Integrating the Ecosystem Approach into Urban and Landscape Planning: Enhancing Ecosystem Services for Sustainable Development

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Abstract. The ecosystem approach can potentially increase political-administrative interest in environmental issues. Pending further exploration (through identification tools and specific indicators) of the value of Ecosystem Services (ESs), urban-territorial and landscape planning tools undertake a path to identify and evaluate ESs. Reevaluating and reconsidering the role of ecological functions of environmental components in terms of anthropogenic benefits (ESs), can allow urban planning tools to give useful indications to reduce the damage caused to ecosystems and natural resources of reference, through the development of strategic choices aimed at reducing or qualifying sustainably the interventions of soil artificialization. From this point of view, the ecosystem approach adopted by land-use and landscape planning tools could allow for focusing attention on the increasing dependence between the stability of landscapes and the balance of ESs. The maintenance and enhancement of ESs in a given landscape area maximizes, in fact, their level of sustainability. At the same time, the ability of a landscape scope to provide ESs allows ecosystem components to be maintained in a given state of balance.

Keywords: Ecosystem approach · Land take · Urban planning tools

1 Introduction

The growing theoretical and conceptual interest in Ecosystem Services (ESs) reflects an increasing awareness of the interdependence between humans and natural systems. This awareness spans various dimensions, including ecological-environmental (regulating ESs), physical-structural (supporting ESs), productive agribusiness (provisioning ESs), and social-ecological and cultural-historical (cultural ESs) aspects.In terms of scientific applications, the focus on ESs is primarily cognitive and analytical. Researchers aim to assess the following aspects [1]:

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– conceptual interpretation (to circumscribe and/or further detail the field of investigation);
– interdisciplinary studies (to quantify and qualify the presence of distinct types of ESs);
– studies aimed at further investigating the role of ESs (and contextual variables);
– Cognitive feedback informs intervention needs at the policy, administrative, and decision-making levels as research advances and concepts in the field of ESs become systematized.

1.1 The Reason for an Ecosystem Approach

Despite the current awareness of humans' strong and unavoidable dependence on various ecosystem functions, the planning-decision-making level experiences severe difficulties in introducing ES issues pertaining to ESs into the defection and organization of the contents of urban planning tools [2].

Indeed, analysis and interpretation work are indispensable for understanding the system of relationships between ecological functions and ESs. Yet, "*many investigations still focus on a few selected ecosystem services and exclude trade-off analyses. Assessments of ecosystem services tend to be tailor-made to respond to the scale level of analysis and goal of the case study, making the comparison of different study outcomes difficult. As a result, scientifically focused ecosystem services assessments are often too complex and thus too complicated to be directly used in practical application, such as eco-audits or environmental impact assessments*" [3] (p. 55). This means that it is not enough to set up methodologies and define data analysis toolsbecause cognitive details and increasingly in-depth and specific information will not necessarily enable planning tools to enhance their strategic operational role. It is necessary to investigate the end to which the derived results tend: interpretative cognitive purpose and strategic function. In many cases, moreover, the sometimes anachronistic planning tools are unable to respond quickly to the problems and transformation needs that arise daily. The result is a scenario that leads to continuous consumption of natural resources and potentially exceeding environmental carrying capacity [4].

2 The Ecosystem Approach and the Governance of Land Take in Urban Planning Tools

The analytical and strategic contents of planning tools must first protect ESs and then manage the drivers of land use change (i.e. land consumption), as alterations in ecosystems are largely driven by these factors [5, 6]. The identification and assessment of ESs allows for strong consideration of the ecological-environmental value of specific land areas. This provides the opportunity: on the one hand, to better understand the characteristics and ecosystem role of natural components and, on the other hand, to protect these components and related ESs from compromising processes of anthropogenic origin, first and foremost, the artificialization of soils. Indeed, "*changes in land use play a central role in the delivery of ESs and urban planning, in turn, has a significant influence on their conservation or enhancement* […]" [6] (p. 2).

2.1 Literature Review

The operational function of plan instruments plays a crucial role in sustainable land use management by integrating assessments on ESs.

As highlighted by Karrasch, Klenke, and Woltjer (2014) [7], the approach to ESs,], is a key element in promoting sustainable development whichrequires adaptive planning strategies and spatially explicit actions. A significant example is the methodology applied in the Krummhörn region of Germany, which combines ESs analysis and social impact assessment, providing a sound basis for establishing sustainable land use strategies.

Albert et al. (2016) [1] propose two integrated analytical models: the DPSIR and ES evaluation models. The former schematizes the interactions between anthropogenic pressures and responses to improve environmental conditions. At the same time, the latter proposes a distinction between ESs offered and used, facilitating a detailed assessment of ecological and social dynamics. This approach provides crucial information to curb land consumption, a factor that negatively affects ESs.

The integration of ESs in urban planning decisions, according to Cabral et al. (2016) [8], is essential to improvingawareness of the importance of sustainable land management. The study on the Urban Community of Bordeaux shows how a quantitative spatial assessment of ESs can support planning decisions, particularly through urban planning tools such as the Plan Local d'Urbanisme (PLU), which aim to balance urbanization and ecosystem protection.

Nin et al. (2016) [9] propose a structured method for integrating ESs into land use transformation planning through a process that includes human activity selection, land suitability modeling, and spatial prioritization. This approach makes it possible to identify areas for protection and areas for sustainable transformation while minimizing environmental impacts.

Van der Biest et al. (2020) [10] outline a step-by-step process for integrating ESs into land use planning, considering external factors, habitats, and natural and anthropogenic processes. This approach allows for the identification of areas where land consumption could compromise the availability of ESs, guiding decisions toward sustainable interventions.

At the national level, the LIFE SAM4CP project, analyzed by Salata et al. (2020) [11], applied the approach to ESs in three municipalities in the Metropolitan City of Turin, Italy, intending to limit land consumption and promote sustainable management strategies. The analysis highlighted the need to conserve areas with high capacity to provide ESs and to plan urban development consciously.

A further contribution is made by the SOS4LIFE project, studied by Calzolari et al. (2020) [12], which focuses on the city of Carpi (Italy) and aims to integrate soil knowledge into urban planning. The ESs maps developed showed how different soils can provide ESs of varying quality depending on the degree of sealing, underscoring the importance of wise urban area management to preserve natural capital.

In conclusion, the integration of ESs into planning tools is an essential strategy for sustainable land management, enabling the balancing of urban development needs with environmental protection. The adoption of advanced analytical models and spatial assessment of ESs provides concrete operational tools to guide planning policies toward a more sustainable future.

3 Assessment Process and Steps for Governing ESs and Land Take

To participate in the initiated discussion, a scheme focused on the interdependent relationship between the assessment process and the steps of "governing" ESs and land take was developed in the form of a conceptual map (Fig. 1). The concept map aims to systematize the relationship between governance of ESs and governance of land consumption. Urban planning tools take on the task of:

1. circumscribe the ecosystem components (cognitive-analytic status), by the ecosystem functions involved (different in types and characteristics), by the processes highlighted (environmental, social, economic), and by the interactions and connections (between components);
2. analyze its ESs (cognitive-analytical status) in relation to values (actual or potential), presence (more or less widespread and/or relevant), aggregation characters (in terms of quantity and quality), recognized at the territorial level;
3. to define, accordingly, strategies to govern ESs (operational-decisional status) in relation to the implications called into question in (1) and (2) and to the translation of ecosystem benefits into functional values for the qualification of processes and activities of sustainable governance of urban-territorial transformations;
4. finally, define strategies to govern land consumption, starting with monitoring of ESs and ecosystem strategies adopted, in relation to the status of the values considered (supporting, regulating, supplying, cultural, etc.) and their conditions of use (for particular purposes and objectives).

4 ESs and Decision-Making Processes

The factors of anthropization (on which land take depends), so that the limits of ecosystem resilience are not exceeded, must respect the general guidelines for the preservation and enhancement of available natural capital.

The added value of concretely introducing the ecosystem approach within urban planning tools allows [13]:

– consider all ESs, supportive, regulatory, procurement and cultural. "*Implementing the ES concept in a systematic and holistic manner in landscape planning processes fosters integration between the environmental, social and economic aspects of ecosystem utilization*" [14] (p. 119);
– recognizing differentiated and interrelated ESs within territories understood as "open systems," linked by deep ecological-structural dynamics;
– operate at an appropriate spatial scale of intervention to consider and include different types of ESs, both in analysis and in strategic and operational planning;
– adopt adaptive management and governance strategies that take into account, not only, the long-term state and dynamics of ecosystems, but are able to maintain the energy flows derived from ESs in a state of equilibrium;
– provide specific information on ESs dynamics to define "[…] *(1) current land-use/land cover and (2) its change over time, although the relationship may be nonlinear*" [15] (p. 12).

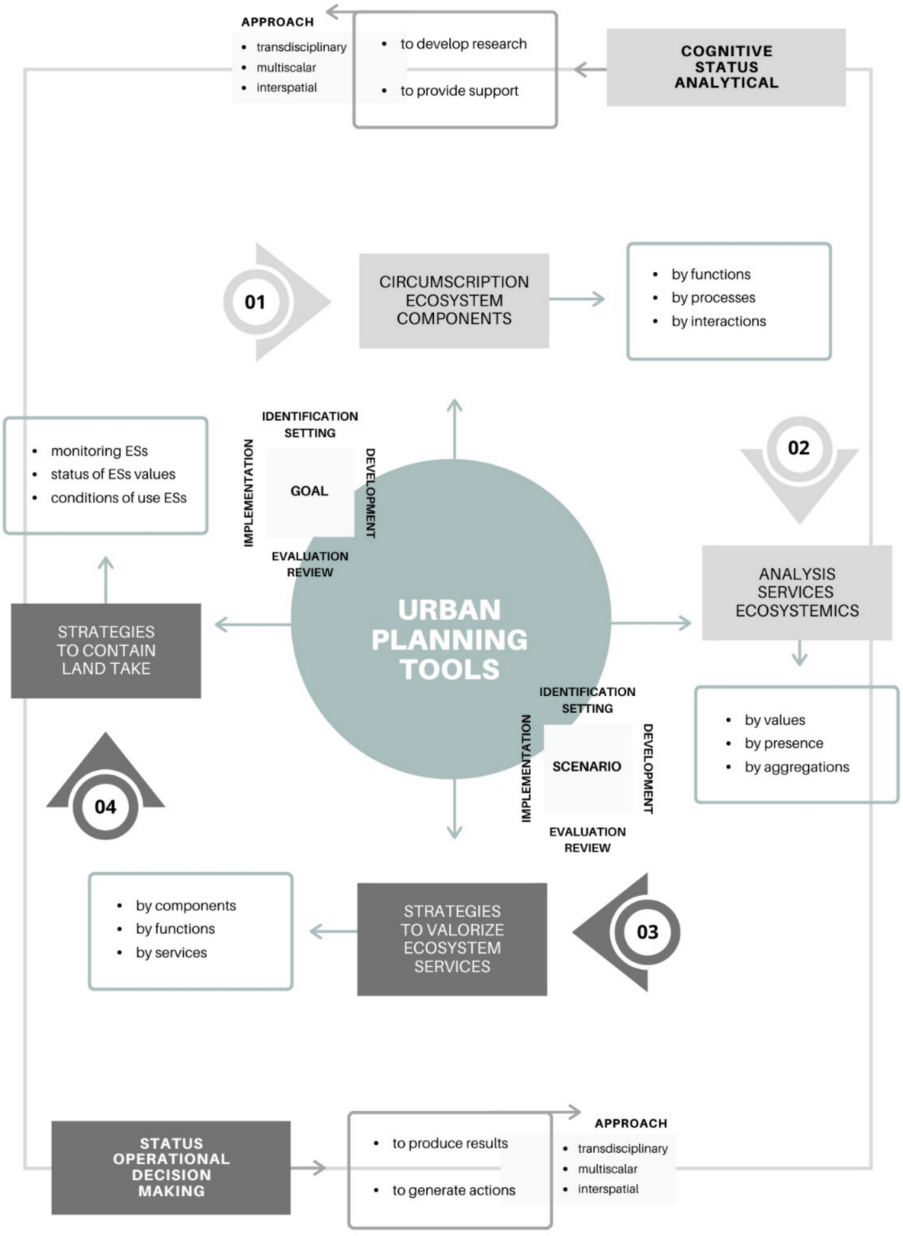

Fig. 1. The role of urban planning tools in circumscribing ecosystem components, analyzing ESs, enhancing I ESs, and containing land take.

5 Conclusions

Research pertaining to the identification and assessment of ESs has been established and has continued to receive attention and in-depth study, starting with the scientific feedback given by the Millennium Ecosystem Assessment (MEA), a research project that, between 2001 and 2005, engaged numerous experts in the field on the topic at hand: the challenge accepted by the ecosystem approach in reversing the course of the degradation of ESs components, functions and related ESs. The utility of adopting such an approach lies in the fact that the way ecosystems are managed and governed can be improved by having full and greater awareness of the link between the benefits provided to humans by nature (as a function of ecosystem quality) and the conditions of ecosystem integrity of which nature is composed.

"*The ES approach provides one way of categorizing characteristics of ecosystems to improve legibility for decision makers in a way that remains more comprehensive in scope*" [2]. In the context of urban planning tools, it aims to support:

- the strategies aimed at integrating the demands of social and economic development with the need to protect the environment, its components and functions;
- the actions put in place to influence the conservation and enhancement of a wide range of ESs, and to contain, as a result, the interventions that cause the increase in land consumption (and its resources).

Yet, although the results of the case study examination presented are promising, we are still far from having truly satisfactory data to propose homogeneous and functional ecosystem approaches in the context of planning tools [16]. The results open a new space for dialogue on a conceptual and scientific basis related to the approach to ESs [17, 18], which presents different scenarios and development perspectives for urban planning tools [19]. Work on the integration of ESs, both in the analytical phase and in the proposal phase of the plans [20], will no longer be able to be ignored, starting with the fine-tuning of certain issues:

1. the systematic nature of the recognition and evaluation process of ESs;
2. the gradualness of the inclusion of ESs in urban planning instruments;
3. the integrability of the values of ESs in urban planning instruments;
4. the adaptability of urban planning tools to the ecosystem issue;
5. the reliability of ESs monitoring processes.

Beyond the issues addressed in this study, the challenge will be to continue to work on the usefulness of the ESs approach and how it can effectively influence decision-making activities in urban, land use and landscape planning, contributing to the maintenance of functioning soils and ecosystems in general.

References

1. Albert, C., Galler, C., Hermes, J., Neuendorf, F., Von Haaren, C., Lovett, A.: Applying ecosystem services indicators in landscape planning and management: the ES-in-planning framework. Ecol. Ind. **61**, 100–113 (2016)

2. Wilkinson, C., Saarne, T., Peterson, G.D., Colding, J.: Strategic spatial planning and the ecosystem services concept. An historical exploration. Ecol. Soc. **18**(1) (2013)
3. Koschke, L., Fürst, C., Frank, S., Makeschin, F.: A multi-criteria approach for an integrated land-cover-based assessment of ecosystem services provision to support landscape planning. Ecol. Ind. **21**, 54–66 (2012)
4. Murgante, B., Borruso, G., Balletto, G., Castiglia, P., Dettori, M.: Perchè prima l'Italia? Aspetti medici, geografici e pianificatori del Covid-19. GEOmedia **24**(1) (2020)
5. Arcidiacono, A., Ronchi, S., Salata, S.: Managing multiple ecosystem services for landscape conservation: a green infrastructure in Lombardy region. Procedia Eng. **161**, 2297–2303 (2016)
6. Colavitti, A.M., Floris, A., Serra, S.: Urban standards and ecosystem services: the evolution of the services planning in Italy from theory to practice. Sustainability **12**(6), 2434 (2020)
7. Karrasch, L., Klenke, T., Woltjer, J.: Linking the ecosystem services approach to social preferences and needs in integrated coastal land use management. A planning approach. Land Use Policy **38**, 522–532 (2014)
8. Cabral, P., Feger, C., Levrel, H., Chambolle, M., Basque, D.: Assessing the impact of land-cover changes on ecosystem services: a first step toward integrative planning in Bordeaux, France. Ecosyst. Serv. **22**, 318–327 (2016)
9. Nin, M., Soutullo, A., Rodríguez-Gallego, L., Di Minin, E.: Ecosystem services-based land planning for environmental impact avoidance. Ecosyst. Serv. **17**, 172–184 (2016)
10. Van der Biest, K., Meire, P., Schellekens, T., D'hondt, B., Bonte, D., Vanagt, T., Ysebaert, T.: Aligning biodiversity conservation and ecosystem services in spatial planning: focus on ecosystem processes. Sci. Total Environ. **712**, 136350 (2020)
11. Salata, S., Giaimo, C., Alberto Barbieri, C., Garnero, G.: The utilization of ecosystem services mapping in land use planning: the experience of LIFE SAM4CP project. J. Environ. Planning Manage. **63**(3), 523–545 (2020)
12. Calzolari, C., Tarocco, P., Lombardo, N., Marchi, N., Ungaro, F.: Assessing soil ecosystem services in urban and peri-urban areas: from urban soils survey to providing support tool for urban planning. Land Use Policy **99**, 105037 (2020)
13. Mooney, P.: A systematic approach to incorporating multiple ecosystem services in landscape planning and design. Landsc. J. **33**(2), 141–171 (2015)
14. Bezák, P., Mederly, P., Izakovičová, Z., Špulerová, J., Schleyer, C.: Divergence and conflicts in landscape planning across spatial scales in Slovakia: an opportunity for an ecosystem services-based approach? Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. **13**(2), 119–135 (2017)
15. Bürgi, M., Silbernagel, J., Wu, J., Kienast, F.: Linking ecosystem services with landscape history. Landscape Ecol. **30**, 11–20 (2015)
16. Pilogallo, A., Saganeiti, L., Scorza, F., Murgante, B.: Ecosystem services approach to evaluate renewable energy plants effects. In: Misra, S., et al. (eds.) Computational Science and Its Applications – ICCSA 2019, pp. 281–290. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-24311-1_20
17. Pilogallo, A., Scorza, F.: Ecosystem services multifunctionality: an analytical framework to support sustainable spatial planning in Italy. Sustainability **14**(6), 3346 (2022). https://doi.org/10.3390/SU14063346
18. Annunziata, A., Scorza, F., Corrado, S., Murgante, B.: Unveiling intra-rural divides: investigating decline and prosperity in rural areas. The case study of southern Italy. Eur. Plann. Studies **32**(7), 1478–1505 (2024). https://doi.org/10.1080/09654313.2024.2335312;WGROUP:STRING:PUBLICATION

19. Scorza, F., Pilogallo, A., Saganeiti, L., Murgante, B., Pontrandolfi, P.: Comparing the territorial performances of renewable energy sources' plants with an integrated ecosystem services loss assessment: a case study from the Basilicata region (Italy). Sustain. Cities Soc. **56**, 102082 (2020). https://doi.org/10.1016/j.scs.2020.102082
20. Pilogallo, A., Scorza, F.: Mapping regulation ecosystem services specialization in Italy. J. Urban Plann. Dev. **148**(1) (2022). https://doi.org/10.1061/(ASCE)UP.1943-5444.0000801