation of these multiple values is structured into a tripartite framework distinguishing between economic (hereafter referred to as monetary), cultural, and ecological values [20,78,87,88].

The SEEA EA framework provides rigorous and shared guidance for all aspects related to the biophysical assessment of ES. Such assessments must remain flexible with respect to scale and analytical purposes but should generally be conducted in a site-specific manner, adopting rigorous modeling techniques consistent with the nature of the ES being assessed. This approach falls within multidimensional quantitative assessment, on which planning can and should rely, preferably through spatially explicit methods rather than rapid assessment approaches, which are instead more widespread in the literature. With regard to the assessment of socio-cultural aspects that are not strictly utilitarian, however, the SEEA EA shows clear shortcomings and appears explicitly unconcerned with this evaluative dimension, whose usefulness has, in contrast, been repeatedly highlighted in the review conducted.

Noticeably, acknowledging the multi-value nature of environmental goods does not necessarily imply rejecting the use of a single-dimensional valuation approach, such as monetary valuation. Although partial and not exhaustive, monetary valuation techniques developed over the decades within the field of environmental economics allow for the representation of value dimensions that are purely ecological or socio-cultural—non-exchangeable and non-market in nature, yet still amenable to valuation in monetary terms. Different monetary metrics—such as shadow prices or willingness to pay—can capture environmental and social dimensions still inside of an economic valuation. However, exchange value, used in the SEEA EA, captures only a small portion of total value, the tradable one (which is consistent, with some exceptions due to the use of shadow prices, e.g., [89]). In other words, the SEEA EA framework for monetary valuation captures only the monetary values of ES, while overlooking ecological and socio-cultural values, even though the literature suggests that these could still be expressed within an economic language through the selection of appropriate metrics. As in the previous paragraph, where it was argued—by discussing methods, objectives, and contexts for integrating ES assessment into planning practice—that spatial planning alone is insufficient and should be complemented by market-based instruments grounded in ES values, it is likewise argued here that no form of public soil protection, whether regulatory or market-based, can rely solely on the economic value of ES, particularly when such value is derived using an exchange value metric. As a consequence, regulation must act accordingly.

Indeed, public authorities must consider collective interest and the full meaning of soil value. In any case, reasoning regarding the metric and the rationale underlying the concept of soil value is mandatory; urban planning operates within a regulatory mandate, but effective regulation must be grounded in a clear, fair, and scientifically robust notion of value. In the literature review conducted, no study explicitly addresses the most appropriate valuation metric (e.g., exchange value) while assessing ES from a monetary point of view. However, only on the basis of the type of value being considered—and, consequently, safeguarded—can effective instruments be designed, the relevant actors be involved, and appropriate methodologies be employed.

This does not preclude the possibility that, for certain phases of the planning process requiring lower levels of accuracy and fewer resources (Figure 11), the examples emerging from the literature review may still prove useful and somehow merged with the use of the SEEA EA framework. For example, insights from participatory and qualitative assessments (e.g., [65]) may be valuable in addressing some of the gaps of SEEA EA, both because they can support the economic valuation of ES through additional metrics (for example, willingness to pay) and because they can capture socio-ecological and non-strictly utilitarian dimensions of soil and its services that SEEA EA tends to overlook.

Moreover, insights arise, for instance, from the many studies that have employed the benefit transfer method based on the unit values proposed by Xie and Costanza, even across highly different geographical contexts. Some authors (e.g., [23]) propose local adjustments; however, the rigor of such valuations remains highly debated. Within the prospect of establishing institutional and supra-municipal governance systems capable of enabling ecosystem-based, rather than merely administrative, territorial management (e.g., [30,42]), applying the SEEA EA assessment to selected contexts and subsequently transferring those values—provided this occurs within the same territorial system—appears to be a viable option and one that is, to some extent, suggested by the review. Likewise, the use of remote sensing indices (see Section 3.1.3) may provide support in contexts characterized by limited resources and technical capacity.

4.3. Reconsidering Scale in Ecosystem Service Assessment: From Administrative Boundaries to Ecologically Coherent Territories

That said, a further consideration appears necessary. Across the reviewed studies, scale emerges as a fundamental issue: ES operate across ecological boundaries, while planning is constrained by administrative ones, making multi-scale and cross-scale approaches essential. The literature also underscores the importance of the landscape scale as the most appropriate level to capture ES interactions, leading to the emergence of concepts such as landscape multifunctionality and participatory governance, in line with frameworks such as the "Aarhus Convention" (1998) and Strategic Land Use Planning (SLUP). Another emerging trend is the evaluation of ES at scales driven by specific socio-economic dynamics, such as individual neighborhoods, urban–rural fringe areas, single farms, or project-based contexts. In this regard, a particularly interesting approach proposes assessing ES at the scale of functional planning units, areas defined by socio-economic boundaries (e.g., the "15 min city"). This approach also emphasizes the importance of ensuring fair and equitable distribution of ES. The fact that the SEEA EA originates from the discipline of environmental accounting inevitably raises the question of the most appropriate scale for ES assessment, which still remains in this contribution, in some way, an open question. As seen, this was also one of the main themes that emerged during this literature review—the most appropriate scale for the assessment—and it is not self-evident that the SEEA approach, despite its adaptability in terms of modeling proposals, suggested procedures, and required data, adequately addresses the needs and questions arising within the field of urban planning. Accounting systems—both environmental and conventional—operate within clearly defined boundaries and units within which relationships and flows are structured and measured. In the case of SEEA EA, the accounting unit is typically the nation, characterized by specific regulatory frameworks, resource flows, and the need to report on the condition of natural capital, including in monetary terms. In a hypothetical closed system, such accounting would be driven by subsistence needs and an awareness of human dependence on natural systems; however, as the global system itself can be understood as a closed system, it is not surprising that environmental accounting has progressively become a shared legal requirement across countries. This perspective connects to the concept of Ecoregions, which are identified as fundamental spatial units for ecosystem accounting as they represent ecologically homogeneous areas shaped by climatic, biogeographical, geomorphological, and hydrological factors that influence the distribution of species and ecosystems [90–92].

In Italy, ISTAT has been leading the mapping and classification of ecoregions through a hierarchical system. Within each ecoregion, ecosystem potential and disturbance dynamics tend to be relatively homogeneous, allowing for consistent interpretative frameworks. However, within urban planning, the ecoregional perspective may appear overly narrow and mono-disciplinary. If one accepts the definition of urban planning provided by the European Commission—namely, as a discipline aimed at balancing development needs with environmental protection and social and economic objectives [93]—it becomes evident that human well-being, in the broadest sense, is still the primary goal. This implies that planning must simultaneously address economic, environmental, and social dimensions within an anthropocentric yet sustainability-oriented framework. In this light, relying exclusively on monetary metrics and market-based valuation appears reductive and yet very useful.

Conceptually, given the multi-value nature of ES and the broader mission of urban planning, ES assessment aligns more naturally with the Bioregional paradigm, developed in Italy by Magnaghi [94] and Fanfani and Poli [95]. This approach emphasizes the value of agroforestry systems, ecosystem structures, and landscape characteristics as components of a territorial "heritage", understood as an ensemble of resources, relationships, and identities. Within this framework, the concept of "territorializing flows" becomes central, implying a return to the recognition of local limits and the need to regulate resource use in ways that do not compromise the long-term integrity of territorial capital [95]. To address the uncertainties inherent in complex territorial systems, bioregional assessment emerges as a promising alternative to traditional planning. As defined by Herring [96], it is a method grounded in a comprehensive set of social, economic, and ecological information, processed through an ecosystem-based approach that prioritizes natural processes over administrative boundaries. In this sense, planning would become rooted in the intrinsic characteristics and capacities of the territory.

ES assessment can play a crucial role in this framework, as it contributes to generating knowledge and awareness of the relationships between natural and social capital [97], or, more broadly, of human dependence on surrounding environmental systems. Coherent with the concept of the Bioregion—here evoked in a preliminary and theoretical sense—such assessments should ideally be conducted at supra-local scales (between municipalities and regions). This would support the development of governance systems involving multiple municipalities and territorial actors, further reinforcing the relevance of environmental accounting frameworks such as SEEA EA.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/su18168089/s1, Figure S1 (S1): Semi-qualitative and self-constructed review process conducted in the literature review. Source: own elaboration by authors; Figure S2 (S1): Research workflow and terminological and syntactic choices for the construction of search strings. Source: own elaboration by authors; Figure S3 (S1): Automatic filtering conducted in RStudio for clusters generation. Source: own elaboration by authors; Figure S4a,b (S1): Annual scientific production of the operational records (OnM, above, and OM, below) before the temporal filtering. Yellow dash lines delimitate milestone years for ES assessment and blue arrows highlights picks and slope changes. Source: own elaboration by authors with "bibliometrix" package with RStudio; Table S1 (S1): Filtering criteria applied withing each Database and consequent results in number of records. Source: own elaboration by authors; Table S2 (S2): Sample of papers selected for the literature review.

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