A Reformulation of the Planning Process in the Light of Ecosystem Services: The European *Blue and Green City* Project

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Abstract. The desire to attribute to urban planning the ability to interface with the needs and problems of the city and the contemporary territory has meant that in recent years a large part of the scientific literature and urban planning practice has been directed towards the identification of actions that can contribute to resolving the climate issue. Having scientifically ascertained the importance of biodiversity in the process of climate mitigation and adaptation, it has become urgent and indispensable to start a process of safeguarding, valorising and restoring natural ecosystems, both in urban and territorial contexts, identifying the services they produce as the main drivers of biodiversity. The transformation processes determined in the urban sphere by the urban plan can increase the supply of ecosystem services as well as reduce their diffusion in the territory; the plan, even with possible compensation actions, must instead guarantee a high supply of ecosystem services. It is in this context that this contribution is made, which emphasises the role of urban planning in the safeguarding of biodiversity, in particular by referring to the *Blue and Green City* project, a good example of urban planning that, through the valorisation of Green and Blue Infrastructure, initiates the regeneration of the social system, landscape and environmental system of a sample area in the Piedmont Region through a trans-scalar approach that, by crossing the Vulnerability and Resilience factors with the abundance or lack of Ecosystem Services, identifies the most suitable planning actions for the valorisation of the infrastructures themselves as the main providers of ecosystem services at the various scales of the territorial and urban space.

Keywords: Ecosystem Services · Blue and Green Infrastructure · Urban and Territorial Planning

1 Foreword

The research that is being developed, in which this contribution is included, is grounded in the worldwide focus on the importance of safeguarding biodiversity for the survival of our planet. The interest in biodiversity attracts the attention of various profiles, from the institutional to the scientific and research ones, since the awareness has matured that only by guaranteeing the maintenance of an adequate level of biodiversity is it

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possible to succeed in mitigating environmental risks of various kinds (hydrological, geological, climatic) that undermine the security of life on the entire planet, both in the most developed and in the most backward areas. Together with the loss of biodiversity, climate change, the modification of the biogeochemical cycles of water, atmosphere and soil, and the spread of pandemics show that there is a limit to the Earth's capacity to withstand the degradation of ecosystems (Rawtorth, 2012). Increasing natural capital and reactivating ecosystem cycles and processes is crucial to meeting the challenges of ongoing change. Natural resources and ecological functions expressed by natural capital provide free ecosystem services (ES) to human society that underpin the development of landscapes where human societies thrive and their activities take place (Gibelli et al., 2022).

Protecting, valuing, restoring biodiversity and keeping ecosystems healthy is essential for the essential services and benefits they can provide. Through the flow of ecosystem services, nature can offer long-term, smart, cost-effective and integrated solutions to numerous challenges, such as climate change mitigation and adaptation, disaster risk management and pollution, with positive impacts on the health and well-being of individuals and communities. Ecosystem services are the pillars on which the resilience of landscape systems is built, so territories need flexible tools built on diversity, resources, inherent characteristics and capacities to adapt to change. The rational and responsible use of land resources, together with decisions on land use, can help to build liveable spaces, to mitigate the effects of ongoing climate change, to find a balance between consumption, renewal and reuse of resources functional to a healthy environment. In this perspective described above, it is possible to think of a new form of urban planning that will be substantially aimed at the transformation of the existing environment through a process that is strongly contextualised and particularly attentive to the natural components of the urban space that, in order to revitalise the natural capital, need to be strongly connected through the creation of a true network, now also recognised at a European level, as green and/or blue infrastructure. This becomes the focus of the proposed research, i.e. rediscovering the link between the plan and the enhancement of ecosystems with a consequent increase in the provision of the services they produce to increase human wellbeing.

The issue of the protection and restoration of ecosystem services is an important novelty in territorial and urban planning, especially in the perspective of regeneration; assessing the performance of ecosystem services becomes fundamental for developing urban and territorial regeneration scenarios and for measuring the sustainability effects of choices (Santolini, 2022). Ecosystem services are one of the new interpretative paradigms that are supporting the transition of the urban planning discipline towards greater environmental values. The potential of the valuation of ecosystem services is precisely that of estimating, on the basis of use transformations, the ecosystem value differentials of transformed soils in both quantitative and qualitative terms. The interest on the valuation of ecosystem services in the institutional and academic debate, therefore, is high precisely at a time when one of the criticisms levelled at the theoretical advancement and practical development of ecosystem valuation is that of not being able to support the effective construction of the spatial and regulatory structure of the urban plan in response to territorial vulnerabilities (Caldarice, Salata, 2019).

Today, there is an increasing awareness of the weight that urban areas assume in altering environmental balances, and ecological issues are now becoming inescapable priorities for territories in transition from vulnerability and, therefore, ideal environments for ecological research. An important contribution to this renewed interpretative dimension of the discipline is provided by Ecosystem Services. Since the 1990s, Ecosystem Services have gained a growing consensus both with regard to the importance of their assessment in supporting natural resource management decisions in the context of land-use planning and their role in counteracting the loss of biodiversity caused largely by increasing territorial vulnerabilities. In this perspective, ES constitute a support for urban and spatial planning and design practices as they enable the understanding and evaluation of the environmental effects resulting from land use transformations and their consequent economic and social impacts. The assessment of ES implies, with respect to land use transformations at different time thresholds, the ecosystem value differentials in both quantitative and qualitative terms. Unfortunately, the connections between the theoretical knowledge of ES and their concrete use in urban planning and design are still weak (Caldarice, Salata, 2019). From this awareness derives the desire to know, understand and analyse those urban planning instruments and studies that in various ways have made use of the concrete use of ES in their structuring; several of them have been taken into consideration and of varying nature that have affected urban and regional levels.

The current Italian panorama presents, in fact, several experiences of integrating ecosystem services in urban and territorial planning processes at different scales, which are based on the increasingly felt need to have an integrated and multifunctional approach to land management, aimed at reducing the overall vulnerability of the system and the loss of ecological functionality and the services and benefits that ecosystems can provide (Santolini and Morri, 2017). These experiences have experimented with different issues including that of identifying and developing innovative schemes and tools and methodologies for the integration of ecosystem services in the assessment practices and planning and design of the issue of protection and restoration of ecosystem services (D'Ambrogi, Gibelli 2022).

In particular, in this contribution, we focused on the Blue Green City project, funded by the Interreg Europe 2014_2020 programme, which has the overall objective of improving policies that promote the value of green and blue infrastructure as an integral part of a local or regional natural heritage conservation strategy, and which after an initial period (of approximately two and a half years) during which each partner's policy instruments were assessed, potential barriers and drivers for the uptake of green and blue infrastructure, and exchanged practices and experiences to develop and improve policies to support the construction of these infrastructures in the participating cities and regions, Guidelines were drawn up, that build on the outcomes of the previous European project LOS_DAMA!, with which they share the methodologies and study area and capitalise on the results of the governance activated with the Corona Verde strategic project for the realisation of a metropolitan green infrastructure. The result of these Guidelines is a comprehensive guideline for the strategic planning, design and sustainable maintenance of green and blue infrastructure with an integrated, participatory and place-based approach, addressed to local public administrations, technicians and stakeholders.

The process of deepening the knowledge of these experiences of plans is aimed at achieving the first milestone, the construction of a catalogue of ES, of Goal 4.6 "Climate change planning to promote cultural and natural heritage: Demand-driven ecosystem services based on ICT and AI enabling technologies" of the Pilot Project "Climate adaptation plans for the reduction of the ecological footprint and ecological debt aimed at improving the conservation" within SPOKE 4 "Resilience and accessibility in the enhancement of local cultural and natural heritage" of the TECH4YOU Research Project "Technologies for climate change adaptation and quality of life improvement". In addition to this introductory part, in which the subject under study is contextualised and specified, the paper is divided into a second paragraph in which the concept of ecosystem services is analysed by referring to the existing scientific documentation, a third paragraph in which a critical-interpretative summary of the Green Blue City project and the consequent Guidelines is proposed, and a last paragraph containing some concluding reflections. Finally, it should be emphasised that the first milestone of the Pilot Project, i.e. the construction of a data catalogue for the systematisation of ecosystem services over two selected areas in the Basilicata and Calabria regions, takes place according to Action 5 of the European Biodiversity Strategy. Similar to Natural Capital, the EU prioritises biodiversity, the loss of which can affect the resilience of ecosystems by compromising the provision of ecosystem services. The new strategy is one of the key pillars of the European Green Deal, containing an Action Plan that sets the goal of establishing protected areas for at least 30 per cent of seas and land, restoring degraded ecosystems through sustainable agriculture, halting the decline of pollinators, restoring rivers to a free-flowing state, reducing pesticides by 50 per cent and planting trees.

2 Evolution of the Meaning and Classification of ES at Territorial and Urban Scales

2.1 Ecosystem Services at the Territorial Scale (PTCP Lecco, 2022)

The concept of ecosystem services took off, in parallel with Urban Ecology (a discipline for the study of urban ecosystems), in the 1980s, and the first publication containing this term, as indicated by most studies on the subject, is entitled "Extinction: the Causes and Consequences of the Disappearance of Species" (Ehrlich P.R, Ehrlich A.H., 1981). The first classifications are those made by Robert Costanza; in his article "The value of the world's ecosystem services and natural capital", Ecosystem Services are represented by the goods, materials, energies and information of natural capital that, combined with the artifacts and services of human capital, produce human well-being (Costanza, 1997) (Fig. 1).

By biologist G. Daily, ecosystem services are defined as the conditions and processes through which natural ecosystems and the species that create and sustain them make human life possible. Complementing this definition is the clarification that ecosystem services, in addition to producing goods, constitute the current primary life-supporting functions, such as sanitation, recycling and regeneration, also encompassing many intangible aesthetic benefits and cultural benefits. The services listed are as follows: air and

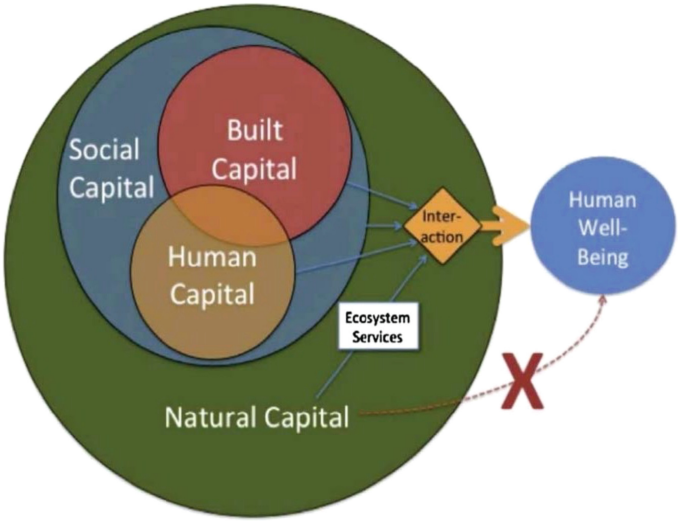

Fig. 1. A schematic representation of the aforementioned concept that renders the relationship between ecosystem services and different capitals, taken from a more recent article by R. Costanza et al. (2014), is given (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/prlecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.).

water purification; flood and drought mitigation; toxicity reduction and waste decomposition; soil and fertile soil generation and replenishment; pollination of crops and natural vegetation; control of most potential pests for agriculture; seed dispersal and nutrient processing; preservation of biodiversity; protection from exposure to the sun's ultraviolet rays; partial stabilisation of climate; mitigation of temperature extremes and wind and wave force; support for diverse cultures; and provision of aesthetic and intellectual stimuli that elevate the human spirit. (Daily, 1997).

In 2005, the Millennium Ecosystem Assessment project was developed for the United Nations under the Environment Program (UNEP) to analyse how ecosystems have evolved in relation to human activities and the resulting impacts, in terms of welfare conditions, and then to identify intervention strategies for sustainable development (Ma, 2005). The study, coordinated by R.T. Watson and A.H. Zakri, includes a survey of ecosystem service categories.

The MA proposes a very simple definition of eco-systemic services as the benefits that people obtain from ecosystems. This approach, which puts the human population at the centre, derives from the project's aims of assessing the effects on ecosystem balances that have occurred in recent times and the resulting impact on socio-economic health and well-being so as to incentivise ecosystem conservation policies.

The classification of eco-systemic services is based on a distinction of them according to the type of benefit and is divided into the following four categories: support; supply; regulatory; and cultural (Fig. 2).

Supporting services (*Supporting*) include habitats and genetic biodiversity; supply or provisioning services (*Provisioning*) provide goods (food, water, fuel, and other raw materials); regulating services (*Regulating*) deal with climate, air and water quality, and soil formation; and cultural services (*Cultural*) refer to non-material aspects, such as cultural identity, spirituality, intellect, aesthetic values, and recreational dimensions.

At the same time, the MA defines the relationship between ecosystem services and societal well-being, according to a scheme in which flows from the former to the latter are highlighted, based on the general concept that human well-being depends on the services provided by nature.

In addition, the interaction cannot be traced only to the natural and anthropogenic dimensions because some external determinants condition the dynamics and change the relationships; these are, for example, changes in land uses and land cover or the effects of climate change. For this reason, the management of ecosystem services and their enhancement must take into account future scenarios and the aforementioned dynamics, in the spatial dimension (global, regional, local) and at the temporal scale (short- and long-term).

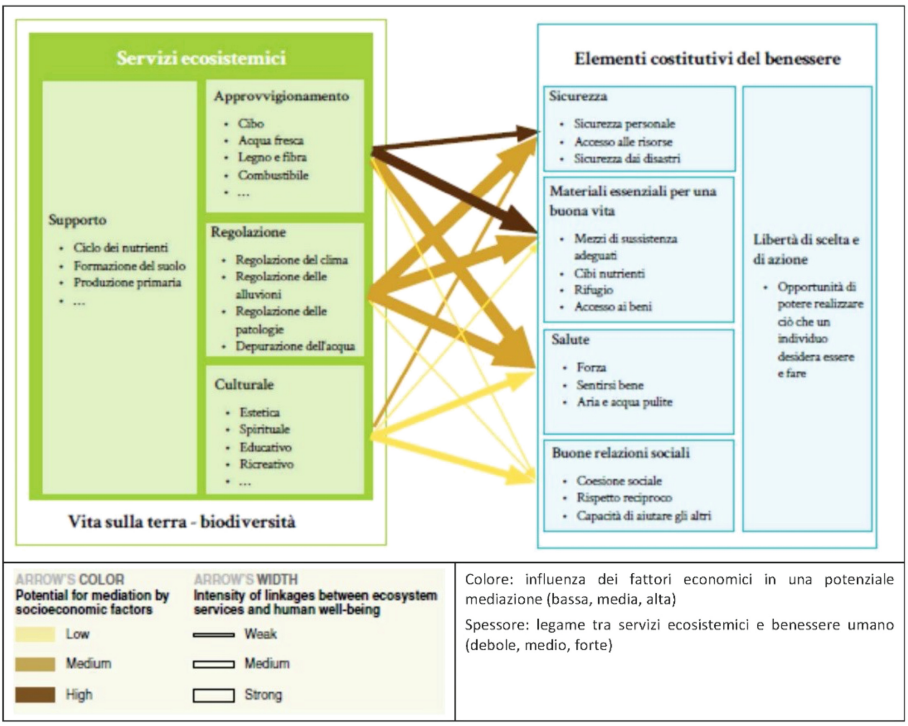

Fig. 2. Relational diagram between ecosystem services and the human well-being dimension. (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/prlecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.)

Following the definition of ecosystem services elaborated by the Millennium Assessment there are different views in subsequent years that differ from the proposed classification in that it does not distinguish between the means used to produce the goods and services and the goods themselves.

Among the most interesting definitions, subsequent to that of MA, is the one proposed by Fisher et al. who, in a 2009 article, emphasise that structure, functions and ecosystem services are not identical or synonymous, and repropose the distinction into three types of services: the "intermediate" ones, understood as intermediaries between ecological functions and the spherulation (associated with structure and ecosystem processes), the "direct" or "final" ones, and the "benefits" or goods, the latter usually realised through human capital or technology (Fisher et al., 2009). As an example, considering the water resource, clean water is the result of an (intermediate) service generated by natural cycles of purification and storage (nutrient cycling) that occur independently of man and the nutrient cycle is therefore a service that man uses, but indirectly. Clean water, when consumed for drinking, is a benefit of ecosystem services. The supply of clean water is a (direct) service that man uses and requires capital and technological investments to obtain water for domestic use that is a benefit.

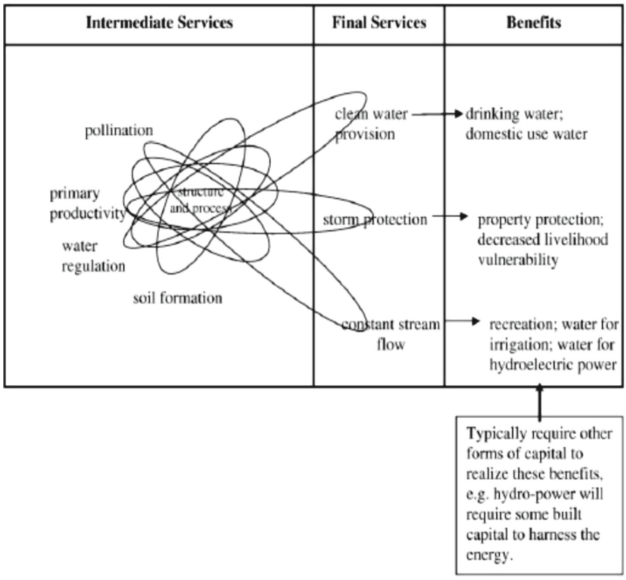

Fig. 3. Conceptual diagram of the relations between intermediate and final services, related to benefits (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/pr-lecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.).

The proposed classification scheme (Fig. 3), which divides ecosystem services into intermediate (e.g. pollination, soil formation, water regulation, primary productivity), final (e.g. water purification, storm protection, constant water flows) and benefits (e.g. drinking water, reduction of vulnerability levels, recreation, irrigation and hydropower

production) is substantiated as being the most appropriate and allowing a differentiation between the former and the latter drinking water, reduction of vulnerability levels, recreation, irrigation water and for hydropower production, it is sublated to be the most appropriate and such that it is possible to differentiate whether it is the former (intermediate ES) or the latter (final ES), in relation to the connection with human benefit. With regard to the temporal and spatial dimension, however, ecosystems and ecosystem services are not equal in the terrestrial and marine landscape and are not static phenomena, but rather heterogeneous in space and evolving over time; spatio-temporal dynamics is indicated as a feature that can help understand and classify ecosystem services. For example, still with regard to water, its regulation guaranteed in the mountains by forest cover will become a benefit later on, in the form of regular and extensive water supply. Also with respect to landscape management, we note the relationship with the classification of ecosystem services on the basis of their spatial characteristics and the need to describe the relationships between the production of services and the places where the benefits accrue, traced to three situations: in situ, when services and benefits occur in the same place; omni-directional, when services are generated in one place and the benefits affect the surrounding territory; directional, when services give benefits in a specific place according to the direction of flow.

The distinction of services between supply and use gives the possibility, if the beneficiaries of the services are located in places other than where they are generated, to define compensations through the mechanism of payment for ecosystem services.

The different interpretations and systematisations of ecosystem services prompted the United Nations, under the UNEP programme (UN Environment Programme), and the EU, as the European Commission with the participation of several ministries from European countries, to support new research on the economics of ecosystems and biodiversity, which returns the results of the study on the economics of ecosystems and biodiversity, provides a new definition of ecosystem services and reformulates the classification of the same, implementing the method proposed by the MA.

The TEEB scheme identifies two blocks, that of ‘Ecosystems and Biodiversity’ and that of ‘Human wellbeing (socio-cultural context)’, which are linked in one flow direction by ecosystem services (Fig. 4). The first block includes ‘biophysical processes and structures’, which do not, such as, constitute a service for human beings, and the ‘functions’ or capacities that those processes possess. To the second block belong the ‘benefits’ for human beings, deriving from ecosystem functions, and the ‘economic values’ (monetary or non-monetary) that are attributed according to different methods of evaluation and quantification. The (ecosystem) services, placed between the two blocks, to be traced back to an anthropic dimension, are those that constitute the intermediary; these are declined according to the distinction into the four categories of supply, regulatory, habitat and cultural services. The definition of ecosystem services proposed by the TEEB group, “Direct or indirect contribution of ecosystems to human well-being”, differs somewhat from that of the MEA in that the TEEB differentiates between services and benefits by specifying that the former can provide benefits in multiple and even indirect ways; ecosystems are, however, identified as a factor that makes a contribution to the well-being of the human population. The TEEB group proposes 22 types of eco-services, associated systemic services and grouped into one of the above-mentioned

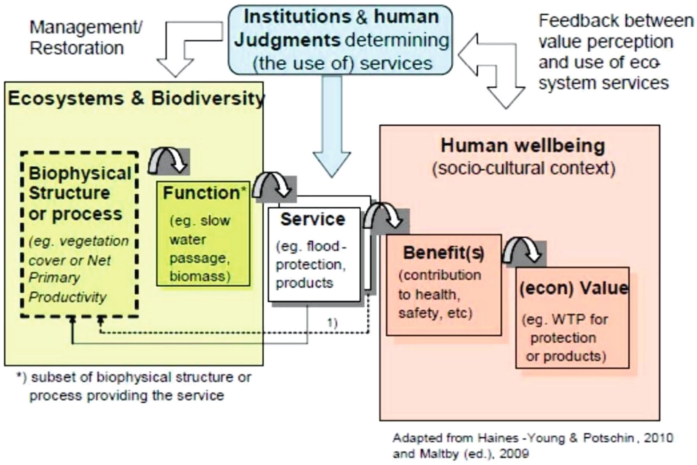

Fig. 4. First operational diagram, contained in the TEEB document, summarising the transition from ecosystem structure, ecosystem processes and human benefits (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/pr-lecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.).

four main categories; eliminating, compared to the MEA classification, the category of support services and adding, instead, the category of habitats, thus reinforcing the role of ecosystems in providing habitat for migratory species and as protectors of gene pools.

In 2011, a new classification was proposed by Roy H. Haines-Young and Marion B. Potschin, as an evolution of the MA categorisation, which was given the name CICES 'Common International Classification of Ecosystem Services'; the action that led to this new definition was promoted by the European Environmental Agency (EEA) with the aim of finding common grids to evaluate ecosystems in a uniform way at a European level (Haines, Potschin M.B. et alt, 2011). This classification has recently undergone revision, with the contribution of the System of Environmental-Economic Accounting (SEEA), under the United Nations Statistical Division (UNSD). The latest version of the CICES classification, V5.1 of 2018, provides the following definition of Ecosystem Services: "Ecosystem services are defined as the contributions that ecosystems make to human well-being. They are seen as arising from the interaction of biotic and abiotic processes, and refer specifically to the 'final' outputs or products from ecological systems" (Haines, Potschin, 2018). For the purposes of the ICESCR (International Covenant on Economic, Social, Cultural Rights) ecosystem services are thus defined as the contributions that ecosystems make to human well-being, with the clarification that these are seen as arising from the interactions of biotic and abiotic processes, and refer specifically to the 'final' outputs or products from ecological systems.

Going backwards to understand the evolution of the meaning of eco-systemic services according to the CICES classification, it can be seen that in the first CICES proposal, it identifies three levels, i.e.: that of the themes (later renamed sections), which includes supply, regulation, maintenance and cultural services; that of the classes (which, for example, with regard to supply includes food, materials, energy) and finally that of

the groups (which, for example, with regard to food includes terrestrial, aquatic and marine plants, food animals, drinking water). The section Supporting (support services) is elided, compared to the MA scheme, as it is considered by the authors as not relevant to the final assessment of the ecosystem service. A subsequent 2013 version takes the original version and confirms the hierarchical structure but introduces some changes by inserting, after the Section, the Division, anticipating the Group and adding, after the Class, a fifth level represented by the Typology (Class Type) (Haines, Potschin, 2013) (Fig. 6). This version provides the definitions of final ecosystem services, ecosystem goods and benefits, and human well-being, summarised below. Final ecosystem services, from which people create or obtain goods and benefits, are identified with the contribution that ecosystems make to increasing human well-being and are characterised by having a connection with the ecosystem functions, processes and structures that generate them. Human well-being, on the other hand, is that which provides adequate access to the basic materials for a good life, necessary to sustain freedom of choice and action, health, good social relations, and security; the conditions for such well-being depend on the overall supply of ecosystem goods and benefits, the provision of which can change the state of well-being. The three strands of ecosystem services are: provisioning services, which include all food, materials and energy from living systems; regulating and maintenance, which include all the mechanisms of living organisms that can regulate the environment and affect the human condition; and cultural services, which include all the non-material and normally non-consumable ecosystem services that affect people's physical and mental conditions. The cascade model (Fig. 5), in the latest formulation described by Potschin and Haines-Young, is the one depicted in the figure below, in which the (ecosystem) services are placed in the 'final services' box (Haines, Potschin et al., 2016).

In 2012 The MAES, a working group established by the European Commission, with the expanded name of "Mapping and Assessment of the Ecosystem and their Services", set out to support and increase the mapping of ecosystems and their services for the European territory(Fig. 7).

Four interim reports on specific aspects are published under this project (in 2013, 2014, 2016a, 2016b) and the final report, 'Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition,' is published in 2018 by the European Union (Maes J et, 2018). In addition, a specific report on soil ecosystems is published in 2018 and the sixth report entitled 'Natural Capital Accounting: Overview and Progress in the European Union' is published in 2019 (EU, 2019).

In 2018, MAES, on behalf of the European Commission, DG Environment, published the report 'Mapping and Assessment of Ecosystems and their Services Soil ecosystems' in which ecosystem services specifically related to soil are considered, again for the purpose of mapping and assessing the condition of soil ecosystems and their services, identifying reference indicators. In the foreword to the document, it is pointed out that soil ecosystem services can contribute to the achievement of the United Nations Sustainable Development Goals (SDGs) and in particular Target 15.3 concerning combating desertification and restoring degraded soils and lands. The report identifies, in illustrative tables, the soil ecosystem services pertaining to the three main categories, identifying the functional processes required to generate these services and provides, again in tables,

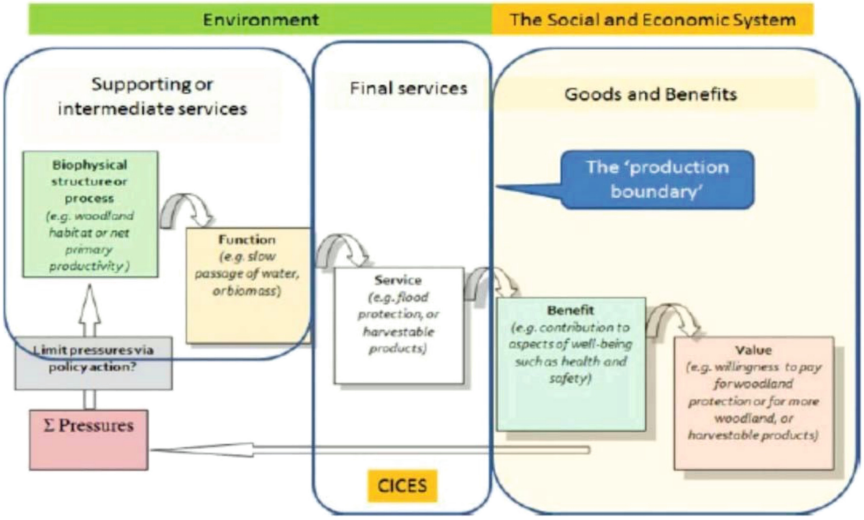

Fig. 5. Ecosystem Services cascade model, Haines, Potschin et al., 2016 (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/pr-lecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.).

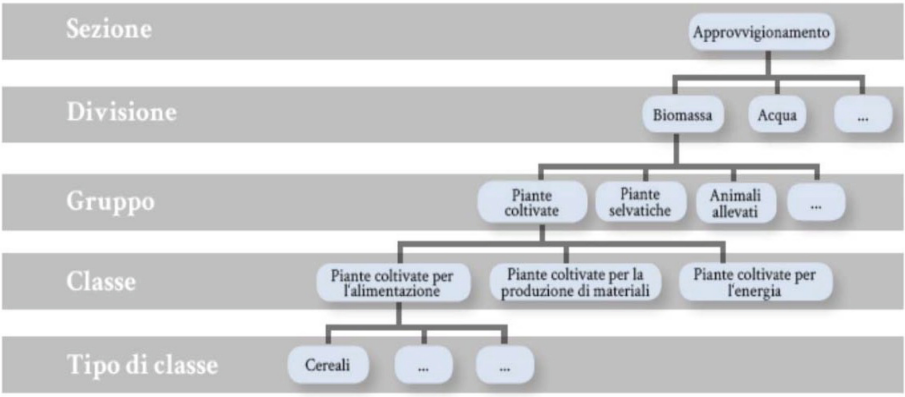

Fig. 6. Latest version of the CICES confirming the above-mentioned five-level articulation, represented in the following diagram (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/pr-lecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.).

for each ecosystem service, the list of related indicators for which the spatial dimension of reference (regional or local) for their application is specified, whether they are supply or use services, and the availability of data. Indicators for assessing soil pressures and ecosystem conditions are also listed in the document (Van der Meulen S., Maring L., 2018).

2.2 Ecosystem Services at the Urban Scale

After reconstructing a summary of the different types of classification of ecosystem services on a territorial level, we briefly focus on the specificities of urban ecosystems, understood as those areas in which the built-up system occupies most of the land surface or as those characterised by a high population density.

It is important to point out that, in the context of urban planning, urban ecosystems are often represented as being embedded with both built and ecological infrastructure. In particular, the concept of ecological infrastructure focuses on the function that water and vegetation play in or near built-up areas and their ability to provide ecosystem services at different scales of urban space (building, street, neighbourhood, city). This concept includes, therefore, all 'green and blue spaces' in urban and peri-urban areas, including: parks, cemeteries, gardens and courtyards, urban gardens, urban forests, individual trees, green roofs, wetlands, watercourses, rivers, lakes and ponds (European Environment Agency EEA, 2011).

CICES - Version 5.1 - Structure		
Sector	***Division***	***Group***
Biotic supply	Biomass	Cultivation of terrestrial plants
		Cultivation of aquatic plants
		Breeding of land animals
		Breeding of aquatic animals
		Wild plants
		Wild animals
	Genetic material	Plants, algae, fungi
		Animals
	Other supplies from biotic resources	More
Biobiotic supply	Water	Surface water for feed, materials or energy
		Groundwater for food, materials or energy
		Other supplies from aquatic ecosystems
	Supplies from non-aquatic natural abiotic ecosystems	Mineral substances for food, materials and energy
		Non-mineral substances or properties of ecosystems used for food, materials or energy
		Other minerals or non-mineral substances or ecosystem properties used for food, materials or energy

Fig. 7. CICES Ecosystem Services Classification Scheme (PTCP Province of Lecco) (Source: PTCP Province of Lecco - Monograph G - Ecosystem Services, https://www.provincia.lecco.it/pr-lecco-media/2022/08/03_Monograph_G_Services_Ecosystem_2022.pdf.).

CICES - Version 5.1 - Structure		
Sector	***Division***	***Group***
Adjustment and Maintenance biotics	Transformations of biochemical or physical inputs of ecosisthemes	Assimilation of waste or t o x i c substances by living processes
		Assimilation of disorders of antr
	Regulation of physical, chemical and biological conditions	Flow regulation and east events
		Maintaining life cycles and pro gene banks
		Pest and disaster control
		Soil quality regulation
		Water conditions
		Composition and conditions of the atmosf
	Other regulation and maintenance by processinations	More
Adjustment and Maintenance abiotics	Transformations of biochemical or physical inputs of ecosisthemes	Assimilation of waste or t o x i c substances by non-living processes
		Assimilation of disorders of antr
	Regulation of physical, chemical and biological conditions	Flow regulation and east events
		Maintaining physical conditions, ch
	Other regulation and maintenance by abiotic processes	More

CICES - Version 5.1 - Structure		
Sector	***Division***	***Group***
Cultural biotics	Direct, on-site or external interactions with living systems depend on the presence of environmental contexts	Physical and experiential interactions co
		Intellectual interactions and natural representation
	Indirect, remote, indoor interactions with sistemivents that do not require presence in environmental counts	Spiritual, symbolic or natural environment interactions
		Other biotic characteristics
	Other characteristics of living systems that have cultural unsignification	More
Cultural abiotics	Direct on-site or external interactions with natural physical systems that depend on the presence of environmental contexts	Physical and c abiotic experiential interactions of the natural environment
		Intellectual interactions and abiotic representations of the natural environment
	Indirect, remote, indoor interactions with system physics that do not require presence in environmental contexts	Spiritual, symbolic or abiotic interactions of the environment n
		Other abiotic characteristics that h do not use
	Other abiotic features of nature that have cultural significance	More

Fig. 7. (*continued*)

Defining clear-cut boundaries for urban ecosystems is, very often, not an easy task, as many of the important flows and interactions essential for understanding the functioning of urban ecosystems expand far beyond urban boundaries that can be traced back to administrative or biophysical reasons. For this reason, the scope of cataloguing and investigating urban ecosystems must be considered beyond the canonical urban perimeters, as it encompasses not only the ecological infrastructure within the city, but also the hinterland - including catchment areas, agricultural areas and wooded areas - that are explicitly affected by flows from the urban core.

In recent years, a large body of literature has improved our knowledge and understanding of urban ecosystem services, their role and their biophysical, economic and socio-cultural components. Furthermore, urban ecosystem services have been the subject of consideration in the aforementioned major projects such as the *Millennium Ecosystem Assessment* (MA, 2005) and *The Economics of Ecosystems and Biodiversity* (TEEB, 2011) and, in recent years, have received increasing attention within the more general debate on ecological infrastructure. However, despite the fact that more than half of the world's population now lives in cities, the interest assigned to urban ecosystems in the literature on ecosystem services is still quite limited compared to that assigned to other spatial-level ecosystems.

The following is a classification and description of ecosystem services in urban areas, focusing on how they can contribute to increasing the quality of life in cities. Building on previous categorisations of ecosystem services (Daily 1997; et al.), the aforementioned *Millennium Ecosystem Assessment* (MA 2005) and *The Economics of Ecosystems and Biodiversity* (TEEB 2011) have grouped ecosystem services into four main categories: supply or provisioning, regulating, cultural and recreational, supporting or habitat.

Supply services include all material products obtained from ecosystems, including genetic resources, food and fresh water. *Regulation services* include all benefits obtained from the regulation of eco-systemic processes, including the regulation of climate, water and some human diseases. *Cultural services* are the non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, recreation and aesthetic experience, as well as their role in sustaining knowledge systems, social relations and aesthetics. *Supporting or habitat services* are those necessary for the production of all other ecosystem services. Examples include biomass production, nutrient cycling, water cycling, provision of habitat for species and maintenance of gene pools and evolutionary processes.

Since different habitats provide different types of ecosystem services, general classifications must be adapted to specific types of ecosystems. Urban ecosystems are particularly important in providing services that have a direct impact on human health and safety, such as air purification, noise reduction, urban cooling and water runoff mitigation.

3 The European Blue Green City Project

In the course of the research underlying this contribution, a number of urban planning projects were analysed that aim to integrate ecological services into the plan in order to strengthen the resilience of urban areas and increase their bio-diversity. Among the many projects examined - the urban regeneration of disused industrial areas of the Municipality

of Trento, the Territorial Plan of Milan, the Municipal Plan for the City of Mangalia, the Territorial Plan of the City of Lecco, etc. - the Blue Green project is examined.

The Blue Green Cities project, which concerns a group of municipalities belonging to the Piemonte region, is chosen for the rigorous methodological approach developed to outline the planning actions starting from the mapping of the ecosystem SEs in the various UPAs (Landscape and Environmental Units) into which the entire area of intervention is subdivided and to constitute; with the drafting of the Guidelines for Green and Blue Infrastructures that accompany the plan, this project represents a capitalised experience that, if well understood, can be translated and adapted to other territorial contexts.

The BLUE GREEN CITY project ("*Green and Blue Infrastructure for sustainable cities*") was activated under the Interreg Europe Programme 2014–2020 building on the results of an earlier applied project LOS_DAMA! (Green Infrastructure for Better Living) financed by the Alpine Space Programme 2014–2020. With the pilot activity of this project, a methodology for the sustainable planning of Green and Blue Infrastructures and a wide area planning scheme were defined, with an approach that integrates landscape matrices and the mapping of potential ecosystem services with the aim of providing strategic responses to needs and vulnerabilities and enhancing the resilience of the study area through the planning of green and blue infrastructures.

Subsequently, with the Blue Green City project, the methodology and the wide area planning scheme (Figs. 8 and Fig. 9) were tested and validated in a more restricted area involving the Union of Municipalities North East of Turin and the Municipality of Mappano in a participatory planning process that led to the definition of a more detailed inter-municipal planning scheme, with the identification of actions and strategies that can be implemented on a local scale and the definition of specific guidelines. The result is a comprehensive guide for the strategic planning, design and sustainable maintenance of green and blue infrastructure with an integrated, participatory and place-based approach, addressed to local public administrations, technicians and stakeholders.

In the *Blue Green City* project, the Intermunicipal Planning Scheme, comprising the Local Action Programme (LAP), integrates the following objectives into the spatial planning and governance tools to promote collaboration and multilevel exchanges to define innovative planning models oriented towards sustainability and increasing the resilience of territories; to improve policies that promote Green and Blue Infrastructures as an integral part of a local or regional strategy for the conservation of Natural Capital; to increase the knowledge of stakeholders on the concepts of ecosystem services and the value of Green and Blue Infrastructures; to build a programme of actions to increase the capacity of territories to adapt and respond spontaneously to environmental, social and economic changes.

The starting assumption of the project is to consider it necessary to construct an interpretative diagnostic system to effectively describe the structuring characteristics of the various Spatial Units that make up the Pilot Area and the problems and values from which to extract the priority Ecosystem Services at different scales. The planning process developed for the project is develops in five phases. The first phase consists of building a framework of basic knowledge in order to understand the structure and organisation of the landscape at different scales. It consists of three stages: general knowledge

Fig. 8. Logical diagram of the sustainable planning process (Gibelli et al., 2022) (Source: Project Blue Green City, Green and Blue Infrastructure strategically planned Guidelines in https://www.regione.piemonte.it/web/sites/default/files/media/docu-menti/2023-01/Line%20Guide_complete.pdf.)

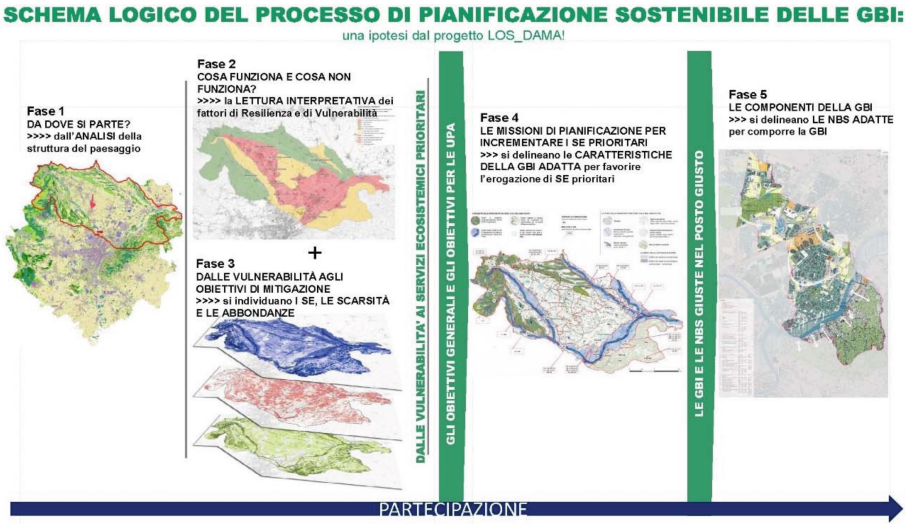

Fig. 9. The logical scheme of the Sustainable Planning Process (Gibelli et al., 2022) (Source: Project Blue Green City, Green and Blue Infrastructure strategically planned Guidelines in https://www.regione.piemonte.it/web/sites/default/files/media/docu-menti/2023-01/Line%20Guide_complete.pdf.)

to understand the structure of the landscape, landscape-environmental mapping to represent the diversity of the territorial area under examination, (the "Green Crown"), to identify structural patterns and subdivision into sub-systems, (UPA Territorial Units of Reference), and finally the selection of reading keys suitable for the definition of needs and their localisation in order to be able to transform them into policies and actions, corresponding with the concepts of Vulnerability and Resilience. The second phase consists of identifying priority 'needs' to work on through spatial indicators that estimate the vulnerability of socio-ecological systems; this is indispensable since not all vulnerabilities are primary. The latter are those that most affect the equilibrium of spatial units and thus the possibilities for spontaneous adaptation. They generally belong to both the large and intermediate scales and can be defined through spatial indicators and the classification of results in the different spatial units. After defining Vulnerability and Resilience on the large scale, one then proceeds to the estimation of vulnerability on the intermediate scale, i.e. the pilot area and the 14 UPAs. Finally, by comparing the vulnerability factors of the UPAs with those of the broad scale (Green Crown), it is possible to understand which broad scale processes affect the Vulnerability of the pilot area and vice versa, and those vulnerabilities that correspond between the intermediate and the broad scale are considered priorities. Once the priorities have been identified, priority ecosystem services are defined, i.e. those effective in resolving or mitigating the various PAUs whose needs they signal. The third phase concludes with the definition of scarcity and abundance levels of priority ecosystem services within the various PAUs. In the fourth phase, functional "Planning Missions" are developed to enrich the scarce ecosystem services through the definition of the multifunctional Green and Blue Infrastructure (IVB), in which the necessary functions are clearly dictated by the priority ecosystem services (Gibelli, D'Ambrogi, 2022); these "Planning Missions", organised into Objectives-Strategies and Actions, are reported in the Summary Sheets (which constitute a sort of identity card for the UPAs). Below is a summary sheet referring to a specific UPA (Fig. 10).

UPA	PERCHE'	COSA	DOVE	
	Obiettivi	Missioni di Pianificazione	Paesaggi	Sistemi funzionali
Si riporta l'UPA in esame	Si riportano uno o più obiettivi specifici della UPA	Sono descritte le azioni che attuano gli obiettivi. Ogni obiettivo può prevedere una o più azioni	Si individuano le categorie di paesaggi per i quali quelle determinate azioni sono efficaci	Le categorie di paesaggi sono eventualmente specificate ulteriormente in sistemi funzionali
La riga seguente riporta un esempio di scheda compilata tratta dal progetto LOS_DAMA!				
6 Alta pianura	Ridurre la conflittualità tra elementi incompatibili	Mitigare le infrastrutture, con interventi attenti anche alla ricucitura del paesaggio originario e non solo alla mitigazione visiva	Paesaggio delle infrastrutture	Agroecosistema
				Ecosistema Urbano
		Lavorare sui margini degli insediamenti sparsi per ridurre le interferenze con le aree agricole; impedire/ ridurre la frammentazione delle aree agricole	Paesaggi periurbani rurali	Ecosistema Urbano/Agroecosistema

Fig. 10. Overview diagram of a UPA specification (Gibelli et al., 2022) (Source: Project Blue Green City, Green and Blue Infrastructure strategically planned Guidelines in https://www.regione.piemonte.it/web/sites/default/files/media/docu-menti/2023-01/Line%20Guide_complete.pdf.)

The "Actions" or "Planning Missions", to be implemented by means of the most suitable Nature Based Solutions (NBS) and policies, which outline the most effective infrastructures to erect Ecosystem Services are translated into Planning Schemes. The

scheme elaborated with the European projects Los_Dama! and Blue Green City is the response to the needs that emerged from the analyses and assessments carried out at the different scales considered and specifically: at the intermediate scale it was developed within the Los_Dama! project and represents an overall IVB development scenario aimed at increasing the provision of priority Ecosystem Services, proposing a stock of appropriate, feasible and sustainable actions and solutions capable of attracting the necessary funding (the Planning Missions); at the local scale it was developed within the Blue Green City project for the Unione dei Comuni Nord Est Torino and the municipality of Mappano and represents a programme of actions aimed at implementing the Planning Missions through the implementation of effective actions starting from the priority ones selected to respond to the priority vulnerabilities and selected during the participatory process that accompanied the whole planning process.

The inter-municipal planning scheme (envisaged by the Blu Green City project), of which the Programme of Actions constitutes the heart, is composed of the mapping of the Green and Blue Infrastructure at present on which to graft the overall planning scenario of the same Infrastructure, the map of the IVB project, which represents the strategic areas (the areas of intervention) where to build the new IVBs and the Nature Based Solutions for the completion of the network, the actions to start implementing the scenario (the Programme of Actions) and the priority action sheets that contain the information and data needed to develop them. In particular, the Programme of Actions (PAL) contains those actions that prioritise the territorial problems and are feasible because they are agreed and shared with the stakeholders, the actors involved are defined, they are accompanied by a schedule, the timeframe and the approximate costs of realisation. The fifth phase of the project's methodological pathway concludes the planning process at the local level with the selection of the most suitable NBSs to increase priority ecosystem services; the NBSs are therefore the ultimate result of the planning process and the local response to landscape needs. The selection of the most effective NBSs represents the final building block for the construction of the IVBs; in this sense, they come downstream of all the previous steps and incorporate them in terms of a concrete response to landscape needs.

The planning process just illustrated allows for the setting up of planning tools suitable for responding effectively to real adaptation needs of territorial systems at different spatial scales. The plan is, therefore, supported by a "dynamic frame of reference" within which ecosystem services become tools to reduce vulnerabilities and improve the resilience of PAUs and the whole territory in a multi-scalar approach (Gibelli et al., 2022).

4 Conclusions

In recent decades, scientific evidence of the benefits of natural capital and biodiversity has been consolidated; these environmental and social benefits that constitute Ecosystem Services make cities and societies more sustainable. This diffuse naturalness is mostly constituted by green and blue infrastructures and by Nature Based Solutions (NBS), which have recently taken on new and central roles in urban and territorial planning, no longer contributing exclusively in quantitative terms (town planning standards Ministerial Decree No. 1444/1968) as a compendium accompanying urban development, but

above all as strategic 'assets' for the sustainability of urban settlements and the quality of human life in the city (ASVIS, 2023). In this context, the European project Blu Green City is certainly a good urban planning practice for the methodological approach used in the valorisation process of the Green and Blue Infrastructure aimed at the production of ecosystem services in the awareness of having to consider them and the permeable soils that support them as the pivot of a new season of urban and territorial planning for the ecological transition of the city (ASVIS, 2023).

The knowledge of the contents and the method characterising the Blue Green City project gave rise to some important general reflections, reported below, on the IVBs, SEs, NBSs and the close concatenation between these and planning actions, which certainly go beyond the specific case dealt with, but which can instead contribute to building a wealth of knowledge useful in similar conditions, even if in different territorial contexts, in which the objective of increasing the sustainability of cities and territories is achieved through effective planning tools.

IVBs are created to produce environmental, social and economic benefits for the territory and its communities, so before planning, it is necessary to be clear on which benefits to aim for.

IVBs are governance tools for adaptation and for improving the sustainability of policies and plans, so design is only one part of the project. Participation, integrated policies and monitoring of benefits are the indispensable tools for action.

The design of IVBs must express the community's "visionary response" to the demands of environmental, social and economic adaptation and sustainability; it cannot therefore be a specific design, but rather a mosaic of localised demands that can be resolved through suitable NBSs that constitute a system capable of enhancing ecological functions and thus Ecosystem Services.

The Planning Scheme, which concludes the methodological path proposed by the Los Dama! and Blu Green City projects, represents an effective tool for increasing the sustainability of cities and territories by offering a response to the challenges that climate, social, environmental and economic changes are also throwing at planning. It is an active tool for an overall redevelopment of the environmental landscape system capable of responding to the contemporary needs for resilience and increased sustainability of both natural and cultural landscapes. It constitutes a strategic framework for local planning and territorial transformations; it is a catalyst for economic resources that can be allocated to the landscape-environmental redevelopment of the territory through the construction of the Green and Blue infrastructure; it stands as a useful tool for the knowledge of the landscape and its elements, contributing to the awareness of the population towards the great themes of global changes.

The proposed planning process is characterised by providing a comprehensive vision of the landscape/environmental system that goes beyond, at least in part, the more traditional approaches.

It is not a closed plan to be realised with public economic resources, but a process in which several actors can participate, without prejudice to the objectives, expected results and certain fundamental principles and criteria. The planning process does not end with the realisation of the project; the IVBs and the spaces they are made up of are living,

dynamic organisms, which must modify themselves over time, adapting, mutually with the cities, to changes.

Finally, it is necessary to monitor and measure, using spatial indicators used for Vulnerability and Resilience, what is being achieved in order to understand whether the objectives are being met, in particular that of improving the health of landscapes, responding to vulnerabilities and increasing Ecosystem Services, and also which actions have been most effective.

In light of what emerged in the analysis of the Blue Green Cities project, several useful elements were transferred to the implementation of the objectives of Action 1, Pilot Project 4.6.1 of the Spoke 4 of the Tech4You Innovation Ecosystem and, in particular, the recognition of the centrality of the Green and Blue Infrastructures, of which all the constituent and applicative aspects have been examined, in the process of valorising ecosystem services and safeguarding biodiversity and, again, the identification of a possible way forward, also in the case of Pilot Project 4.6.1, to assess the vulnerability and resilience of a territory through its capacity to provide ecosystem services and to be able to direct planning actions accordingly.

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