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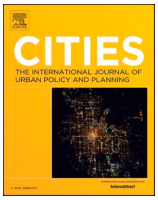

Beyond food: Framing ecosystem services value in peri-urban farming in the post-Covid era with a multidimensional perspective. The case of Cascina Biblioteca in Milan (Italy)

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ABSTRACT

The idea that it is possible to overcome the post-covid crisis starting from urban projects is becoming increasingly popular (Balducci, 2020). This moment becomes a precious opportunity to experiment with innovative, multi-disciplinary and multi-scalar methodologies for an urban planning and design capable of condensing apparently distant concepts and approaches that are nonetheless congenial to the same goals. In this sense, multifunctional agriculture (MFA) recognizes multiple functions including food production, environmental preservation and social inclusion, which can be identified as Ecosystem Services (ESs). In our contribution, the case study of a multifunctional farmhouse in the Milan suburban area is proposed as an opportunity to test an integrated preliminary evaluation model to support decisions concerning urban planning and design, with the goal of maximizing the performance of the ecosystem services provided in MFA field.

1. Introduction

As a response to multiple problems, exacerbated by the COVID pandemic, many local governments worldwide have introduced food actions oriented to redesign food systems, with a view to enhancing Ecosystem Services (ESs). By learning from the COVID-19 pandemic, the European Commission efforts are addressed to develop a plan for ensuring the global transition to sustainable agri-food systems (European Union, 2020).

At local level, and especially in developed countries, peri-urban areas play a central role as determinants for structuring the response and improving preparedness to COVID-19 shocks according to the WHO (World Health Organization) social model of health (Capolongo et al., 2016).

Urban Agriculture (UA) plays different roles by benefitting personal and community wellness (Hynes & Howe, 2002), reducing food miles and mitigating carbon emissions (Marino & Cicatiello, 2012), improving community relations, conserving habitat for wildlife in urban areas, increasing land and real estate prices, managing water and waste (Slater, 2001), encouraging cultivation of traditional crops (Larson et al., 2001), promoting environmental education (Camps-Calvet et al., 2015; Coles & Costa, 2018; Hardman et al., 2018;) and preserving rural tradition within urban borders.

In fact, in the last century we witnessed a progressive decoupling of food consumption from sources of food supply thanks to cheap and abundant availability of energy inputs, both for the transport and storage of food together with global market liberalizations (Langemeyer et al., 2021). Food chains, similarly to all the other supply chains, became global and long.

In this sense, peri-urban areas, which have long been crucial to food production for urban consumption, were prioritized for different and more profitable land uses, including housing, commercial and transport areas, confirming and actualizing Von Thünen's observations and modelization (Von Thünen, 1875). At the same time, peri-urban areas became marginal and degraded with a high rate of criminality, unemployment and in general low level of development indexes (Vindigni et al., 2021). In particular, open and green spaces have been abandoned, underutilized or misused (YY), until becoming non-places. This process, so called 'urban land teleconnection' (Seto et al., 2012), links urban consumption patterns with land-use changes. It resulted in the jeopardization of the peri-urban landscape, where green areas are intercluded by urban sprawl and infrastructures (YY).

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During periods of stressful societal and economic conditions (e.g., recessions, wars, conflicts and pandemics), UA emerges as an important instrument to increase the cohesion of the communities and temporarily make up for food shortages in global supply chains (Bellemare & Dusoruth, 2020; Brown & Jameton, 2000; Marino, 2016).

The COVID-19 pandemic hit has newly raised awareness for the vulnerability of global food supply chains and the need for resilience in the long-term food security of cities (Barthel et al., 2019). After the COVID-19 epidemic set off all alarms, people emptied out grocery stores and, in some cities, food supply was critically affected (Zhou & Delgado, 2020) – especially for those who saw a lowering in their purchasing power to buy food (OECD, 2020).

The COVID-19 pandemic has strengthened the role of UA with three main components: food production, recreational services and environmental protection (Khan et al., 2020)).

In fact, the temporary lockdown and food chains disruption have impacted on the usual food provision with a reduction of basic goods stocks on the shelves; an increase in retail prices, especially fresh vegetables and fruit; a change in the consumption habits, less meals out and more at home; an exposure of a huge number of dwellers, including low-income households, to food insecurity; newly unemployed and homeless people; and an increase in food losses and export costs, especially for perishable goods (Pulighe & Lupia, 2020).

Most of the countries have taken emergency measures to cope with the risk of food shortage, by set limiting food commodities shipments and export, to safeguard food reserves, and by reducing food safety and plant health standards on imported food (Marti et al., 2021). In the last months, exporting countries, especially China, have enacted restrictive policies on commodities export to increase the reserve dedicated to domestic market and supply chains. This resulted in the exceptional price increase of several commodities (e.g., maize and soy, which are fundamental for animal feeding, and spare parts of machinery) and the exposure to market risk for farms and actors of the food chains.

For these reasons, UA will become central in feeding cities, contributing to the overall supply of healthy and nutritious food produced few miles away from the urban centers. Various forms of smart and innovative UA, such as vertical indoor farming, greenhouses, aquaponics, soil-less hydroponics, aeroponics, etc. (Armanda et al., 2019), combined with the more traditional farming practices, may revitalize abandoned buildings, brownfield sites and vacant spaces (Pulighe & Lupia, 2020).

Secondly, one of the most unexpected and impactful effects of the lockdown was the restriction of freedom of moving. Citizens, especially in urban centers, were not allowed to go out of their municipality, or even their neighborhood, and were confined in their own home except when having to buy basic products. Schools and companies were closed, and families had to share the limited space of their houses for weeks. This incoming awareness of the importance of open spaces within the urban borders has led to reconsider the management and the access to peri-urban green areas (XX & Paris, 2022). UA guarantees a careful land management, regulates the access, and improves and characterizes landscape (Dezio, 2020). Several studies confirm the positive impact of agricultural landscape on human wellbeing (Panagopoulos et al., 2016). Moreover, according with YY and Bellemare and Dusoruth (2020), some forms of UA imply the participation of citizens, who are engaged in self picking or in gardening – and these activities contribute to their psychological wellness and to social inclusion (Chenarides et al., 2020; Suryantini et al., 2021). After the COVID-19 restrictions, social activities in open space are what people look for to recover from stress, fear, uncertainty and loneliness.

Finally, in the perspective of ecological transition towards a more sustainable world, UA preserves green spaces in urban areas, contributing to the improvement of the environmental quality. During the lockdowns most of the critical pollution indicators (e.g., fine dust, average localized temperature) lowered, thanks to the stop of main human activities (Madineni et al., 2021). Furthermore, COVID-19 outbreak highlighted the importance of good health to prevent more severe symptoms of the disease. UA performs a regulating and mitigating function (Zasada, 2011).

In conclusion, UA has played a relevant role during the COVID-19 emergency and will be crucial to rethink the interaction of urban planning and food system in the urban environment (Pulighe & Lupia, 2020). It contributes to enhancing the overall urban system by promoting multifunctionality and improving ecosystem services provision. In fact, the importance of UA in the post COVID-19 urban management will engage production of healthy and affordable food, recreational activities and environmental protection.

The change in dwellers habits (including smart working, food consumption behaviors and transport and mobility) due to the COVID-19 breakout implies to better understand the role of UA in the new "urban metabolism", which encompasses nutritional, cultural and environmental challenges.

Given these preconditions, this paper proposes both a theoretical reflection and an operational procedure for enhancing peri-urban multifunctional agriculture according to the ecosystem paradigm (Section 2). In order to strengthen the multifunctionality of peri-urban agriculture and to increase its ecosystem value, a multimethodological evaluation approach is proposed (Section 3) and then a first application to a case study in the city of Milan is proposed (Section 4). The results and future perspectives are discussed in Section 5.

2. Conceptual framework: multifunctional agriculture and ecosystem services

Today farm is changing towards new forms of business, through the development of activities that add value to products (ISMEA, 2016) according to the perspective of multifunctional agriculture (MFA) (UNCED, 1992). The OECD defines multifunctional agriculture as the one adding multiple functions to its primary role, such as *landscape design, environment and biodiversity protection, sustainable resource management, contribution to the socio-economic survival of rural areas, food safety guarantee* (Organization for Development and Economic Cooperation - OECD, 2001).

In the OECD definition, multifunctionality is related to the joint presence of both the ability of agriculture to produce food goods, as well as secondary goods and services, of a tangible and intangible nature, thus carrying out an additional social, cultural and environmental function, as well as a productive one. The coexistence of many kinds of services is the essential feature of ESs, meant as *"the benefits that human populations derive directly or indirectly from ecosystem functions"* (Costanza et al., 1997). The convergence of the two above-mentioned notions sheds a light on the relationship between MFA and ES (Huang et al., 2015; Turetta et al., 2016; Rovai & Andreoli, 2016; Ricart et al., 2019; Boeraeve et al., 2020).

MFA and ES were conceived at the same time and had similar goals for recognizing the benefits and impacts of agriculture beyond food and fiber production (Huang et al., 2015). However, MFA and ES have given different meaning to the term "function", which is based on the mechanisms for providing multifunctionality and ecosystem services (Huang et al., 2015). The ES scientific community believes that "function" more aptly defines the ecosystem's ability to provide services (Haines-Young and Potschin-Young, 2010), and some use the term to describe the internal functioning of ecosystems, such as energy flow and recycling nutrients, or as a synonym for "ecosystem process" (de Groot et al., 2002; Wallace, 2007). The MFA community uses "function" or "land function" to describe the provision of goods and services by "land systems", which include natural environment and human activities (e.g., OECD, 2001; Jongeneel et al., 2008; Verburg et al., 2009), understood as the output of a farm

In summary, then, the supply of goods and services in MFA is a direct result of agricultural activities, while in ESs it is the direct result of ecosystems that are subjected to agricultural activities (Huang et al.,

2015).

Despite these differences, it is undoubted that an encounter between the two concepts would bring advantages both for the quality of the productions and for the protection of environmental systems (Cowling et al., 2008; Renting et al., 2003; Huang et al., 2015; Rovai & Andreoli, 2016). In this sense, it is possible to find an opportunity to produce, maximize and enhance ecosystem services in the multifunctional farm (MEA, 2005). The farm itself plays a complex role in relation to ecosystem services: if on one hand the production processes use ecosystem services generated by the territory, on the other hand agriculture supplies other services to society (Blasi et al., 2012), in terms of providing food, fuel, fiber, but also maintaining soil fertility, providing habitats for biodiversity, regulating pollinator or parasite populations and much more (Swinton et al., 2007). What is certain is that agriculture still manages most of the environmental resources and is essential in landscape organization and in the peri-urban and extra-urban open spaces design, for which there is a growing demand in terms of green tourism.

Multifunctional farm has the potential to meet a combined protection of ecosystem services and the urgent needs of post-COVID-19 society. Brunori et al. (2005) already argued that agriculture has the ability to respond to the new demands expressed by society and consumers through the provision of public goods (such as biodiversity, landscape, water management); private goods for non-food markets (such as tourism, energy, teaching, educational and therapeutic services); foods with specific attributes (traditional, high quality products). Specifically, according to Belletti et al. (2003), the primary sector can use multifunctional practices to:

- Protect the socio-economic system's growth of rural areas, guaranteeing vitality and quality of inhabitants' life, with particular reference to the marginalized and fragile areas, dramatically affected by the pandemic;
- Contribute to safeguarding food safety, ensuring healthy and economically accessible products on markets;
- Guarantee quality and variety of food production, acting against the standardization of food imposed by industrialization and consumption models;
- Supervise protection of environmental resources by contributing to the reduction of environmental and climatic impacts, protecting hydrogeological resources and preserving biodiversity;
- Hand down and preserve landscape, protecting local cultures, traditions and typical food and wine;
- Offer recreational services, creating conditions and opportunities for usability.

The multifunctional practices can be summarized in the model of the *"Value Triangle of modern agriculture"*, developed by van der Ploeg and Roep (2003) in the "IMPACT Project". This model identifies three ways through which the farm can implement a post-productivistic approach by multifunctional practices: a *deepening* of agricultural production, a *broadening* of functions activated by farms and a *regrounding* of farm processes.

The three strategies in question are listed below (van der Ploeg & Roep, 2003):

- *Deepening* (intensification): the farm's ability to enhance its production potential by orienting it on goods with characteristics different from conventional ones, such as typical products. Said *deepening* is also often considered as the transformation of the product within the same farm (meat, milk, honey, wine, etc.), which in most cases is associated with direct sales on the farm (short food chain). According to this concept, it is evident that all types of product marketing are forms of *deepening*, including internet sales, farm outlets, the sale of animals on the farm, the involvement of consumers in the activities that distinguish the farm, products *("pick it yourself")*. A strong tendency to the deepening of primary activities leads to an agricultural farm that differentiates its product by favoring, directly and indirectly, the production of positive externalities. In this case, the ecosystem services involved are mainly provisioning services, therefore the production of quality food.
- *Broadening* (enlargement, expansion): the expansion of activities that generate an alternative income to production, some of which may even be completely independent from real agricultural production, exploiting entrepreneurial activities in a wider rural context and providing useful services to community (i.e., rural tourism, landscape management, biodiversity conservation). An example is agritourism, which can be considered as a possible strategy to support farms, but above all for the sustainable development of the territory on its different dimensions (Ammirato et al., 2020; Dezio, 2020). In addition to the main classic agritourism activities (hospitality and catering), in recent years a large number of activities have been connected to them (i.e., educational farms, museum farms, art workshops, pet-therapy, etc.). A strong broadening process produces externalities but leads to a sort of farm that can also reduce, or progressively eliminate, its original primary activity. In this sense, the *Broadening* can lead to a diversification of the agricultural sector. In this case, the ecosystem services involved deal on one hand with the benefits directly linked to the protection of the landscape and biodiversity (regulating services) and on the other hand with those linked to the supplementary activities of the agritourism involving community (cultural services).
- *Regrounding* (external relocation): cases in which some production factors, in particular labor, are dedicated to activities outside the company. It concerns all those activities not classified as "agricultural", but which are integrated in a complementary way with the latter in the rural context. The main purpose of the *Regrounding* is to provide additional income opportunities for the farmer and the farming family. For example, *Regrounding* activities are all activities related to improving the quality of life and rural integration, such as artisan and artistic workshops, rural workshops or activities that are carried out on the farm regardless of the agricultural activity (e.g., watching a movie in the vineyard). *Regrounding* also affects the multifunctional activity of farms: pluri-activity implies less time to devote to other practices (because family members are involved in other non-agricultural, sometimes non-rural, activities), as well as the proximity of multi-active farms to urban centers offers farms the opportunity to specialize in the services requested by citizens and increasingly provided by farms (such as recreational services, therapeutic services, educational services, etc.). In this case, the ecosystem services involved mostly concern cultural ecosystem services, i.e., recreational benefits for local communities.

Given this framework, what actually happens most frequently is a combination of deepening, broadening and regrounding, which creates various levels of farms' multifunctionality. With reference to the percentage of farms involved, in Italy over 30 % of farmers are engaged in *deepening*, and roughly 6 % in *broadening*, whereas in Ireland the situation is reversed, with 33 % of farmers oriented towards *broadening* and less than 5 % towards *deepening* (Aguglia et al., 2009).

To immediately understand the close relationship between a multifunctional farm and its ability to enhance ecosystem services, a synoptic analysis will be undertaken through the study of the scientific literature (Table 1).

In the following paragraphs we will address the case study of a multifunctional farm in the city of Milan, proceeding with the evaluation of the ecosystem services it provides.

3. A methodological approach to assess ecosystem services by multifunctional agriculture

According to the concepts previously discussed, this section will

Table 1
Cross-reading of multifunctionality and ecosystem services (Elaboration by the authors).

Multifunctionality (van der Ploeg & Roep, 2003)	Definition (van der Ploeg & Roep, 2003)	Examples (van der Ploeg & Roep, 2003)	Ecosystem services involved (MEA, 2005)	References
Deepening	Farms differentiate their productive potential by moving towards agricultural goods with unconventional characteristics or by moving along the supply chain, acquiring functions down the line from production	Organic farming; high quality production and regional products; short supply chains	Provisioning services	Power, 2010; Robertson et al., 2014; Bethwell et al., 2021
Broadening	A process of expanding income-producing activities, some of which can also be independent of real agricultural production, by exploiting entrepreneurial activities in a rural context wider than the strictly agricultural one	Agritourism; new on-farm activities; diversification; nature and landscape management	Regulating services and cultural services	Robertson et al., 2014; Sanyè-Mengual et al., 2020; Bellingrath-Kiura et al., 2021
Regrounding	Some production factors, especially labor, are devoted to activities outside the farm.	New forms of cost reduction; off-farm income	Cultural services	Milcu et al., 2013; Robertson et al., 2014; Kosanic & Petzold, 2020

describe the methodological approach aimed at assessing the provision of ESs within a urban planning and design process (Fig. 1).

The framework provided by the Millennium Ecosystem Services has been adopted as a value tree (MEA, 2005; Dell'Ovo & Oppio, 2020) to assess the provision of ESs under the multifunctional agriculture perspective. The methodological approach is divided into three phases.

3.1. Analysis

The first step consists in a deep investigation of the business as usual scenario of the farm under investigation (scenario T0), by listing the activities involved and the ESs they provide. A special attention should be paid both to the intrinsic and to the extrinsic characteristics, i.e., the services provided by T0 have to be assessed together with their influence on the context. More in detail, the intrinsic features consist in the activities hosted and organized by the farm under evaluation, i.e., the different types of cultivated areas, the landscape elements as well as paths and routes, while the extrinsic features are divided into grey, blue and green infrastructures and services.

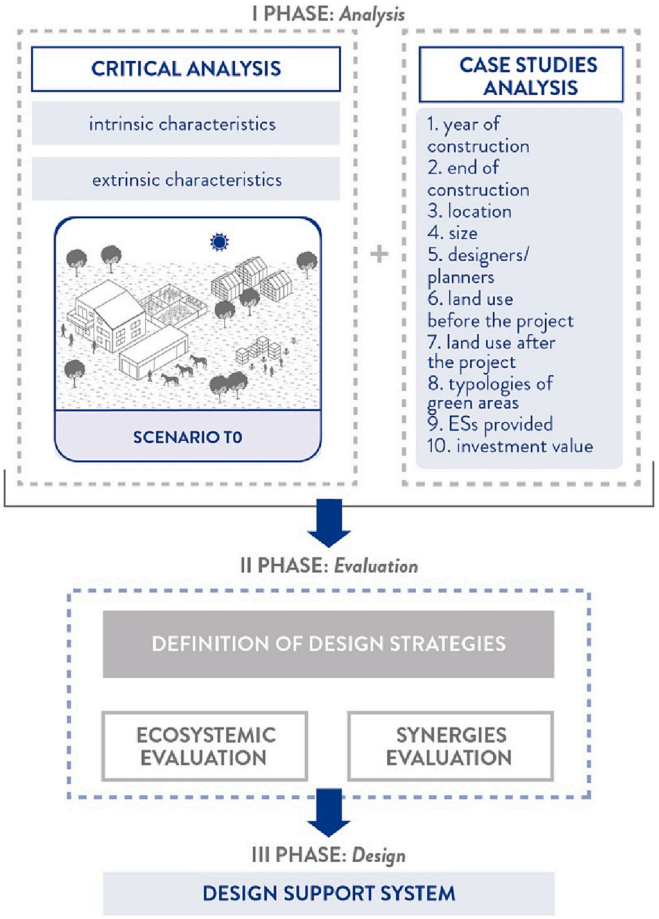


Fig. 1. Methodological approach (source: Elaboration by the authors).

Furthermore, in order to increase the potential design actions that can generate ecosystem benefits and implement the set of actions already defined by the investigation of the state of the art, case studies of MFA can be included into the analysis. The case study research should point out the following basic features: 1. year of construction, 2. end of construction period, 3. location, 4. size, 5. designers/planners, 6. land use before the project, 7. land use after the project, 8. types of green areas, 9. ESs provided, 10. investment value. The combination of these analytical phases allows defining a first sample of design elementary actions, which can be classified and divided into basic groups as services, crops, landscape elements, mobility, recreational areas.

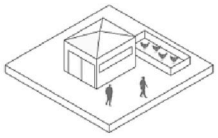
3.2. Evaluation

The second phase consists of the assessment of ESs provided by the actions previously pointed out and their mutual interactions (Colorni et al., 2017). This phase requires the definition of two different questionnaires. The first one, by taking Burkhard et al. (2009, 2012, 2014) as reference, asks a selected group of experts (panel of experts) to rank the ESs from the most to the least provided, according to the 4 categories defined by the MEA and with respect to the proposed design actions. The ESs provision is measured by the following verbal scale:

1. no significant intensity;
2. low significant intensity;
3. medium significant intensity;
4. significant intensity;
5. high significant intensity;
6. very high significant capability.

Fig. 2 presents an example of the questionnaire, while Attachment A displays the complete version to use to assess the Provisioning class. Each design action has to be evaluated for the four categories of ESs (i.e., supporting, regulating, provisioning and cultural), the example proposed is related only to the category Provisioning.

Answers are collected and aggregated by performing the average value resulting from the preferences elicited from the experts. Scores are standardized according to the maximum value that is possible to obtain for each of the four categories of ESs. Data could be aggregated by considering the expertise of the actors interviewed, i.e., by assigning a different weight/influence based on their knowledge on the ESs topic; however, given the limited number of collected preferences, the average is performed and selected as a method coherent with the purpose of the



City farm

3. Considering the project action **City farm** orders the services within category 3. Provisioning (3.1 Food; 3.2 Raw materials; 3.3 Medicinal resources; 3.4 Fresh water) by assessing the level of intensity with which they are provided with reference to the defined verbal scale.

VERBAL SCALE	ES: 3. Provisioning
• very high significant capability	
• *intermediate value*	
• high significant intensity	
• *intermediate value*	
• significant intensity	
• *intermediate value*	
• medium significant intensity	
• *intermediate value*	
• low significant intensity	
• *intermediate value*	
• no significant intensity	

Fig. 2. Example of questionnaire administered.

approach. Moreover, the aggregation among the four categories of the ESs is performed by applying the Weighted Linear Combination (WLC) and by assigning the same importance to the different classes according to a neutral system of preferences. The WLC consists in summing up the yield values obtained by multiplying the standardized score of each criterion by the assigned related weight.

The second questionnaire assesses the level of synergies among pairs of design actions using a pairwise evaluation based on the following verbal scale:

a. very positive synergy (++);
b. positive synergy (+);
c. neutral (0);
d. negative synergy (-);
e. very negative synergy (–).

When two different actions can maximize the supply of benefits, they will obtain a positive score, otherwise, when benefits are minimized, the synergy and consequently the score will be negative.

The answers obtained by the experts are aggregated by the weighing sum of the elicited preferences, in order to have a final evaluation of the provision of ESs given by different design actions with different level of synergy.

Fig. 3 shows an excerpt from the matrix of relationships between actions.

Design actions have been grouped to facilitate the experts in understanding their main context and project outcome.

Both the matrices have been structured as a support for the design phase since they allow generating and evaluating design alternatives under the ecosystem paradigm. More in depth, the pairwise synergies matrix points out the most suitable actions combination, while the ecosystem evaluation provides information about the multidimensional provision of ESs, both at the single action scale and at the entire project scale. Moreover, according to the analysis of the mutual relationships it is possible to understand to which extent the benefits will be maximized or minimized.

3.3. Design

The last phase is conceived as a design support system. Through the abacus previously defined and the evaluation activities developed, both in terms of ESs and synergies, it is possible to support designers and planners in the definition of design strategies resulting from the combination of consistent actions and the choice of the most performative ones. This phase allows exploring the ESs provided by urban projects, testing multiple combinations and developing awareness about the ecosystem design potentials also during the concept phase when new alternatives are under definition (Colorni & Tsoukiàs, 2018). Given the methodological approach presented and the results of the questionnaires aimed at providing information about both the supply of ESs and the synergies resulting from possible combinations, a design support card is developed for each action. The card is divided in two main parts according to the two questionnaires mentioned above. On one side it is possible to read which ESs are delivered and their intensity, (i.e., scale from 0 to 5), at the same time positive and negative synergies with other actions are presented to facilitate and support their combination. This step further supports the design phase, especially the definition of design strategies and the selection of the most suitable project.

Scores are moreover standardized in order to be further aggregated, and within the card it is possible to visualize the assessment obtained concerning the four categories of ESs (partial results) and the overall, expressed in terms of percentage. Fig. 4 presents an example of the structure of the design support card.

4. Case study application: analysis of scenarios for Cascina Biblioteca (Milan, Italy)

Within this context of multifunctionality and provision of multiple services and benefits, Cascina Biblioteca represents a valuable example of multifunctional urban farm and an important resource for the dense area where it is located.

The case study under evaluation is located in the Eastern part of Milan (Northern Italy), in the third municipality (Milan is divided in 9 municipalities), at the centre of a system of open spaces between the urban border and Segrate (Milan 2 and the San Raffaele hospital) that includes the Lambro Park and the agricultural areas on the east side of a ring road (Figs. 5 and 6).

Cascina Biblioteca is a social cooperative born in 2013. It is both a historical building and a piece of agricultural plain at the centre of a territorial system, while also being the node of a system of integrated

PATHS AND ROUTS			RECREATIONAL AREAS				PAIRWISE SYNERGIES	
Pedestrian Path	Parking	Bicycle Path	Sport Areas	Recreational Spaces	Dog Areas	Square	Social Educational Center	SERVICES
							Bicycle repair shop	
							City farm	
							Riding school	
							Garden-share	CULTIVATED AREAS
							Marcite	
							Hay	
							Cereals	
							Wooded strips	LANDSCAPE ELEMENTS
							Rows of trees	
							Pedestrian Path	PATHS AND ROUTS
							Parking	
							Bicycle Path	
							Sport Areas	RECREATIONAL AREAS
							Recreational Spaces	
							Dog Areas	

Fig. 3. Example of the Pairwise Synergies Matrix.

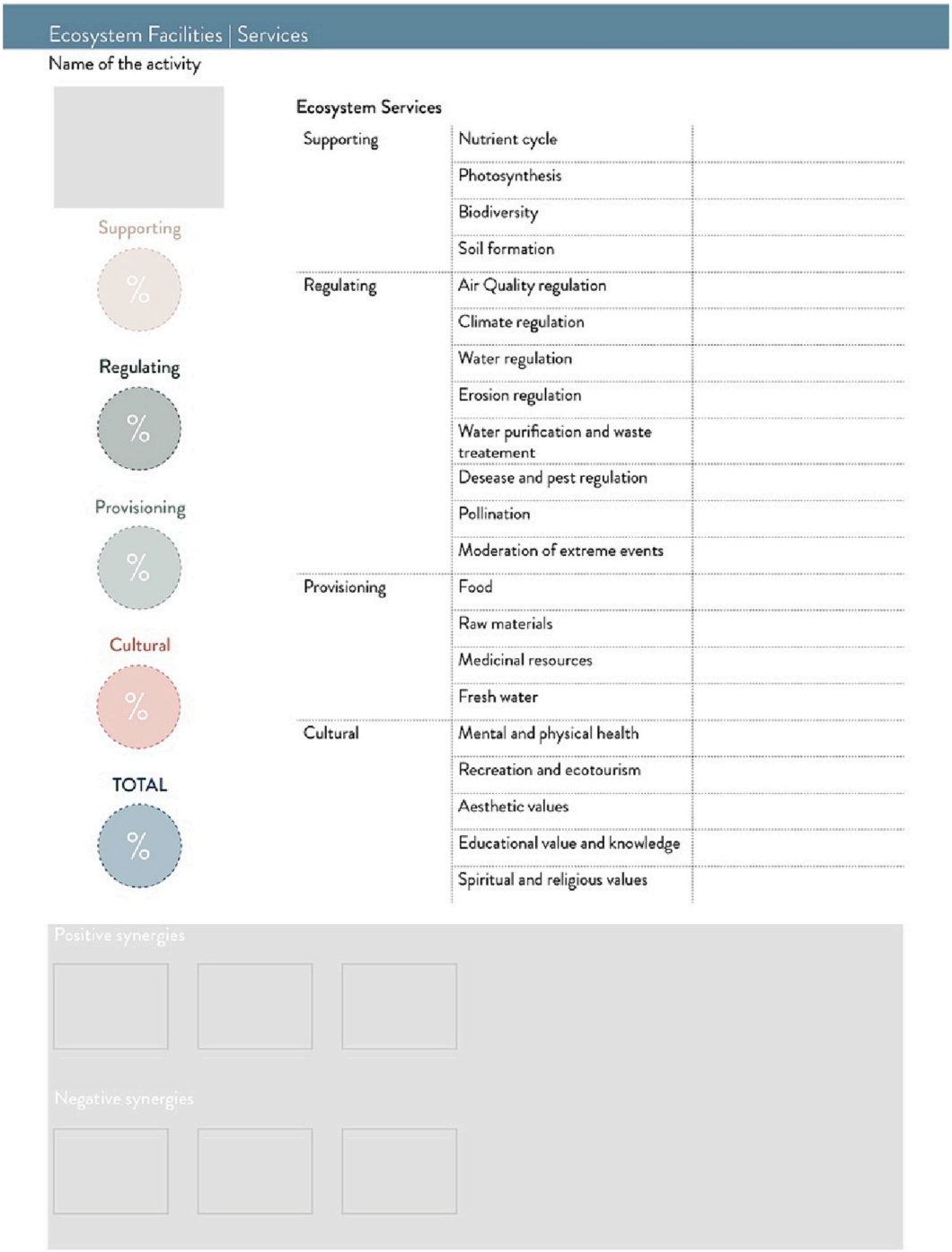


Fig. 4. Design support card.

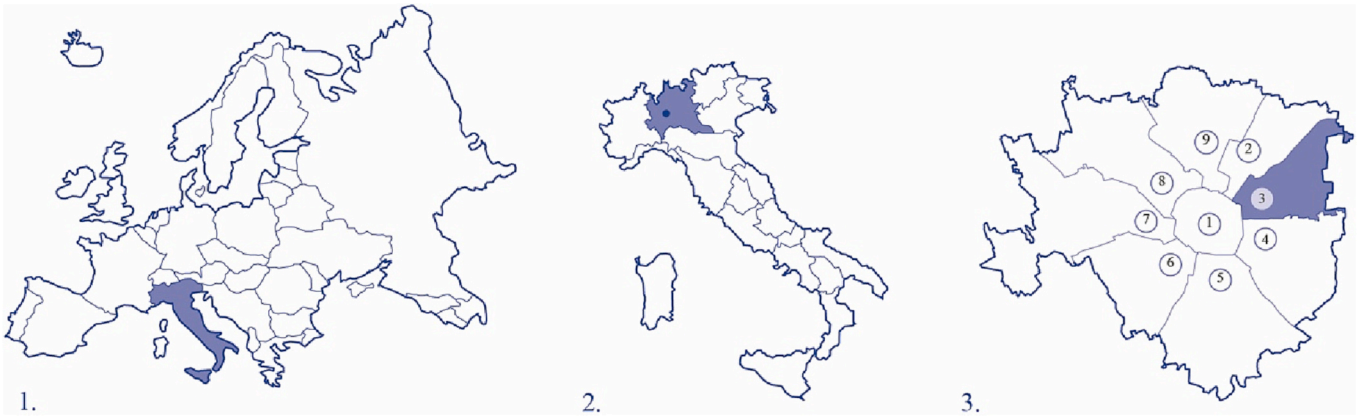


Fig. 5. Cascina Biblioteca Cooperative in the Milan region.

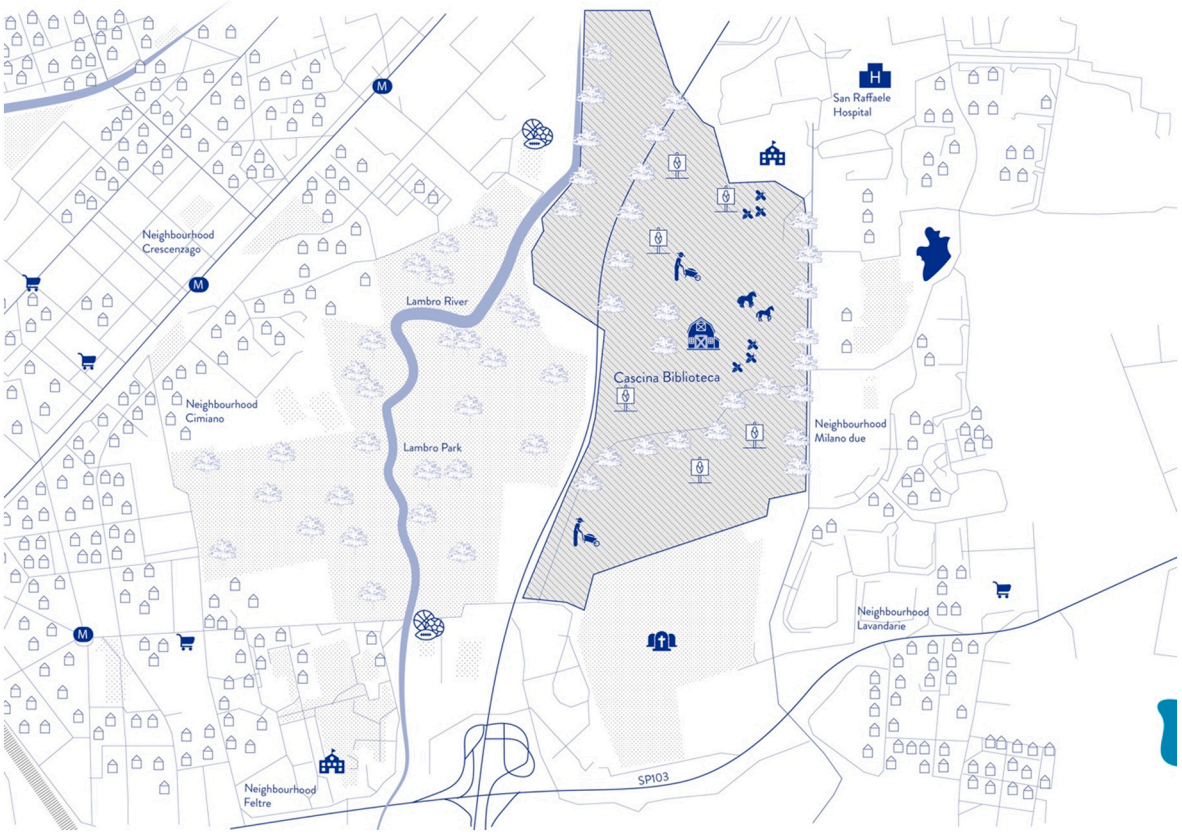


Fig. 6. Cascina Biblioteca Cooperative and its context.

services.

The interest in the case study stems from several factors that allow us to explore the topic of ESs, their definition, their measurement and the evaluation of their mutual relationships.

Cascina Biblioteca covers a wide range of activities, from nursing home to training, job placement, production of goods and services, catering, direct sale of products, management of collective and community spaces.

It includes a part of the Lambro Park, with its agricultural areas and arable land, permanent meadows, vegetable gardens, public spaces and *marcite* (cultivation technique of the plains of northern Italy, which consists in the permanent irrigation of meadows in order to protect the growth of the grass from low temperatures in winter).

The agricultural business includes many types of activities that make Cascina Biblioteca a multifunctional farm for the coexistence of animals, beekeeping, horticultural crops, cereal crops, areas of residual naturalness, etc.

The Cascina offers a wide range of the ESs defined by the MEA (2005). Therefore, it can be defined as an open system, both from a territorial and from a functional point of view, adaptive and able to offer multiple services including organizational consulting to other similar activities.

Given the presence of socio-cultural, environmental and economic values, Cascina Biblioteca can be considered as the starting point of integrated territorial strategies aimed at the development of agricultural resources as well as at the creation of a network of local farms. This strong agricultural vocation is consistent with the Food Policy promoted by the City of Milan (https://foodpolicymilano.org) together with a

private foundation (Fondazione Cariplo). In line with the Sustainable Development Goals (SDGs), five priorities have been identified as drivers for social innovation:

1. ensuring healthy food for all;
2. promoting the sustainability of the food system;
3. educating on food;
4. fighting waste;
5. Supporting and promoting scientific research in the agri-food field.

Several internal governance tools in addition to plans, projects and monitoring system have been defined and proposed, in order to achieve the beforementioned objectives.

Cascina Biblioteca perfectly fits within this context, thanks to the relevance given to the improvement of local agroecosystems through the development of short supply chains to innovate the agricultural market and by paying attention to its strategic location.

In addition to the services provided and previously mentioned, new interventions are under development, which have been funded by Fondazione Cariplo[1] and designed and proposed by the board, internal workers and external partners of the farm Cascina Biblioteca, consisting in an environmental redevelopment project with interventions to enhance the agricultural heritage (scenario T1). The new scenario has been developed by considering the context necessity to introduce livestock and pasture areas in addition to the agricultural ones. In fact, the most important objectives pursued by the scenario T1 are:

- agricultural enhancement through environmental redevelopment focused on horticulture and existing greenhouses;
- reconversion of current meadows into cultivated fields and pastures;
- insertion of a new irrigation system (with wings) to bring water to the fields for educational purposes;
- planting of hedges in areas where they are uncultivated;
- enhancement of the connections with Cascina Nibai (north-east of Cascina Biblioteca), with particular attention to a micro-cattle breeding;
- enhancement of the meadows.

According to these objectives and their close connection with the ESs, it is important to evaluate these actions within an ecosystem perspective aimed at assessing Cascina Biblioteca, both in its current state (T0) and considering the redevelopment/design scenario (T1), under the point of view of multifunctionality.

The consideration of ESs within the paradigm of Multifunctional Agriculture could support the combined and integrated evaluation of benefits they provide under multiple aspects, in order to enhance the design process by applying the strategies previously described (i.e., deepening; broadening; regrounding).

Considering the above-mentioned methodological approach, the next sections will describe the main steps developed and the first results obtained to evaluate ESs and to design according to the ecosystem paradigm.

4.1. Analysis•••

As far as the critical analysis is concerned, given the presence of two scenarios, both for the state of the art (T0) and the one under development (T1), the intrinsic and extrinsic characteristics and the ESs they provide have been listed by the use of a binary scale (1/0) trying to qualitatively detect their presence. A total of 28 different design actions have been defined. Attachment B represents the results of the analysis developed for T0 while Attachment C for T1; Fig. 7 shows the different classified elements which have been categorized according to the four classes of ESs defined by MEA (2005):

- Supporting Services: nutrient cycle, photosynthesis, biodiversity, soil formation;
- Regulating Services: air quality regulation, climate regulation, water regulation, erosion regulation, water purification and waste treatment, disease and pest regulation, pollination, moderation of extreme events;
- Provisioning Services: food, raw materials, medicinal resources, fresh water;
- Cultural Services: mental and physical health, recreation and ecotourism, aesthetic value, educational value and knowledge, spiritual and religious values.

Moreover, by considering the concept of multifunctionality and demonstrating the multifunctional nature of the farmhouse, the activities listed in Attachment B and Attachment C have been divided according to the three dimensions of *deepening, broadening and regrounding* to better explore their close integration with the notion of ESs (Table 2).

By following the first phase explained in the third section, together with a deep analysis of the two scenarios, a case study research has been carried out about projects of urban valorization and regeneration which can be considered as best practices for providing a wide range of ESs. 36 different case studies have been selected and mapped, namely 12 in Italy, 12 in Europe and 12 in extra-EU areas. This further investigation has allowed classifying and listing new design actions for a total of 44.

4.2. Evaluation

The analysis and the assessment of the design actions developed in the first phase is mainly qualitative, given the use of a binary scale, and the evaluation has been based on the literature and the case study investigated. To validate these assumptions, in the second phase of Evaluation two questionnaires have been administered to a group of experts, with specific knowledges in project appraisal, urban planning design and ESs. As the paper aims to propose and test a methodological approach, within this context eight experts (four academics and four practitioners) have been involved with the aim of considering their multidisciplinary experiences and backgrounds. The panel of experts has been selected as method to submit the questionnaire. Experts are researcher or professionals with good knowledges on the topic investigated (De Leeuw et al., 2008) and able to cover all the competences necessary to reach the saturation. The saturation is considered as the point when additional information detected no longer changes the results (Tran et al., 2017). In the context of a panel of experts, it has been demonstrated that to reach saturation should be adequate to interview between six and twelve experts (Francis et al., 2010; Marshall, 1996; Saunders & Townsend, 2016). Before the administration, both questionnaires have been discussed and reviewed with an expert in the field of Operational Research.

The first questionnaire is introduced by an explanation of the meaning of the ESs under evaluation, the general objective of the research and the scale of measurement to use to answer to the question proposed. After this preliminary part, the expert is asked to rank the ESs delivered by each design action according to the provision intensity; the question is moreover supported by an explanatory drawing. Considering the first questionnaire submitted (Attachment A) and the opinion elicited by the experts, Figs. 8-13 show the results, i.e., the provision of ESs for each design action proposed. To facilitate the overall comprehension, actions have been divided in the previously identified classes of characteristics (services, activities, cultivated areas, landscape elements, paths and routs, recreational areas).

The charts illustrate the final evaluation obtained, in terms of

[1] A foundation of banking origin that carries out philanthropic activities and is committed to creating value and opportunities for people and communities in the Lombardy region (Italy), through the support of projects in the fields of art and culture, the environment, social work and scientific research

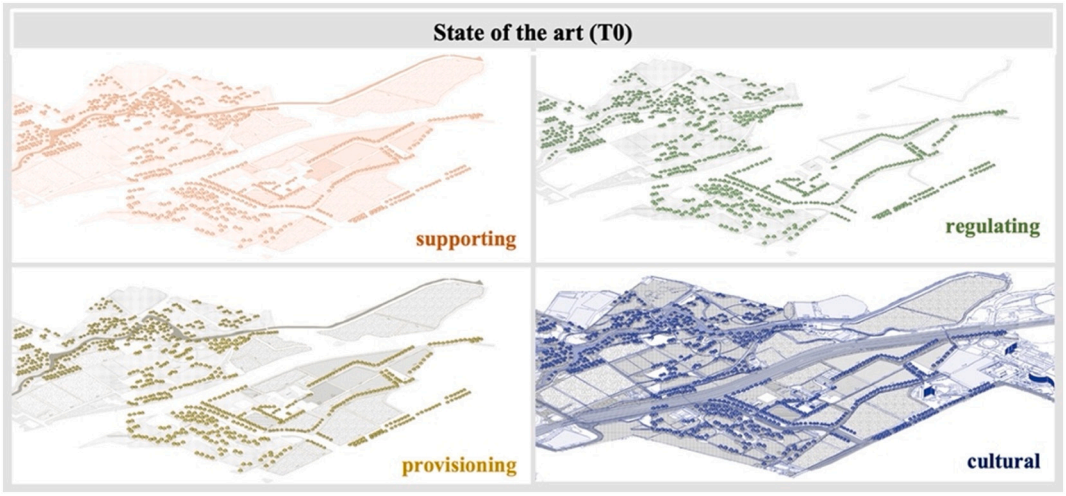


Fig. 7. Ecosystem Services provided by the State of the art T0.

Table 2
The activities provided by Cascina Biblioteca have been divided according to the three dimensions of MFA. In normal character, the activities of scenario T0; the additional activities of scenario T1 are highlighted in bold (Elaboration by the authors).

Deepening	Broadening	Regrounding
City Farm	Sheltered flats	Social and Educational Center
Beekeeping	Offices	Day Center for the Disabled
Pastures	Agreed residences	Autonomy Training Service
Intensive culture gardens	Restaurant	Animation / Theater
"Marcite" fields	Social Bar	Horse Therapy
hay	Bicycle repair shop	Sports facilities
Cereals	Riding school	San Raffaele Hospital
Corn	Wooded areas	Exodus Foundation
Vegetables	Rows of trees	Ambrosian center of solidarity
Green houses	Water network	Cascina San Gregorio
Breeding	Pedestrian path	Job placement (Migrants)
	Parking lots	
	Private mobility: highway	
	Private mobility: secondary roads	
	Public mobility: bus stop	
	Public mobility: metro stop	
	Public mobility: cycle routes	
	Lambro Park	
	Lambro river	

provision of ESs, from the aggregation of the partial scores achieved in the four categories. The use of a chromatic scale (from red – bad performance – to green – good performance) supports the interpretation of the performances (Table 3). Among the actions being investigated, it is evident how the ones belonging to the cultivated areas and landscape elements perform better compared to the others, considering their natural features and the ability to provide human beings with a higher number of services.

This step brings to an ecosystem evaluation of the design actions, but it does not give information about the potentials of their strategic combination for supporting the planning and design phases. To meet this instance, a second questionnaire has been administered to analyse the potential synergies among the 44 design actions previously detected. In this case, the same group of experts has been asked to individually assess pairwise synergies of design actions. Results have been aggregated in order to obtain a final evaluation.——

As for the results of the second questionnaire, presented in Attachment D, it is possible to underline the following pairs of synergies among classes of design actions:

- Services have a positive synergy with recreational areas and activities, a very positive one with paths and routes, a neutral one with landscape elements and cultivated areas;
- Activities have a neutral synergy with recreational areas, landscape elements and cultivated areas, a positive one with paths and routes;
- Cultivated areas have a negative synergy with recreational areas and path and routes, a positive one with the natural actions of the landscape elements (e.g., rows of trees) and a negative or neutral one with the artificial ones (e.g., fountain);
- Landscape elements have a positive synergy with recreational areas and paths and routes;
- Paths and routes have a positive synergy with recreational areas.

The evaluation previously provided is an average among the different synergies performed by pairs of actions according to the different classes; by the way, it is possible to state how very negative synergies have been assigned when some elements of the natural context are mixed with the built environments, e.g., parking lots and green connections or inland marshes and recreational areas or sports facilities.

By investigating other case studies or with the support of architects and planners, the list of actions could be implemented and the questionnaires newly submitted in order to review the assessment; in fact, as it has been already explained, this contribution should be conceived as a methodological proposal aimed at supporting the design phase under an ecosystem point of view.

4.3. Design

The proposed methodology could have a twofold output, on one side evaluating existing alternatives and on the other supporting the generation new ones. In fact, both the card and the framework here developed can aid the evaluation of projects at the urban and peri-urban scale, during their overall cycle (*ex-ante, in-itinere, ex-post)*.

Considering the perspective of the evaluation, the two scenarios previously described, T0 and T1, could be assessed by aggregating the scores obtained by each design actions. Figs. 14 and 15 show the results of the evaluation with respect both to the present and to the designed activities and actions.

In terms of variety of activities, the two scenarios are quite similar (except for livestock and pastures present in T1). The main difference regards the quantity/dimension of each design action and of the

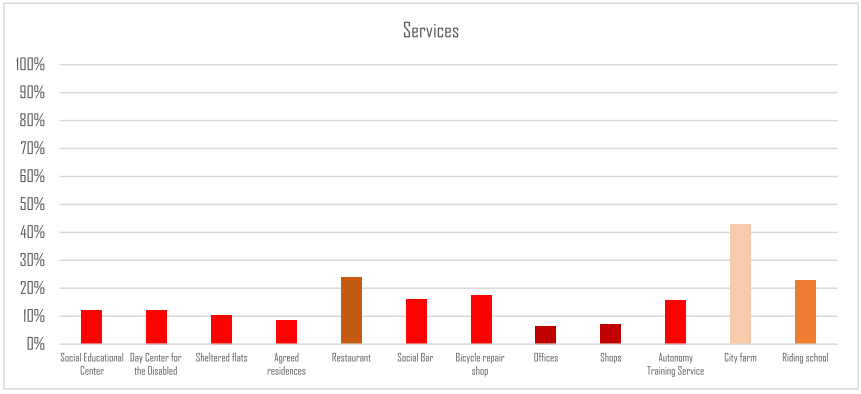


Fig. 8. Provision of ESs for the design actions classified as Services.

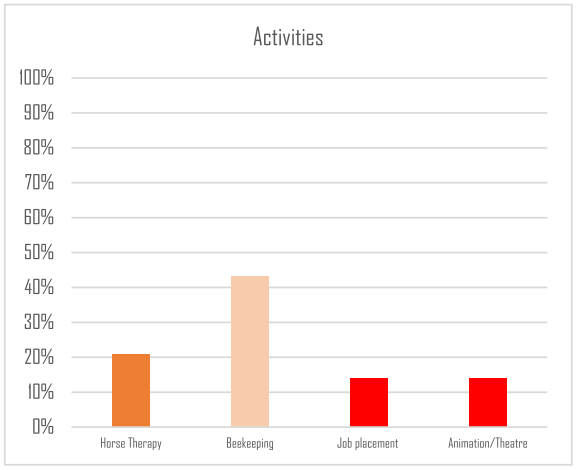


Fig. 9. Provision of ESs for the design actions classified as Activities.

cultivated areas. The selected aggregation procedure does not consider this aspect: in fact, the obtained result provides overall information about the groups of ESs which could be implemented or minimized by the selection and application of a specific strategy. Scores obtained by each action have been first aggregated and standardized according to the four classes of ESs and then further aggregated to visualize the overall provision, ideally one scenario could obtain a maximum 100 %. More in detail, the outcomes (Figs. 14 and 15) prove that the introduction of farms and pastures within the context of Cascina Biblioteca has increased the Provisioning Service (e.g., food; raw materials) while the Regulating one (e.g., air quality regulation; climate regulation) has decreased. According to the concept of multifunctional practices and to the listed strategies, it is possible to underline how T1 is enhancing more the *deepening* of agricultural production, while T0 a *broadening* of functions activated by farms, but given the presence in both scenarios of social and health services the *regrounding* of farm processes is preserved.

Furthermore, the design support perspective could guide the generation of new alternatives with the aim of implementing specific ESs or finding a balance among all the dimensions involved. Within this context, given the presence of two scenarios, namely the current one and the one under development, this second task has not be pursued; nonetheless, especially the definition of the card (Fig. 16) and the possibility to generate several combinations of actions in order to define suitable ecosystem strategies could be relevant to test different design alternatives and visualize their impact in terms of land use and functions.

5. Discussion and conclusions

During the COVID-19 pandemic, UA in European cities acquired a new role and centrality in urban planning, public debate and citizens' vision. The need for open and protected spaces for recreational activities has grown among citizens as a response to the limits to sociability in closed spaces and at the same time the fear that food supplies could be interrupted has fueled the demand for cultivated spaces even within the city.

Peri-urban areas, always poised between abandonment and speculation, are now at the core of urban strategy aimed at food production, recreational services and environmental protection.

Testing the evaluation model proposed on a real case study has brought very interesting and powerful results with respect to the role of the peri-urban areas in city regions, as well to the relevance of assuming

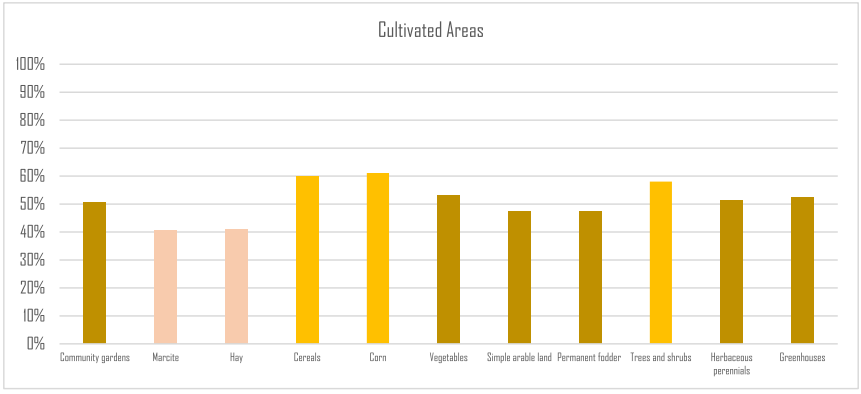


Fig. 10. Provision of ESs for the design actions classified as Cultivated areas.

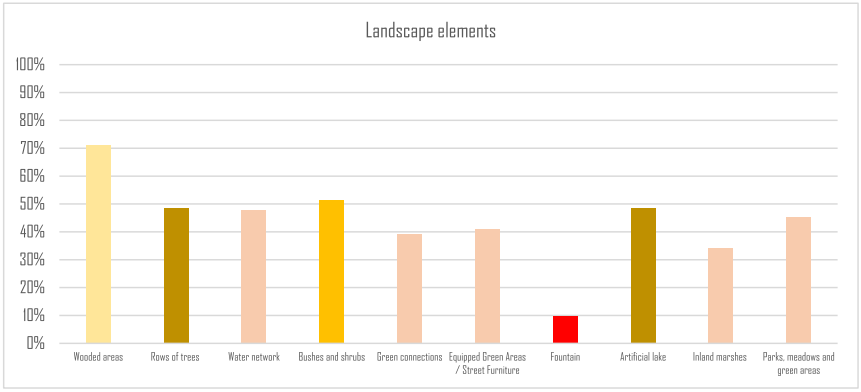


Fig. 11. Provision of ESs for the design actions classified as Landscape elements.

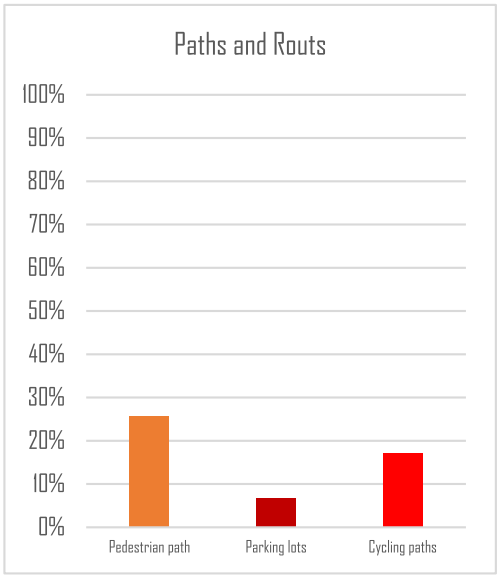


Fig. 12. Provision of ESs for the design actions classified as Paths and routs.

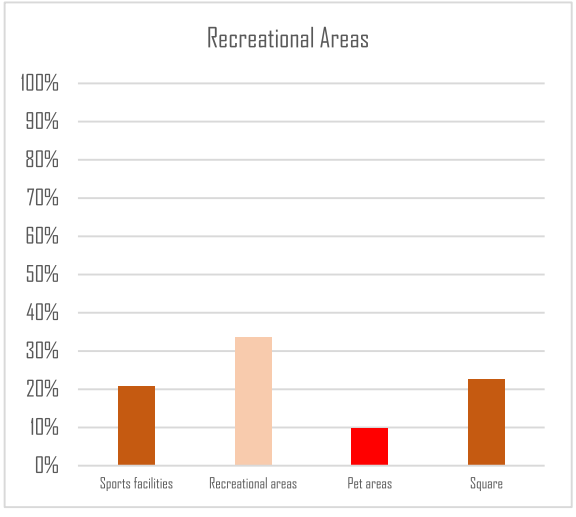


Fig. 13. Provision of ESs for the design actions classified as Recreational areas.

the ecosystems paradigm together with the design perspective as a framework for evaluating urban agriculture.

As shown by the results, the overall level of ecosystem services and multifunctionality provided by Cascina Biblioteca did not considerably increase in the shift from T0 to T1. In fact, the total provision of both ecosystem services and multifunctionality grows only by 1 %, respectively from 28 % to 29 % and from 21 % to 22 %.

At a first glance this could appear as an unsuccessful outcome, which does not compensate the efforts of the new organization. But if we focus on the composition of ecosystem services and multifunctionality, we can notice that some relevant differences emerge.

In fact, in terms of ecosystem services the regulating ones have decreased in favor of supporting and provisioning and at the same time broadening and regrounding have reduced and deepening increased.

First, the main reason behind the low increase of ecosystem services and multifunctionality depends on the initial "stock". Cascina Biblioteca, as described above, is a social initiative already steered towards multifunctionality and the chance to further increase the overall provision of multifunctional and ecosystem services is not necessarily feasible, even more in short time.

Second, in T1 the most relevant change is the shift from *broadening* and *regrounding* to *deepening* and contextually from regulating to provisioning.

In other terms, in T1 farm operations aim at enhancing the production of food (*Deepening*), limiting other income-producing activities, regardless of real agricultural production (*Broadening*), and concentrating the resources within the farm compared to activities outside. In the same way, the ecosystem services referred to provisioning, concerning food production, partially take the place of regulating services.

It is the response to modified conditions due to COVID-19 pandemic and Cascina Biblioteca adapted its mission to the challenges of said new conditions.

This is a very interesting and innovative result, which emphasizes the role of peri-urban areas in the current debate on the urban and territorial planning. Urban planning still focuses mainly on built-up areas or on areas intended for new constructions, but underestimates the role of MFA in providing positive externalities and ESs. A new paradigm is needed to recognize the relevance of non-built-up areas (Langemeyer et al., 2021).

In this view, they shift from the source of free land to be built to the engine of change and adaptation.

Furthermore, the alignment of MFA and ES on the multidimensional nature of goods and services has been confirmed by the growing interest on their interactions during and after the COVID-19 crisis. MFA recognizes and manages multiple services and functions including food production, environmental protection and social inclusion, which can be considered as ESs.

Consistently with this conceptual convergence, our contribution

Table 3
Legend to support the interpretation of the performances.

VERBAL SCALE	CHROMARTIC SCALE	NUMERIC SCALE
very high significant capability		1,00
intermediate value		0,90
high significant intensity		0,80
intermediate value		0,70
significant intensity		0,60
intermediate value		0,50
medium significant intensity		0,40
intermediate value		0,30
low significant intensity		0,20
intermediate value		0,10
no significant intensity		0,00

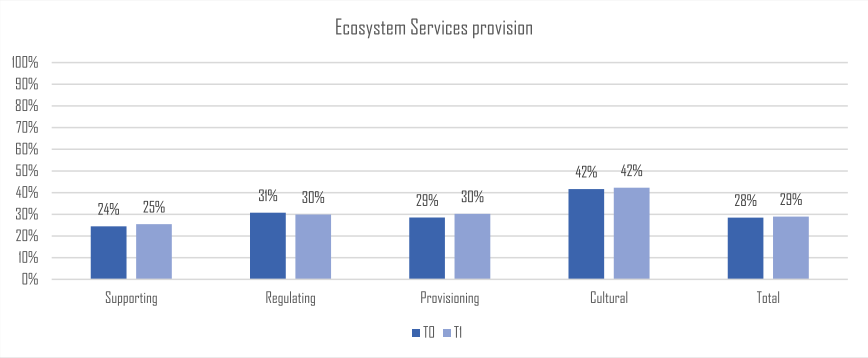


Fig. 14. Comparative result of the Ecosystem Services assessment.

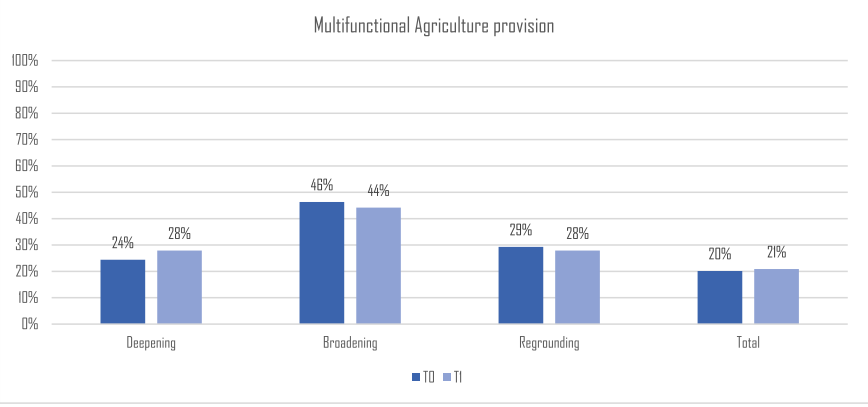


Fig. 15. Comparative result of the Multifunctional Agriculture.

aims at clarifying the relationships between MFA and ES by integrating the dimensions of MFA, identified by van der Ploeg and Roep (2003), and the categories of ES involved (MEA, 2005) into an evaluation model. This attempt contributes to frame the MFA's farm-centered approach into a systemic view where MFA is part of the ecosystem by measuring the contribution of MFA to urban planning and by using the ESs framework to assess the benefits of UA in urban context.

MFA can particularly improve urban environments and foster provisioning, regulating and supporting ESs in urban and peri-urban areas, where land consumption and marginalization contribute to the deterioration of common goods.

Despite the novel approach based on integration of MFA with ESs in urban planning and design processes, some limits from the first and partial application of the current version of the evaluation model have emerged as well as the following research challenges: (1) further integrating MFA dimensions and ESs' framework. Actually the evaluation model is based on two different set of criteria, that needs to be integrated in a unique framework; (2) tuning analysis and evaluation within a multi-scalar perspective in order to test the potential of the evaluation model of assessing the overall benefits descending by the network of ESs at multiple scales (from urban, peri-urban, regional level); (3) including the individual perceptions and preferences about the quality of the multiple services provided by MFA with the aim of including subjective values in addition to technical performances of ESs (Blečić et al., 2021; Fancello et al., 2020); (5) developing a toolkit for including MFA in urban planning with a special attention to the early stages of design

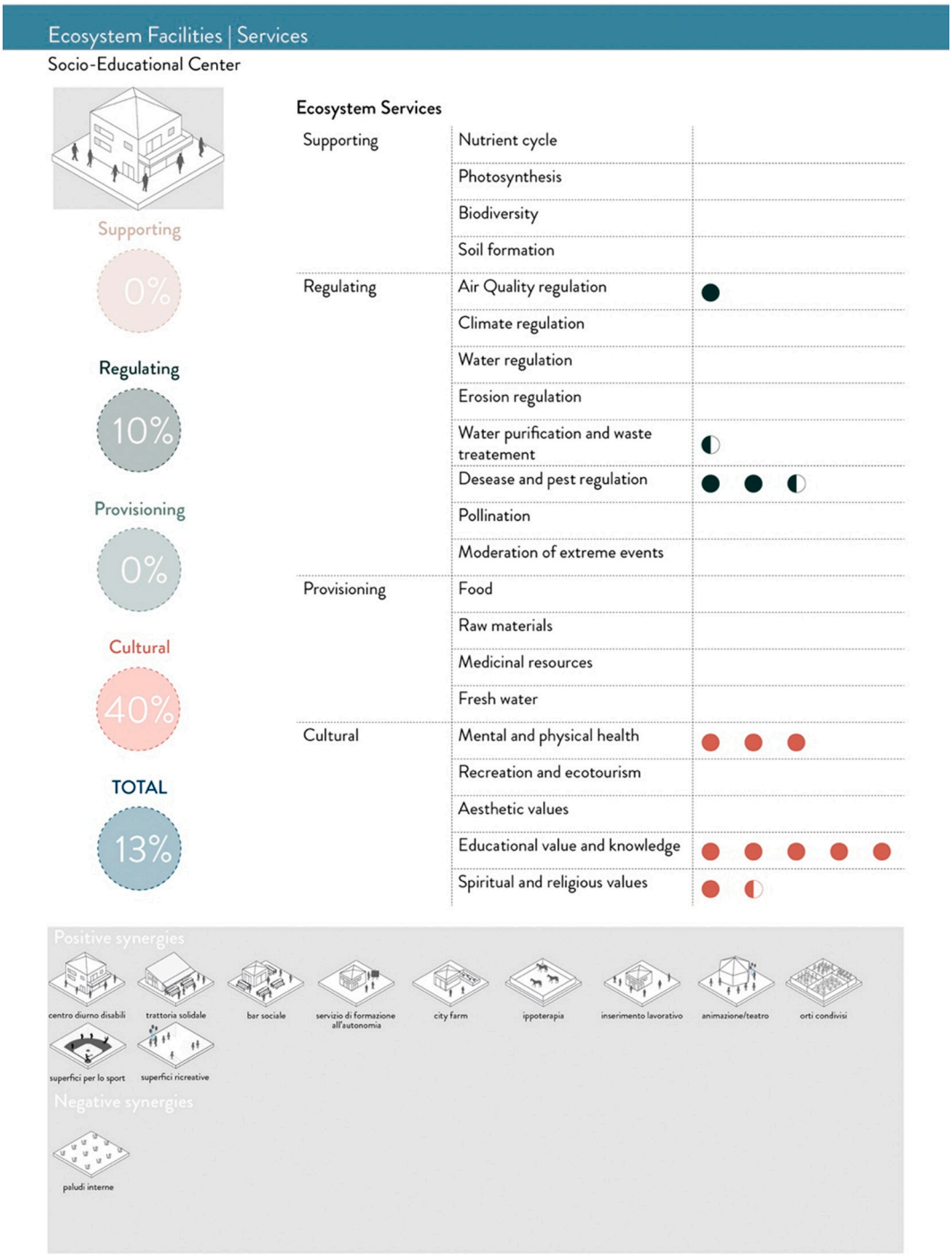


Fig. 16. Design support card developed for the Socio-educational center.

processes, that have been missed in the first application of the evaluation model; 6) considering direct and indirect costs of the intervention, it could be relevant to detect the marginal utility curve of the proposed design actions and to improve the effectiveness of the investments with respect to the stream of benefits they are able to generate.

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CRediT authorship contribution statement

Conceptualization; Corsi, Oppio, Dezio
Data curation; Dell'Ovo,
Formal analysis; Dell'Ovo,
Investigation; Dezio
Methodology; Dell'Ovo
Project administration; Oppio, Longo
Supervision; Corsi
Validation; Corsi, Dezio
Visualization; Dell'Ovo, Dezio
Roles/Writing - original draft; Corsi, Dell'Ovo, Dezio, Longo, Oppio
Writing - review & editing. Dell'Ovo, Dezio, Oppio
Case study management: Longo

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

We have shared data

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