

Editorial

# Sustainable Spatial Planning Based on Ecosystem Services, Green Infrastructure and Nature-Based Solutions

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In the last decade, ecosystem services, that is, the goods and benefits provided by ecosystems to people, have gained significant importance in the planning domain, as a consequence of the growing scholarly awareness about, and interest in, the complex relationship between human well-being and nature. On the one hand, human life is sustained by, and depends upon, healthy ecosystems; on the other hand, spatial plans struggle to keep up with the needs and demands of ever-increasing urban populations and to allocate land uses in such a way to prevent biodiversity loss and ecosystem degradation. It is therefore not surprising that the integration of ecosystem services into spatial planning, and especially into planning practices, has been advocated as a means to strike a balance between these two contrasting issues and to deliver urban environments that are more sustainable and fairer to all kinds of living things, not just human beings.

In this vein, several researchers have been investigating how the spatially explicit assessment of ecosystem services can be put to good use to ground spatial plans and policies, what types of contribution they can bring in the different stages of plan-making processes, or which ecosystem service indicators would better fit and integrate into consolidated spatial planning practices and decision-making processes. Worth mentioning are also newer streams of research concerning the spatial mismatches between ecosystem service providing and demanding areas, the implications of synergies and tradeoffs in ecosystem service provision on the choice between alternative planning scenarios, or the interdependence between climate change effects and ecosystem service provision.

This fast and impressive research growth has, so far, not been accompanied by an equal growth in planning practices, although there is evidence of pioneer urban and regional plans that explicitly assess and integrate nature's contributions. Such limited consideration in planning practice calls for addressing those hurdles that limit ecosystem service integration in real plan-making processes, such as planners' unfamiliarity with the concept and lack of technical skills required to run assessment models and understand assumptions and limitations, availability of data having an appropriate spatial and temporal resolution, and broad mistrust in assessment methods and, consequently, in their outcomes. To address these gaps, more applied science and reflection on the effectiveness of ongoing spatial planning strategies that integrate ecosystem service consideration would be required, but also, improved exchange and collaboration between researchers, practitioners, and policymakers is needed.

Intrinsically polysemic, the concept of green infrastructure can take different meanings, encompassing not only networks of green areas that are purposefully designed, planned and managed to deliver multiple ecosystem services [1], but also those green technologies and artificial vegetative systems that provide benefits especially in urban environments [2] and which are next referred to as nature-based solutions.

The first, and wider, meaning proposed by the European Commission provides a conceptual framework whereby a green infrastructure is used as a strategic tool allowing for the integration of ecosystem services in spatial planning at various scales, and for



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developing a unitary discourse around public and private green areas, natural protected areas, water bodies, and even agricultural land. In urban areas, the focus is especially on the delivery of cultural ecosystem services, such as recreation or health benefits (both physical and psychological), and on regulation of negative or extreme phenomena, such as heat waves, flood, geological instability, air pollution, or soil contamination. However, when planning for wider spaces and landscapes, issues of climate regulation, habitats for wildlife, water supply and purification, or even provisioning ecosystem services become extremely relevant. The green infrastructure concept, when integrated into spatial planning, is therefore instrumental in addressing social, economic, and environmental issues and in strengthening ecological resilience and supporting climate adaptation.

Against the numerous pros, some debated issues and questions arise, of which only three are next mentioned, calling for further research on the integration of green infrastructures in planning practice. A prominent one, particularly relevant in densely populated areas, concerns the tension between, on the one hand, greener cities and, on the other hand, urban spaces that can meet the demands of urbanization, which, in turn, raises the issue of green gentrification and inequitable accessibility to green infrastructures for diverse urban populations. A second one, which especially applies to densely built-up urban areas showing vast predominance of sealed soils, is associated with how to conceptualize and implement the physical and functional connection between green areas that, besides translating the “network” idea conveyed in the definition provided by the European Commission, also provide urban ecological corridors (paralleling the study in this Special Issue carried out by Isola, Lai, Leone, Zoppi at the regional scale), hence enabling animal species to better move around, hunt for food, and ultimately survive in urban areas. Finally, a third one relates to the need for deeper quantitative and evidence-based understanding of green infrastructures’ long-term effectiveness in fostering climate adaptation.

Nature-based solutions are infrastructures, artifacts, and works that make effective use of ecosystem services to address and resolve negative situations encountered in the spatial organization of environments [3], especially in relation to adaptation to climate change and the reduction of associated environmental risk [4].

Climate-related hazard conditions are generally mitigated by increased resilience generated by reduced exposure and economic and social sensitivity to the negative impacts of climate-related events, and improved adaptive capacity [5]. Decreased exposure can, for example, result from the ability of ecosystems to act as a shield against extreme events. In this context, increased flood resilience can be fostered through nature-based solutions aimed at reducing flood damage through maintenance of riverbanks and riverbeds. Increasing green areas in urban areas reduces heat island damage [6]. The sensitivity of the quality of life of local communities to the negative impacts of climate change can be improved through appropriate diversification of land use, which allows them to manage, effectively, the unpredictability of climate-related phenomena [3]. For example, it is more cost-effective to use tree species and crops that are more resistant to water scarcity, both in forest and agricultural production, to diversify income streams. This implies a growth of local communities’ skills in production management, geared toward the integration and development of practices based on climate change adaptation and mitigation of negative climate-related impacts [7].

There are multiple approaches to implementing nature-based solutions aimed at reducing exposure and sensitivity to climate-related hazards. To increase adaptive capacity to such situations, some approaches can be adopted, such as conservation and restoration of natural ecosystems in places of particular relevance to climate change adaptation, or management geared toward resilience to climate impacts of ecosystems that provide different services, such as agricultural areas and forests, if managed appropriately to diversify these services. In addition, it is possible to create from scratch natural ecosystems that provide services related to climate change adaptation, such as green roofs and walls and hybrid solutions for coastal zone management [8].

Within this conceptual, cultural, scientific, and technical framework, the studies published in this Special Issue relate to three main issues, which can be highlighted as follows. A first issue focuses on the relationships between the definition and development of spatial planning processes, both local and supra-local and regional, and ecosystem services, both with reference to their spatial organization and in relation to the recognition of the supply dimension and opportunities for improvement, both qualitative and quantitative. Fistola's study emphasizes the general terms of the inclusion of ecosystem services issues in urban planning, as this implies the integrated reading and interpretation of two complex systems, nature and the city, whose field of interactions and interdependencies highlights open issues that are difficult to address, both from a theoretical and technical and application perspective. In this perspective, the Special Issue opens up some significant avenues to follow, basically based on proposals for the implementation of plan processes based on the exploitation of services offered by ecosystems. This is the case of the study by Cattani, Montaldi, Di Pietro and Zullo, which describes and discusses the role of habitat quality and carbon capture and storage as ecosystem services to be leveraged in the urban planning of the municipalities of the earthquake crater of Umbria, in the post-earthquake time. In this perspective is, also, the article by La Riccia, Assumma, Bottero, Dell'Anna, and Voghera, which explores the issue of the use of the ecosystem services paradigm for the management of cork oak forests in the regional context of Sardinia, proposing an economic evaluation through a methodological approach based on contingent valuation. The issues of ecosystem services related to water resource management in spatial planning are addressed, in the study, with a strong theoretical connotation, by Patano and Camarda, who propose a knowledge organization and management system to be implemented in a multiagent context.

A second thematic order of the Special Issue is represented by some studies aimed at defining the spatial structure of green infrastructures, and the conditions to be put in place for them to operate effectively as spatial networks aimed at the qualified provision of ecosystem services. Within this conceptual framework is the article by Ladu, Battino, Balletto, and Amaro Garcia, which proposes a methodological approach for assessing the feasibility of a project aimed at the implementation of slow mobility of pedestrians and bikers in the context of a bridleway, as an enhancement of the ecosystem services offered by a green infrastructure located in the Sulcis-Iglesiente-Guspinese Bioregion, in the regional context of Sardinia. The study by Pristeri, Di Martino, Ronchi, Salata, Mazza, Benedini, and Arcidiacono defines a green infrastructure in the territorial context of the Alpine Subregion of Media Valtellina, in which the cognitive elements structuring the spatial network are identified in the Landscape Plan, from which prescriptive and guiding contents are also derived. Isola, Lai, Leone, and Zoppi define and implement a methodological approach for mapping a regional green infrastructure, referring to Sardinia, based on the assessment of the spatial organization of multiple ecosystem services, including habitat quality, outdoor recreation, and agricultural production, and a network of ecological corridors identified through the taxonomy of species movement resistance. The article by Isola, Leone, and Zoppi discusses the relationship between ecological corridors and the spatial taxonomy of landscape components, as identified by the Regional Landscape Plan of Sardinia, to assess whether, and to what extent, current regional land use zoning can be used as a basis for implementing regulations aimed at protecting ecological corridors.

Finally, the third thematic order of the Special Issue focuses on green infrastructure aimed at climate change adaptation. With this in mind, Gargiulo and Zucaro identify, as foundational elements of a green infrastructure in the urban area of Naples, the restoration, enhancement, and maintenance of an integrated network of green and open spaces, which constitute a valuable asset in which the definition of nature-based solutions to address the local impacts of climate change is integrated. La Rosa and Junxiang Li analyze the various factors and constraints, related to the urban morphology and the social and economic characteristics of the urban environment, that influence the location of new greening scenarios, generating significant benefits related to decreasing atmospheric temperature. In

the last article of the Special Issue, Ledda, Kubacka, Calia, Bródka, Serra, and De Montis propose a comparative analysis of the spatial planning practice of Italy and Poland, in relation to the use of green infrastructure in the context of climate change adaptation policies, with reference to the regional contexts of Sardinia and Wielkopolska.

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