sustainability

Article

Ecosystem Services for the City as a Complex System: A Methodological Proposal

Romano Fistola

DICEA—Department of Civil, Building and Environmental Engineering, University of Naples—"Federico II", 80135 Naples, Italy; fistola@unina.it; Tel.: +39-081-7685854

Abstract: Originating from the main theories on the interpretation of the city as a system, this paper calls attention to the need to build a new theoretical framework. This framework would be able to support actions related to the consideration of ecosystem services in the activities governing urban and territorial transformations. By adopting the systemic interpretation of the city, it may be possible to more readily identify the ecosystem services related to each of the urban subsystems, and promote a new and different consideration of them when defining urban policies on the sustainable management of urban and territorial systems. This reflection describes a new approach to the problem, by indicating mainly the theoretical references and methodological connections to be considered in the development of a new dimension of territorial government. This dimension would be, by necessity, built upon issues that characterize the current historical phase, such as ecological transition, and the new potential of technological innovation that, if properly reconsidered, could contribute to substantially redefining the field of traditional urban planning.

Keywords: ecosystem services; city as a system; spatial planning

check for updates

Citation: Fistola, R. Ecosystem Services for the City as a Complex System: A Methodological Proposal. *Sustainability* **2023**, *15*, 9318. https://doi.org/10.3390/su15129318

Academic Editors: Corrado Zoppi and Sabrina Lai

Received: 14 April 2023
Revised: 24 May 2023
Accepted: 6 June 2023
Published: 9 June 2023

1. Introduction

The research on the theme of ecosystem services (ESs) and the relationships among them has now reached a mature extent, such that one can find a consistent number of studies in the international literature [1]. For over thirty years, the consideration of ESs as an essential support for the survival of the human species within anthropic contexts has generated numerous reflections, in various fields of scientific research. Significant insights have been developed regarding the role of ESs in biological, economic, natural resource management, and biodiversity contexts [2]. As early as the late 1990s, there were studies in the field of urban planning and land management which examined ESs in relation to the regeneration of abandoned and disused areas. In this context, we adopt the definition provided by the Millennium Ecosystem Assessment in 2005, which classifies ESs into the following categories: supply, which includes products obtained from ecosystems such as food, clean water, fibers, fuel, and medicines; regulation, where benefits are derived from the regulation of ecosystem processes, such as climate, water regimes, and the control of pathogens; cultural, which refers to non-material benefits obtained from ecosystems, such as spiritual, ethical, recreational, aesthetic values, and social relationships; and support, which encompasses the services necessary for the production of all the other ESs, such as soil formation, nutrient cycling, and primary biomass production [3]. The relevance of this field of research is further substantiated by the particular moment of global crisis that the planet is experiencing. This crisis can be traced back to universal phenomena such as climate change, taking into consideration all of the side effects that such upheaval entails, and area phenomena, circumscribable in specific territorial contexts, and generally referring to the presence and action of humans.

There is no doubt that the new sustainable development perspective implied by ecosystem services requires a substantial change in approach, even toward those activities that suggest spatial arrangements which can be traced back to the management of territorial transformation. In light of the above, it appears useful to fully define the theoretical–methodological and interpretive approach that can allow us innovative insights into the evaluation of ecosystem services, and their transfer flow from the natural to the anthropic context. In order to provide a first hypothesis to frame the methodological background, it appears necessary to consider the nature of ecosystem services as complex systems, regarding which it is appropriate to refer to specific interpretive approaches [4]. Considering ESs through a systemic approach allows the establishment of a common ground between these services and the city, which is interpreted as a dynamically complex system [5].

Ecosystems are incredibly complex and dynamic systems that are constantly changing and adapting in response to various internal and external factors. Due to this complexity, it is often necessary to develop multiple classification systems, to help us better understand and manage these ecosystems [6].

Starting from this concept, it appears appropriate to attempt to propose a new vision, useful in the process of urban planning, which relates ecosystem services to the city interpreted as a system, and to the urban subsystems [7].

In other words, in the development of future urban planning policies/actions, we should consider which ecosystem services urban subsystems need (at a minimum) to activate a metabolic process capable of ensuring the survival and correct evolution of the urban system. Such components will need to be identified and quantified as a priority, without which erroneous predictions are likely to generate high levels of urban entropy. We aim to attempt a theoretical homogenization between the systemic approach to the study of urban phenomena, and the reflection on ecosystem services that are, in any case, part of this approach.

Finally, one of the most important objectives is to redefine, within the tools for territorial governance, the urban planning rules that regulate the definition of land use, by considering the ESs associated with each urban zone, while also taking into account the trend toward *mixité fonctionnelle*, and the overcoming of single-land-use designation. Further in-depth analysis is required for such a classification, but it appears that this could be a path to be explored.

The ultimate goal is to reach a new perspective on urban planning which, considering the rapid changes underway, must innovate, to define new, effective policies for sustainable territorial governance.

2. Materials and Methods: The Need for a New Approach

The dynamic and complex nature of cities poses significant challenges for traditional town-planning methods, which often rely on static and closed forecasts of future urban layouts. These methods may fail to take into account the unpredictability and adaptability of urban systems, leading to inefficient or unsustainable outcomes. To address these challenges, new theories of town planning are needed, that embrace the systemic nature of cities, and consider their evolution over time. This requires a shift toward more adaptive and flexible planning approaches that can respond to changing circumstances and uncertainties.

Overall, the adoption of a systemic paradigm for urban planning is essential to addressing the challenges posed by the complexity, and dynamic evolution, of cities. By embracing a more adaptive and flexible approach to town and country planning, we can help create more sustainable, livable, and resilient urban environments that meet the needs of present and future generations. The interpretation of the city as a dynamically complex system is now widely shared. This started with the first studies conducted in this field by J.B. McLoughlin, J. Regulsky, and others [8,9].

Considering the city as a dynamic and complex system, articulated into interrelated subsystems [10], represents the most useful model for establishing a direct relationship with ES. If the city is interpreted as a complex system, it is consequently possible to identify a certain number of subsystems that ensure urban survival, and to prioritize them over others. From a large number of urban subsystems, we can identify five main ones that can be considered the most significant.

As proposed in other studies [11], the urban system can be seen as a complex and dynamic interplay of these five subsystems, each of which contributes to the evolution and transformation of the city over time.

Understanding the interactions between these subsystems is essential for effective urban planning and management. These are the five main urban subsystems that have been identified: the geo-morphological, the anthropic/human, the physical/spatial, the functional, and the psycho-perceptive. These subsystems interact with each other, but are interdependent, meaning that changes in one subsystem can have an impact on the others. Therefore, a holistic approach is necessary for urban planning and design, taking into account the complex dynamics of these subsystems and their interrelationships (Figure 1).

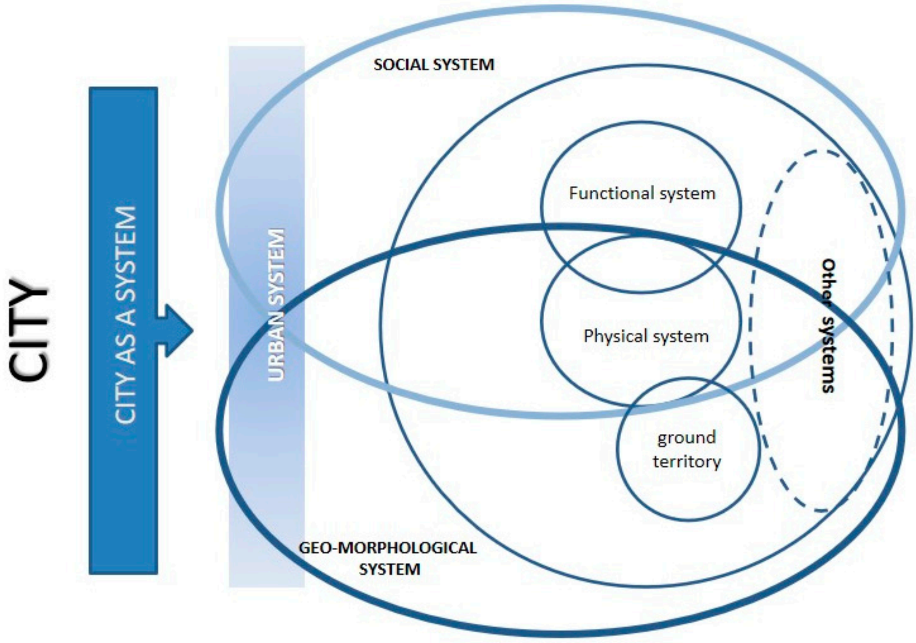

Figure 1. A conceptual scheme of the urban system and its different subsystems. The geo-morphological system and the anthropic/human one (social system) are to be considered "generative" subsystems, because they allow the generation of the urban system as a whole. Furthermore, the functional system and the physical system, as well as the perceptive one, must be considered "generated" systems.

The physical system provides the physical support for the functional system, which in turn represents the activities occurring in the urban space, or running through the area. The functional system includes various elements, such as transportation, commerce, housing, and services, which interact and influence each other in complex ways.

The functional system of the city includes all the human activities that take place within the physical spaces of the urban environment, as well as the relationships and interactions that occur between these activities. This system is responsible for the flow of goods, services, and information throughout the city, and is a critical component of the urban infrastructure. It is often studied in the field of urban planning and design, as well as in related disciplines such as transportation engineering, and public policy.

The psycho-perceptive system, on the other hand, represents the subjective experience of the city by its inhabitants. This system includes elements such as urban image, sense of belonging, and emotional attachment to the urban environment. It is shaped by a variety of factors, such as culture, history, and personal experience.

The physical system and the functional system can be regarded as "generated" systems that arise from the presence of, or interaction between, generative systems. As previously mentioned, each system consists of elements that constitute its systemic architecture: the elements and the relationships. The relationships among elements, as a whole, represent the "structure" of the system. In the case of the physical system, the components are the constructed spaces of the city, such as buildings, squares, infrastructure, and urban sites. The relationships, on the other hand, are the physical channels that connect these spaces, facilitating the flow of functional activities. These channels can be seen as the supportive framework for functional flows.

The psycho-perceptive system is important in the evolution of urban systems, because it influences how individuals perceive and interact with the city. This system is closely related to the physical and functional systems, as the material spaces and human activities within the city contribute to shaping the image and perception of the city [12]. The concept of "memory of places" refers to the emotional and cultural connections that individuals have with specific locations within the city, which can have a significant impact on urban planning and development. This system is included within the other subsystems that make up the urban system, but will not be addressed specifically here.

The geo-morphological system consists of the territorial and environmental substrate of the ecosystem, for which the parts can be identified in territorial areas, however defined (continents, nations, hydrographic basins, macro-regions, municipal territories, etc.), and the relationships in the infrastructure of physical connection between them (roads, railways, canals, energy networks, etc.).

The anthropic/human system, also known as the "social system", encompasses the "biocenotic" aspect of the city, referring to the community that gives meaning to the space. Within this system, the elements consist of human aggregations that operate within urban spaces. These aggregations include individuals and groups who interact with one another, working toward the development and progress of the city. The actors (citizens) and their relationships form the core elements of this social system, driving the dynamics of the urban environment [13].

Ecosystem Services and Urban Sub-Systems

Following a classification [14], it is possible to assert that the studies carried out on ecosystem services have mainly concerned three major thematic areas. The first one considers the articulation of ESs according to the specific field of study, and the different measurement methods. The second area focuses on the study of the flows (ESFs) through which ESs are transferred through the territorial base.

The last thematic area is strongly related to the adoption of ESs in order to achieve sustainable development of the city and territory. The first-mentioned thematic area finds its main reference in the classification and the need to quantify these resources, in order to subsequently calculate their balance in the metabolism processes of human settlements.

The second topic area has been developed in many interesting studies, from which it appears that consistent and standardized definitions and measurement methods for ESFs are essential for effective policy-making and decision-making.

Regarding the demand for ecosystem services, some studies define ESFs based on the actual use or delivery of ecosystem services to people, while others focus on the potential demand for ecosystem services based on the characteristics of the beneficiaries. Spatially, ESFs can be measured by the distance or accessibility between ecosystem services' supply and demand, or by the spatial pattern of ecosystem services' supply and demand in a certain area. In terms of the flow process, ESFs can be measured by the amount, direction and speed of ES flow between ecosystems and people. Without a clear and consistent understanding of ESFs, it is difficult to accurately measure, monitor, and manage ecosystem services. This could lead to ineffective policies, and decisions that do not fully consider the importance of ecosystem services for human wellbeing and the environment.

There is still a need for more standardized and widely accepted definitions and measurement methods for ESF. The last thematic area is the one closest to the debate on new forms of urban planning, and how urban-development planning cannot ignore the consideration and formalization of available resources. As highlighted in the diagram reproduced in Figure 2, in order for ecosystem services to produce positive effects, the presence of sets of capital is necessary: social, built, human, all included in natural capital, which can easily refer to the subsystems of the urban system.

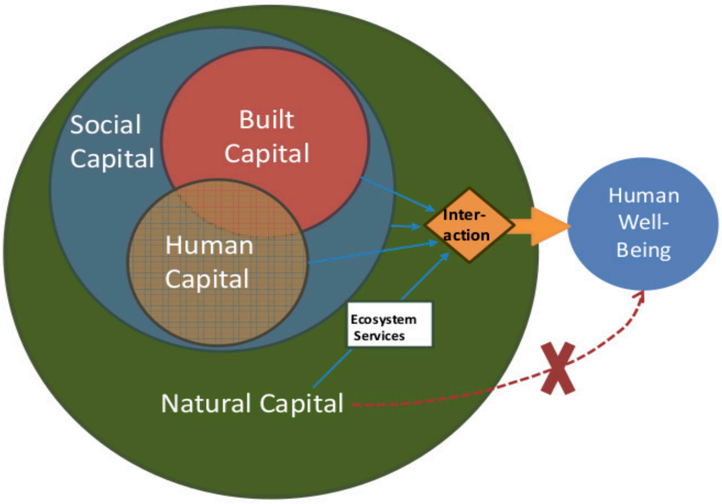

Figure 2. The interaction between built, social, human, and natural capital required to produce human wellbeing (source: Costanza et al., "Changes in the global value of ecosystem services" [15]).

In this sense, it is possible to state that there is a relationship between the subsystems of the city and the ecosystem services, and that the ecosystem services can be connected to the urban subsystems in defining a sustainable future for the city (Figure 3).

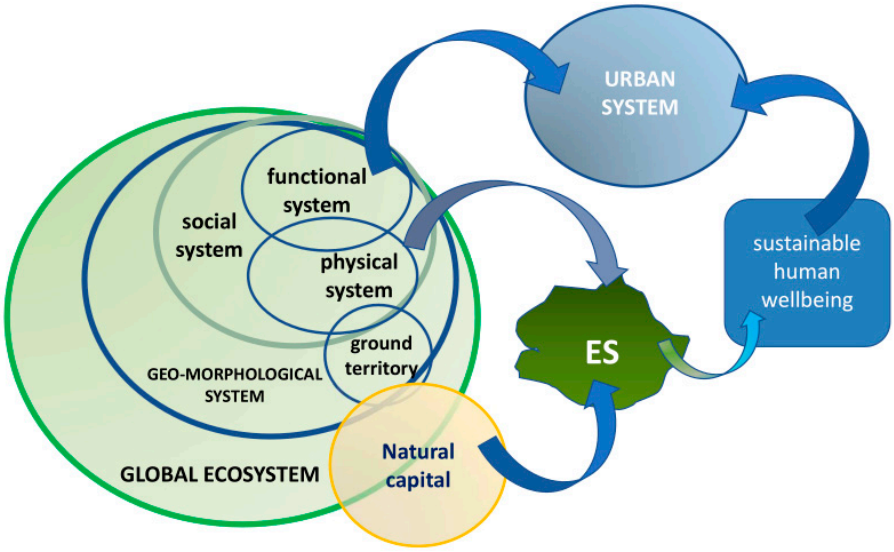

Figure 3. A reinterpretation of the Costanza diagram, considering urban subsystems.

In other words, the appropriate identification of such relationships allows for the minimization of entropic production [16] attributable to systemic evolution that uses energy for its progression over time and space. This energy can be referred to as the production of energy fluid produced by ecosystem services.

Where ESs are identified and properly considered in the planning process, urban entropy is fully metabolized by the urban system, and the "ecosystemic fluid" becomes available within the range of variation of the urban system, determining its sustainable development.

The diagram in (Figure 4) aims to describe this concept by considering the path of the urban system that has to be maintained inside the range of evolution, where possible, to assure sustainable development for it. On the X axis is the time for the system's evolution, and on the Y axis are the resources useful for its sustainable development. If the resources are not able to produce sufficient ecosystemic fluid, the system can fall into the entropic zones, which are very dangerous areas for its development. To return from these zones, it is necessary to use many more resources than before. In other words, the figure aims to represent, in a conceptual way, the nature of the development of the urban system in time and space, and aims to underline the way that this development is strongly related to the amount of ecosystem fluid available inside the range of urban evolution.

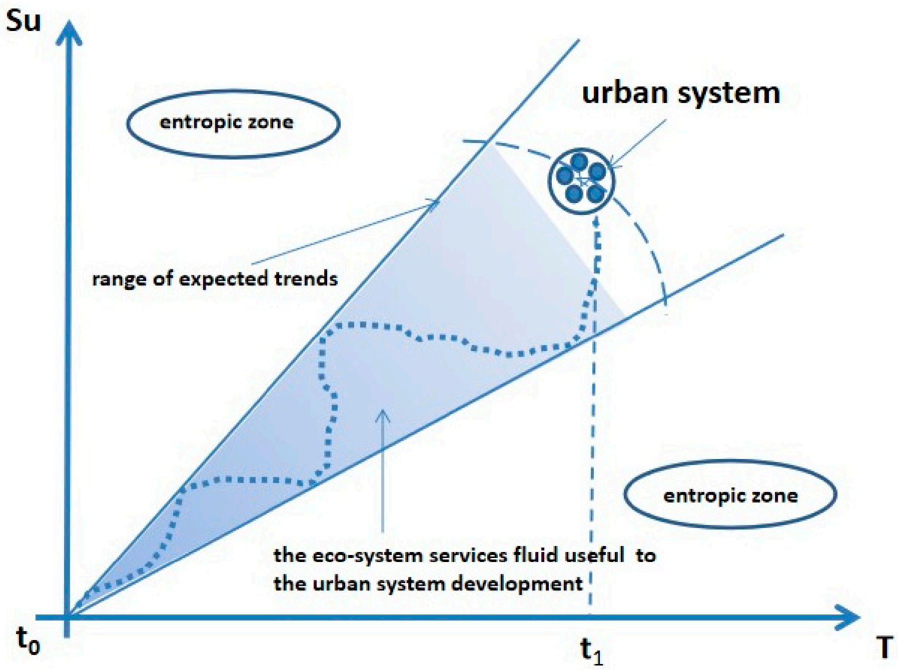

Figure 4. The urban system evolution, in the range of sustainable development filled with the ES fluid.

Another idea that brings out a relevant analogy between the urban system and ecosystem services (which is briefly mentioned here for future research), is complex systems' property of containing subsystems, and of being contained in meta-systems [17].

In a way, it is possible to say that the meta-systems of the two compared systems correspond. In fact, by going up a level with respect to the urban system, it is possible to identify the territorial meta-system, and then the environmental meta-system, and then the planetary meta-system, and so on. On the other hand, going down in level, one observes how the two systems are characterized differently, as cities and ecosystems, but retain mutual relations that are of great importance for the development of spatial governance policies, and that will be described in the following section.

3. Systemic Analogies and Sub-Systemic Relationships

It is true that in recent years, there has been an increase in knowledge about mainstream approaches to spatial planning that incorporate ecosystem services. However, many of these proposals remain limited in scope, and do not fully integrate ecosystem services into the planning process. While tools and technical procedures are essential for improving the knowledge system, they alone cannot effectively impact the planning process. Instead, operational frameworks that fully integrate ecosystem services into the planning process are needed. Unfortunately, such frameworks are still in their infancy, and the full inclusion of ecosystem services in spatial planning has been precluded as a result. To address this issue, further research into, and development of, operational frameworks that can integrate ecosystem services into the planning process are necessary. This will require collaboration between planners, policymakers, and scientists, as well as engagement with local communities and stakeholders to ensure the effective implementation of such frameworks. Reflection on ecosystem services, their taxonomy, their fundamental role in the survival of human contexts, and also the need for management activities in territorial transformations to consider them as a founding element of the planning process [18], has certainly reached a consistent level of maturity, through many contributions present in the various scientific literature related to the study of territorial phenomena [19].

Along with this assumption, the extreme instability of human behavior with respect to the consideration of environmental resources must be considered, particularly that which is determined by geopolitical arrangements and imbalances. In this sense, one can think of the Russian–Ukrainian conflict, which has determined, in a short time, an unacceptable loss of human life, and a global energy crisis, and the reconsideration of the restoration of energy sources, such as coal, which is well known for its environmental impact, and a compromise in the natural assets that generate ecosystem services.

Furthermore, if the conflict aims at the direct destruction of urban contexts and, consequently, physical, functional, and other subsystems, any discussion about the need to identify and preserve environments that generate ESs appears futile. However, studies aimed at building a new perspective, that also sees ESs as being at the center of consideration for urban decision-makers, should not be abandoned.

Referring to the definitions of the Millennium Ecosystem Assessment, mentioned before, and subsequent reflections [20], it can be stated that soil, as a fundamental part of the geomorphological system, is of particular importance in generating ecosystem services and, as such, represents a component directly affected by territorial-transformation processes, and the entropic side effects attributable to consumption (and waste), pollution, impermeabilization, etc. It has been shown that the possibility of linking ecosystem services to urban subsystems also derives from the ability to model the energy flows capable of powering the systems themselves. In this sense, it appears useful to recall the studies of Odum, and his conceptual diagrams related to a system capable of using renewable resources [21].

In particular, we refer to the diagram in Figure 5, which describes a renewable resource whose source is indicated by the letter S. The arrow from the source indicates the energy flow J, toward the system with a part Jr that is dissipated. The arrow R indicates the part of the energy actually converted, to form a stock Q_R. All the quantities in the system depend on interactions with Q_R. In more detail, it is possible to state that the system X polarizes the energy and processes it, before transfer to the meta-system Q_R. The arrow E indicates the part of the resource leaving the stock as entropic output. By reinterpreting this diagram, it is possible to identify S as an ecosystem service that transfers its energy flow (resource), which is processed by the urban subsystem X, which, in turn, transfers the elaborated resource to the urban system Q_R. Q_R uses the resource for its own survival and development, dispersing a part of it in evolutionary entropy.

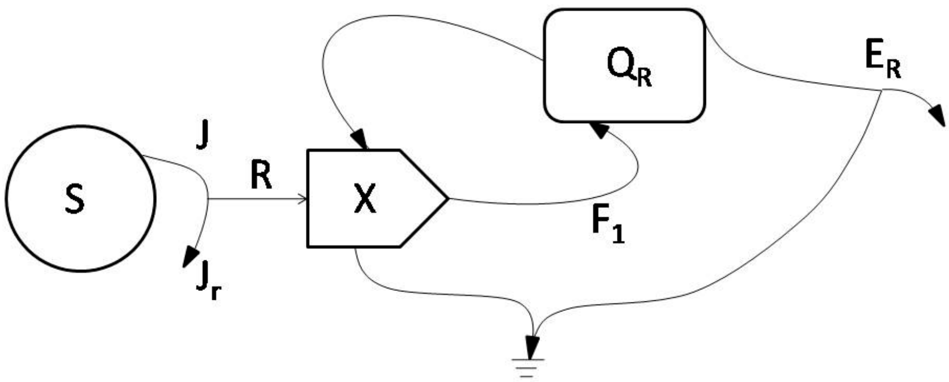

Figure 5. A reinterpretation of Odum's diagram on the use of a renewable resource (source: Pulselli R., and Tiezzi E., "Città fuori dal caos", p. 62 [22]).

Through this reinterpretation, we can connect ecosystem services to urban subsystems.

4. Results: The Relationships among ESs and Urban Subsystems

Following the reasoning developed so far, and recalling the diagram in Figure 1, it is possible to propose a conceptual framework that directly relates ESs to urban subsystems (Figure 6). This diagram highlights the different phases in the process of managing territorial and urban transformation by adopting the systemic approach.

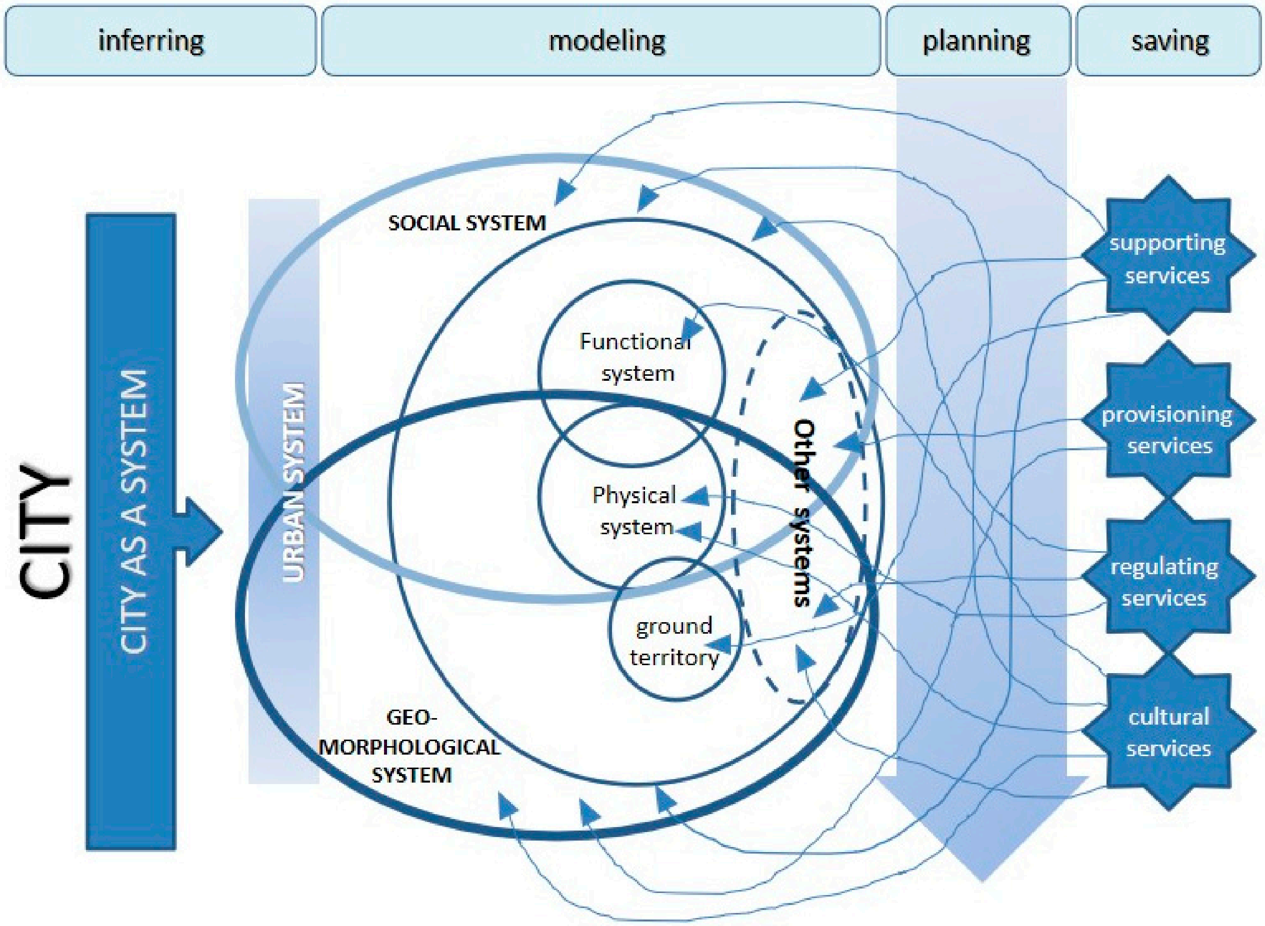

Figure 6. A conceptual scheme demonstrating the relationships among ESs and the urban subsystems.

This process, starting from the systemic modeling of the city, identifies the relevant urban subsystems, mentioned earlier, and the ESs connected to them that need to be prioritized for conservation.

This set of relationships could inform the urban planning of cities, allowing a new vision for the management of territorial transformations.

This new perspective could represent a useful element in the theoretical definition of the relationship between ecosystem services and urban planning, managing to determine which elements must be taken into consideration when defining the organization of territorial transformations. In particular, it is therefore possible to directly identify which ecosystem services need to be safeguarded in the systemic approach to city planning (Figure 7). Depending on the subsystems intended to guide the new urban arrangement, the ecosystem service to be considered and prioritized can be identified, along with all others that are crucial to the survival of the urban system.

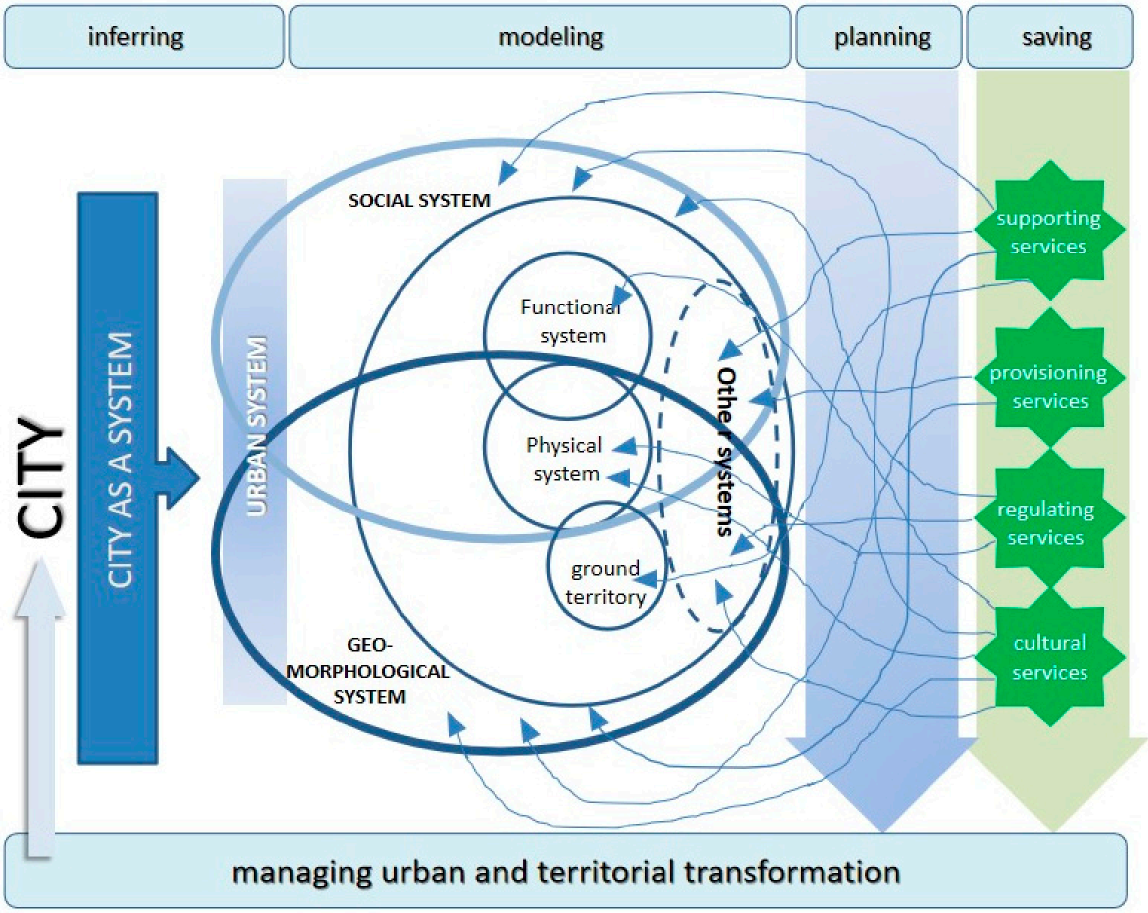

Figure 7. The conceptual scheme demonstrating the relationships among ESs and the urban subsystems, highlighting the contribution (expressed through the arrows) to the government of territorial transformations (GTT).

5. Discussion

Attempting to build a theoretical background for the vast subject of ecosystem services may seem ambitious, and lacking in real usefulness. However, it should be noted that much of today's debate on the topic is focused on the formalization and monetization of ecosystem services, with the aim of obtaining a quantification to consider in territorial policy evaluations and urban planning.

As mentioned earlier, by the late 1990s, a focus on the role of ecosystem services within urban systems had already produced interesting studies. Specifically, attention was given to the capacity of "urban ecosystems" (green and blue infrastructure) within the city to generate ecosystem services for the community in an endogenous manner. More recently, starting from the observation of the entropic impacts caused by increasing urbanization, the effects on the degradation of ecosystem services within spatial contexts have been evaluated [23]. However, referring to the systemic nature, and bringing it back to the modeling of the city as a dynamically complex system, can lead to new research contributions that can complete the treatment of the topic, and provide a concrete disciplinary dimension. The proposal of a new methodological approach requires the generation of a discussion among scholars and, consequently, a specific literature on the subject. In essence, the proposed reflection aims to stimulate discussion among scholars, and foster the exchange of ideas. As is often the case in scientific research, it is sometimes necessary to pause and consider the conceptual and methodological framework that can be applied to a specific practice or action. In the case of ecosystem services and their actual consideration in the governance processes of urban system transformations, it is useful to begin outlining a background methodological landscape that, despite limited literature presence, can contribute to shaping new areas of knowledge. The need for a theoretical reference is recognized by scholars of urban phenomena who pay particular attention to the necessity of defining shared procedures for the adoption of ecosystem services in urban planning processes, with the aim of promoting the governance and sustainable evolution of the urban system [24]. This is probably the most interesting working hypothesis that can be catalyzed by reflection, leading to future in-depth studies that could go beyond the technical dimension that is prevalent in the literature.

6. Conclusions

Undoubtedly, this is only the beginning of defining this possible theoretical construction, to be considered prior to operational actions toward ecosystem services that are involved in urban planning processes. In other words, this conceptual definition represents an initial step toward a complete theoretical–methodological advancement, which requires further reflection to frame a real reference theory.

This consideration, placed at the beginning of the conclusions, is useful in highlighting the main limitation of this paper, but emphasizing, at the same time, its specific contribution in indicating the need for a change in perspective. Another limitation lies in the inability to conduct a comparative analysis of the literature on the topic, mainly because the adoption of a systemic approach, aiming to create a common field of reflection, and naturally identify connections between systems, is still relatively unexplored. A final limitation is the inability to provide specific guidelines and operational actions for professionals involved in territorial transformations. Nonetheless, the objective is to eventually define guidelines, possibly even regulations, within Italian urban planning, that can align with the approach described.

However, highlighting the systemic common denominator, and the connections that can be identified between ecosystem services and urban subsystems, can be particularly useful in urban planning, as it can configure a new dimension of territorial transformation governance, originating from the need to safeguard resource generators and minimize anthropic entropy. This type of consideration appears particularly relevant today, in relation to the scarcity of available resources, the sudden and increasingly impactful changes that are occurring, and in particular, the increasing anthropic entropy that causes increasing degradation, and a high level of uninhabitability, within urban systems.

The thinking that has been proposed in this paper could also be a further contribution to the transition process from Smart City to Eco City, and could contribute to the field of sustainable urbanism [25]. The development of approaches, methods, and procedures that support this evolution should be a common commitment of researchers of urban phenomena.

This reflection fits into the broader consideration that should characterize scientific research activities and, more generally, the task of scholars in every discipline: to share perspectives toward the progress of humanity, in order to overcome the climatic crisis and the self-destructive inversion of the human species. Scientific research must envision and formalize methods and procedures to define a new balance between humans and the environment. The human species constitutes only 2% of the living organisms on planet Earth, yet it is the only species that pollutes its own habitat, and employs a significant portion of its intelligence—which is unique among living beings—in developing technologies of destruction for use in war events oriented toward mutual elimination. Currently, there are over 13,000 nuclear weapons and warheads in the world, and an annual production expense of about two trillion dollars on devices to be employed in conflict. Engaging in defining theories and methods useful to generating a new consideration of the values of nature, and the services it provides to humankind to ensure its survival, such as ES, represents an attempt to contribute to constructing a new awareness of "respectful development". This awareness, in some ways, even goes beyond the concept of sustainable development.

The future of humanity will be decided in cities. We can no longer ignore the necessity to develop policies and actions to ensure that cities can develop in balance with available resources.

Funding: This resarch received no external funding.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Ndong, O.O.; Therond, O.; Cousin, I. Analysis of relationships between ecosystem services: A generic classification and review of the literature. *Ecosyst. Serv.* **2020**, *43*, 101120. [CrossRef]
2. Cordella, M.; Gonzalez-Redin, J.; Lodeiro, R.U.; Garcia, D.A. Assessing impacts to biodiversity and ecosystems: Understanding and exploiting synergies between Life Cycle Assessment and Natural Capital Accounting. *Procedia CIRP* **2022**, *105*, 134–139. [CrossRef]
3. Millennium Ecosystem Assessment 2005. Available online: https://www.millenniumassessment.org/documents/document.356.aspx.pdf (accessed on 1 May 2022).
4. von Bertalanffy, L. *General System Theory*; Penguin Books: Harmondsworth, UK, 1972.
5. Papa, R.; Battarra, R.; Fistola, R.; Gargiulo, C. The city as a complex system in structural crisis. *TeMA J. Land Use Mobil. Environ.* **2021**, *14*, 455–491.
6. Costanza, R. Valuing natural capital and ecosystem services toward the goals of efficiency, fairness, and sustainability. *Ecosyst. Serv.* **2020**, *43*, 101096. [CrossRef]
7. Fistola, R. *ME-Tropolis-Funzioni Innovazioni Trasformazioni Della Città*; I.Pi.G.E.T. CNR, Giannini: Napoli, Italy, 2001.
8. Mc Loughlin, J.B. *La Pianificazione Urbana e Regionale*; Marsilio: Padova, Italy, 1973.
9. Regulsky, J. *La Pianificazione Della Città: Un Approccio Sistemico*; Officina Edizioni: Rome, Italy, 1981.
10. Condon, P.M. Rule one: See the city as a system. In *Five Rules for Tomorrow's Cities: Design in an Age of Urban Migration, Demographic Change, and a Disappearing*; Island Press: Washington, DC, USA, 2019.
11. Fistola, R. La città come sistema. In *Per il XXI Secolo Una Enciclopedia. Città Cablata e Nuova Architettura*; Beguinot, C., Cardarelli, U., Eds.; Università degli Studi di Napoli "Federico II" (Di.Pi.S.T.), Consiglio Nazionale delle Ricerche (I.Pi.Ge.T.): Napoli, Italy, 1992; Volume II, Chapter 2.
12. Lynch, K. *The Image of the City*; MIT Press: Cambridge, MA, USA, 1960.
13. Fistola, R. Ecourbanistica: Toward a new sustainable town planning. In *The Sustainable City VI. Urban Regeneration and Sustainability, the Sustainable City VI*; Brebbia, C.A., Hernandez, S., Tiezzi, E., Eds.; WIT press, WIT Transactions on Ecology and The Environment, Vol. 129, Section 1: Planning, development and management; WIT Press: Southempton, UK, 2010.
14. Wallace, K. Ecosystem services: Multiple classifications or confusion? *Biol. Conserv.* **2008**, *141*, 353–354. [CrossRef]
15. Costanza, R.; de Groot, R.; Sutton, P.; van der Ploeg, S.; Anderson, S.J.; Kubiszewski, I.; Farber, S.R.; Turner, R.K. Changes in the global value of ecosystem services. *Glob. Environ. Chang.* **2014**, *26*, 152–158. [CrossRef]
16. Rifkin, J. *Entropy: Into the Greenhouse World*; Bentam: New York, NY, USA, 1989; Rev Rei edition.
17. Miller, H.; Page, S. *Complex Adaptive Systems, an Introduction to Computational Models of Social Life*; Princeton University Press: Princeton, NJ, USA, 2007.
18. Zoppi, C. Ecosystem Services, Green Infrastructure and Spatial Planning. *Sustainabilty* **2020**, *12*, 4396. [CrossRef]
19. Ronchi, S. *Ecosystem Services for Spatial Planning. Innovative Approaches and Challenges for Practical Applications*; Springer Nature: Cham, Switzerland, 2018.
20. Tondelli, S.; Arcidiacono, A. Suolo e servizi ecosistemici nella pianificazione urbanistica. *Urban. Inf.* **2022**, *305*, 46–48.
21. Odum, H.T. *Ecological and General Systems: An Introduction to Systems Ecology*; Colorado University Press: Niwot, CO, USA, 1994.
22. Pulselli, R.M.; Tiezzi, E. *Città Fuori Dal Caos. La Sostenibilità Dei Sistemi Urbani*; Donzelli Editore: Rome, Italy, 2008.
23. Zhang, Z.; Shen, Z.; Liu, L.; Zhang, Y.; Yu, C.; Cui, L.; Gao, Y. Integrating ecosystem services conservation into the optimization of urban planning policies in eco-fragile areas: A scenario-based case study. *Cities* **2023**, *134*, 104200. [CrossRef]
24. Bolund, P.; Hunhammar, S. Ecosystem services in urban areas. *Ecol. Econ.* **1999**, *29*, 293–301. [CrossRef]
25. Bibri, S.E.; Krogstie, J. Smart Eco-City Strategies and Solutions for Sustainability: The Cases of Royal Seaport, Stockholm, and Western Harbor, Malmö, Sweden. *Urban Sci.* **2020**, *4*, 11. [CrossRef]