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Urban Ecosystem Services to support the design process in urban environment. A case study of the Municipality of Milan

In dense urban areas nature capital is a vital resource for providing numerous ecosystem services important for human welfare and survival but at the same time cities provide several different private and public services. Both, natural and human services, contribute to the overall well being of the citizens. The present paper aims at mapping and evaluating the "Urban ecosystem services" (UESs) that are generated from natural capital in combination with human-derived capital, and that contribute, directly or indirectly, to human well-being in urban areas. This paper aims at analysing, mapping and evaluating different types of UESs both natural and human origin in the case study of the municipality of Milan. A Multi-Criteria Decision Analysis (MCDA) approach has been implemented to synthetize and map the UESs. Finally, the paper describes how the present approach can support the design and urban planning process.

1. Introduction

Nature capital is a vital resource for providing numerous Ecosystem Services (ESs) important for human welfare and survival (Costanza et al., 1997), mainly in urban areas where human activities undermine urban ecosystems but reduce ecosystem functions and capacities to provide services (Kreuter et al., 2001), due to environmental deterioration and landscape fragmentation (Englund, et al., 2017). Moreover, cities contribute to the overall well-being of the citizens by providing several different private and public services. The mapping and evaluation of the ESs in urban areas should consider and account for both natural and artificial services.

In the Biodiversity Strategy for 2030, the European Commission has stressed the role of the ESs in the protection of biodiversity both in natural and anthropized environments, and the need for their comprehensive mapping, monitoring or assessing, to enhance the knowledge and awareness and to ensure the EU's resilience, climate change mitigation and adaptation (European Commission, 2020).

One of the most accepted definition of ESs describes them as the value humans obtain, whether social, economic or ecological, from natural ecosystems (both wild and managed) and the flora and fauna species they comprise (Alcamo and Bennett, 2003). Moreover, they are commonly categorized into four groups including supporting services (e.g., biodiversity and habitat), provisioning services (e.g., food and water), regulating services (e.g., temperature regulation, noise re-

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duction, and air purification) and cultural services (e.g., recreation, aesthetics and cognitive development) (Croci et al., 2021).

ES knowledge can generate actions by supporting the formulation and structuring of the decision problem and the identification of criteria for screening, ranking and spatial-targeting of the alternatives (Cortinovis and Geneletti, 2018).

Urban society is disconnected and independent from ecosystems, but demand for ecosystem services is increasing because citizens are aware of their crucial role in reconnecting cities to the biosphere, restoring local commons, reducing ecological footprints, orchestrating disciplinary fields and stakeholder perspectives, guiding policies to improve quality of life and, finally, guaranteeing long-term conditions for life, health, good social relations and other important aspects of human well-being (Gómez-Baggethun et al., 2013).

Cities seek to increase the amount and quality of green space to ensure benefits to different groups of citizens (Cortinovis and Geneletti, 2018) and the study of ESs in urban environment is emerging as an important research frontier for the incorporation of these benefits in the urban context (Kremer et al., 2016).

The inclusion of ESs knowledge in urban spatial planning processes can contribute to highlight existing needs, to define standards and policy targets, to design implementation tools, to support the selection and fine-tuning of alternatives (Cortinovis and Geneletti, 2018).

"Urban ecosystem service" (UESs) defined as "aspects of ecosystems that are generated from natural capital in combination with human-derived capital, and that contribute, directly or indirectly, to human well-being in urban areas" (Tan et al., 2020), are an innovative concept to describe and measure ESs in urban environment and shape urban landscapes to be more sustainable and liveable (Haase et al., 2014; Luederitz et al., 2015). They refer to a very wide range of benefits provided mainly by a diverse range of urban elements covering natural ecosystems, constructed ecosystems, and to a limited extent, the abiotic components of cities. In fact, as ESs highlight human dependence on natural ecosystems, UESs reinforce the idea that ecosystems services can be locally produced in urban areas to support human well-being in tangible and intangible ways. UESs encompass both ESs belonging to the natural environment and a wide range of services produced by humans, including housing, transport, education, entertainment, or medical care. So, although urbanization leads to a general dissociation of urban dwellers from nature (Turner et al., 2004), UESs provide opportunities for urban dwellers to experience nature (Andersson et al., 2015) and acts as a social tool to bring together diverse stakeholders to foster community driven (Luederitz et al., 2015) and government-led planning (Rall et al., 2015) for urban sustainability.

More than in rural and natural areas, in the urban context the balance and competition between natural and human capital is a relevant factor for the economic development and the liveability. The UESs can support the comprehension and measurement of the trade-off between increased provision of human services triggered by a management choice (Verhagen et al., 2018) and/or human intervention and the reduced provision of natural ones (Deng et al., 2016; Haase et al., 2012; Rodríguez et al., 2006). The knowledge of trade-offs may support decision-making and policy instrument design (Verhagen et al., 2018) up to European scale (Ruijs et al., 2013), by avoiding the loss of important UESs and promoting synergies between different UES (Burkhard et al., 2014; Carreno et al., 2012).

As, different types of UESs are produced depending on which scale is applied, and which boundaries are used to define the ecosystem of interest, mapping them is essential because can allow full assessment and quantification of UESs (Crossman et al., 2013, Yang et al., 2019), including the spatial distance between providing areas and benefiting areas (Fisher et al., 2009; Bastian et al., 2012). Mapping can be also crucial for the evaluation of the benefits of the UES (Sylla et al., 2020). Both monetary and non-monetary methods have been applied to assess the value of ecosystems in decision-making. Multi-Criteria Decision Analysis (MCDA) is suited for integrated valuation of ecosystem services because it can combine information about the performance of the alternatives with respect to evaluation criteria with subjective judgments about the relative importance of the criteria in a particular decision-making context (Vatn, 2009).The present paper aims at analysing, mapping, and evaluating different types of UESs both of natural and human origin in the case study of the municipality of Milan, by applying the methodology developed by Burkhard et al. (2009; 2012; 2014). A MCDA approach has been implemented to synthetize and map the UESs, combine objective and subjective assessments (ref.), and support the Decision-Maker (DM) in designing the most suitable solution among a set of alternatives (Roy, 1985; 2005).

MCDA allows multiple sources of information and value dimensions to be combined, to address UES-related issues within the urban planning framework and offers a structured way and balance diverse and sometimes competing interests (Cortinovis and Geneletti, 2018). Moreover, combining MCDA and UES approach improves the urban planning tools and aids decision-making to maximize multiple ESs benefits to increase human wellbeing in cities (Kremer et al., 2016).

Our study comes on top of other recent papers which have studied the contribution to UES to the sustainability and planning in European and non-European cities. In particular, Gómez-Baggethun et al., (2013) recognized the provision of water supply, flood mitigation, coastal zone protection and tourism as important UES to the City of Cape Town and described programs and projects aimed at attempting to restore these and thereby enhance ESs benefits.

A study on New York City stressed the role of UES in city planning, to better understand trade-offs and synergies and to generate best practices for managing and enhancing biodiversity and ecosystem services in the New York metropolitan region (Gómez-Baggethun et al., 2013). A second one, again on New York City, identifies patterns of distribution and access to UES important for understanding inequity issues with respect to UES benefits and for informing holistic decision-making regarding conservation priorities (Kremer et al., 2016).

A recent research on the City of Toronto highlighted the importance of scale, referring specifically to data resolution (i.e., the granularity of data) and measurement scale, which relates to the number of enumeration units (or census levels). The main output of the paper is the recognition of how specific land use and land cover properties act as representatives of ecosystem processes (Emily C. Hazell, 2020).

Li et al. (2020) have implemented a multi-criteria approach integrating ecological and cultural services evaluation to obtain a more comprehensive assessment of the demand for UES in Beijing. Their results show that some small green spaces located in densely built-up areas have a higher demand for ESs than that of large green spaces, so that the consumption of cultural services is closely related to the distribution of green space and the composition of surrounding residents (Li et al., 2020).

Another interesting study focused on the provision of cultural ESs in Barcelona is also crucial in urban parks, and demonstrated that the limited amount of green space in the dense city requires a broader acknowledgement of citizens' needs in the planning of urban green spaces and brown-fields have a high potential to provide ESs (Gómez-Baggethun et al., 2013).

The presence of brownfields and abandoned areas are at the core of the paper of Cortinovis and Geneletti on the city of Trento, where the expected benefits in terms of improved cooling effect by vegetation and enhanced opportunities for nature-based recreation have been studied to address two of the most critical issues for citizens' well-being in Trento (Cortinovis and Geneletti, 2018).

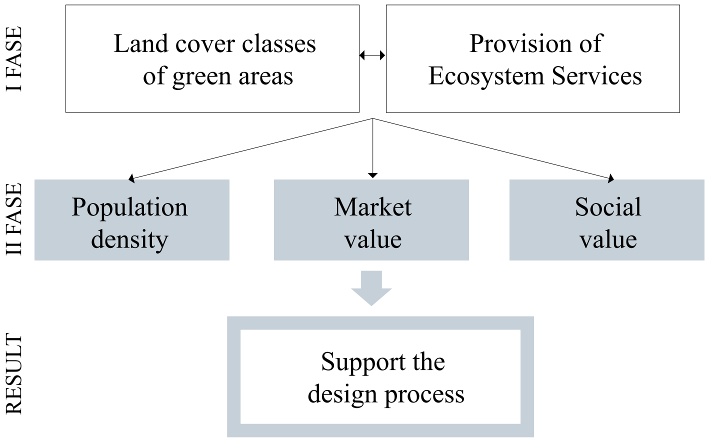
Finally, Cerreta et al. (2020) applied a 3D virtual model to visualize UES trade-offs simultaneously, in order to identify opportunities linked to a sustainable spatial policy, and to implement a multi-scale decision-making process (Cerreta et al., 2020).

Although our results are targeted to the urban planning of the City of Milan, the study framework is repeatable and can be applied to any other study areas if suitable indicators and weights are adopted. The remainder of this paper is organized as follows. The second section presents the methodological framework. The third section describes the case study. The fourth section details the application, articulated in two phases. The fifth section presents and discusses the results both the descriptive statistics and the aggregation. The sixth outlines how the approach can support the design process. A general conclusion ends the paper.

2. Methodological framework

Since benefits produced by the presence of green areas are becoming an evidence given by their positive effects on the wellbeing of the population, the climate change regulation, and the maintenance of biodiversity (Camps-Calvet et al., 2015; Miller and Montalto, 2019), it is strategic to support their design. Moreover, the provision of ESs is directly related to the land use and to the characteristics of the context under analysis. In order to take into consideration both intrinsic and extrinsic features, the methodology proposed within this research combines the evaluation of ESs according to the model developed by Burkhard et al. (2009; 2012; 2014) with the analysis of the population density, the market value and the social value, to result with a critical reading of the current state of the context, aimed at supporting the design process. The approach is based and takes advantage by the support of the MCDA and the generation of maps through the use

Figure 1. Methodological framework.



of Geographic Information Systems (GIS) software which gives the possibility to directly visualize on the territory the results of the investigation. MCDA methodologies aid the DM in structuring the problem and in defining the most suitable solution among a set of alternatives (Roy, 1985; 2005), while GIS allows to elaborate and manipulate a large number of spatial data and information under a georeferenced environment (Dell'Ovo et al., 2020). The application of MCDA methodologies within the GIS environment, implements the potentialities of the decision-making process by improving the transparency of the process and the awareness about the problem (Dell'Ovo et al., 2020).

The analytical phase has been developed in different phases (Figure 1); while the first two are aimed at critical reading the state of the art and the existing characteristics of the territory under analysis, the third one has as main objective the elaboration of data collected in order to support the design process.

- The objective of the first phase is the quantification of ESs according to the land use types. The process has been developed by assuming the values elaborated by Burkhard et al. (2009) and Zhang and Ramírez (2019) within their studies. The method considers the land cover classes included in the CORINE program of European Union and assigns a qualitative/numerical valuation (where 0 is the lowest value and 5 the highest) considering their provision of ESs. As described by Burkhard et al. (2009; 2012; 2014), values have been assessed by first expert evaluations and then based on experience from different case studies. Experts were asked to express their judgement considering the classification of ESs provided by Millennium Ecosystem Assessment (MEA, 2005) and grouped in four categories: supporting services, provisioning services, regulating services and cultural services. The result of the first phase is the visualization of both partial and overall outcomes of the judgments obtained by associating the values carried by the different land uses present in the context under analysis.

- The second phase is aimed at analyzing characteristics of the territorial context and in correlating them with the outcomes obtained in the previous step. By understanding demands, criticalities and strengths of the territory, it is possible to give a specific and contextualized support to planners, architects and policy makers to guide the design process. The process has been developed by involving significant features able to influence the social and economic condition of an area and to provide a picture of the current state. The result of this phase consists in a deep investigation of the following aspects:
    - Population density: allows to understand how many people are positively influenced by the presence of the green areas and could receive beneficial impacts by the provision of ESs;
    - Market value: allows to understand if the market values of residential assets are affected by the presence of green areas and their provision of ESs;
    - Social value: allows to understand the provision of services by considering the presence of health facilities, public transport stops and schools in order to better understand the quality of the urban spaces (Oppio et al., 2018).
- Once these two phases of analysis have been developed and data have been elaborated, the goal of the third and last phase consists in providing operational recommendations to guide new design actions according to their level of priority by critically reading the results obtained through a deep understanding of the context and considering both strengths and criticalities.

3. Case study

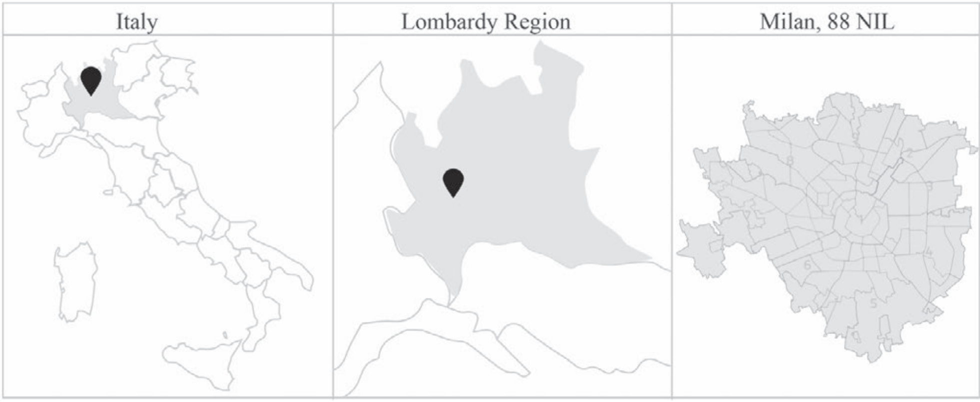
The case study selected to apply the methodological framework previously described is the municipality of Milan, located in the northern part of Italy. Milan has a population of about 3 million people (ISTAT, 2019) and is characterized by a high level of urbanization and, consequently, by a high level of soil sealing. Milan has been affected in recent years by an exponential growth in population with its economic development, in fact its attractiveness is directly related to its inclusion in circuits of the flow economies and high finance (Dicken, 2003; Sassen 2018; 2001; Sdino et al., 2020).

Currently the city is represented by a fragmented belt of agricultural fields still productive, located at the edges and recently (Sanesi et al., 2017) the local Administration is developing new green policies by proposing and supporting sustainable projects. In fact, one of the main objectives of the land management plan 2030 consists in a green city, liveable and resilient to achieve by reducing the soil consumption, designing new parks and green roofs.

Nowadays the metropolitan area is characterized, for administration purpose, by 9 main areas, further divided in 88 local identity centres (Nuclei d'Identità Locale - NIL) (Figure 2).

This smaller division is the one used in this study to map and evaluate the ESs. The small dimension of each NIL allows to detect detailed and punctual information and to give the possibility to observe potential interactions and the perception of the population.

Figure 2. Location of the Municipality of Milan and division in 88 NIL.



Once the case study has been limited and identified, the next phase consisted in mapping and classifying green areas in seven categories, namely: Agricultural areas; Garden; Uncultivated; Vegetable garden; Public park; Traffic island; Highway-infrastructure green (Table 1).

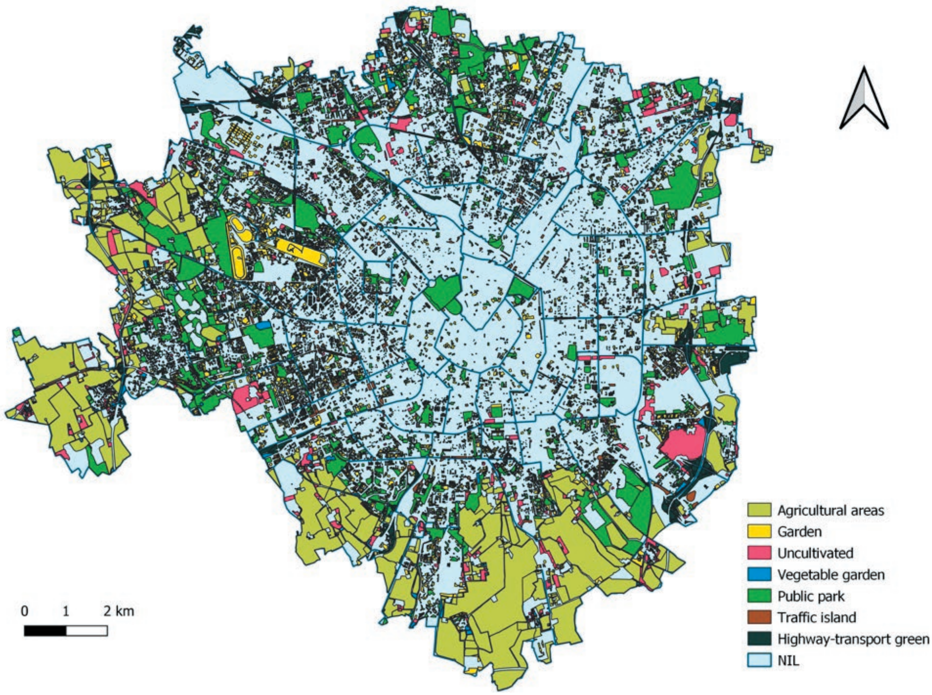
This classification has been applied to analyze each NIL presents in the Municipality of Milan and data regarding classes previously defined have been detected from Google satellite image and elaborated with QGIS since open data available where not sufficient for the analysis and the classification. The collection of data has been carried on by observation and some errors should be taken into consideration given the accuracy of the green area's representation identified. Figure 3 presents the results of the green areas classification by considering the seven categories.

As it is possible to observe from the map, agricultural areas are mainly located in the periphery, and more in detail on the southern and western side of the city

Table 1. Green areas classification.

Categories	Description
1. Agricultural area	Agricultural areas and agricultural production zones
2. Garden	Private green areas
3. Uncultivated	Abandoned areas and uncultivated areas with spontaneous vegetation
4. Vegetable garden	Private or community garden
5. Public park	Public green areas, public parks, and playground
6. Traffic island	Green areas at the border of avenues or large crossings
7. Highway - infrastructure green	Green areas at the border of highways and railways or close to airport areas

Figure 3. Green areas mapping.



while public park, garden and uncultivated areas are present, even if with different dimensions, in all the territory.

4. Application

4.1 First phase

Once data regarding green areas in each NIL of the Municipality of Milan have been detected, it has been possible to proceed with the application of the methodology previously defined. In detail in the first phase, the model developed by Burkhard et al. (2009; 2012; 2014) and Zhang and Ramírez (2019) has been applied considering the values proposed by their researches for each category mapped. As it has been already mentioned in the second section, values assigned to the different land uses have been assessed by first expert evaluations and then based on experience from different case studies. This methodology is based on the concept that different land uses, and within this context different green areas, can provide different levels and typologies of ESs. Their provision has been calculated considering several projects on different scale and eliciting the opinion of experts (Burkhard et al., 2012). In order to result with a final performance of provision of

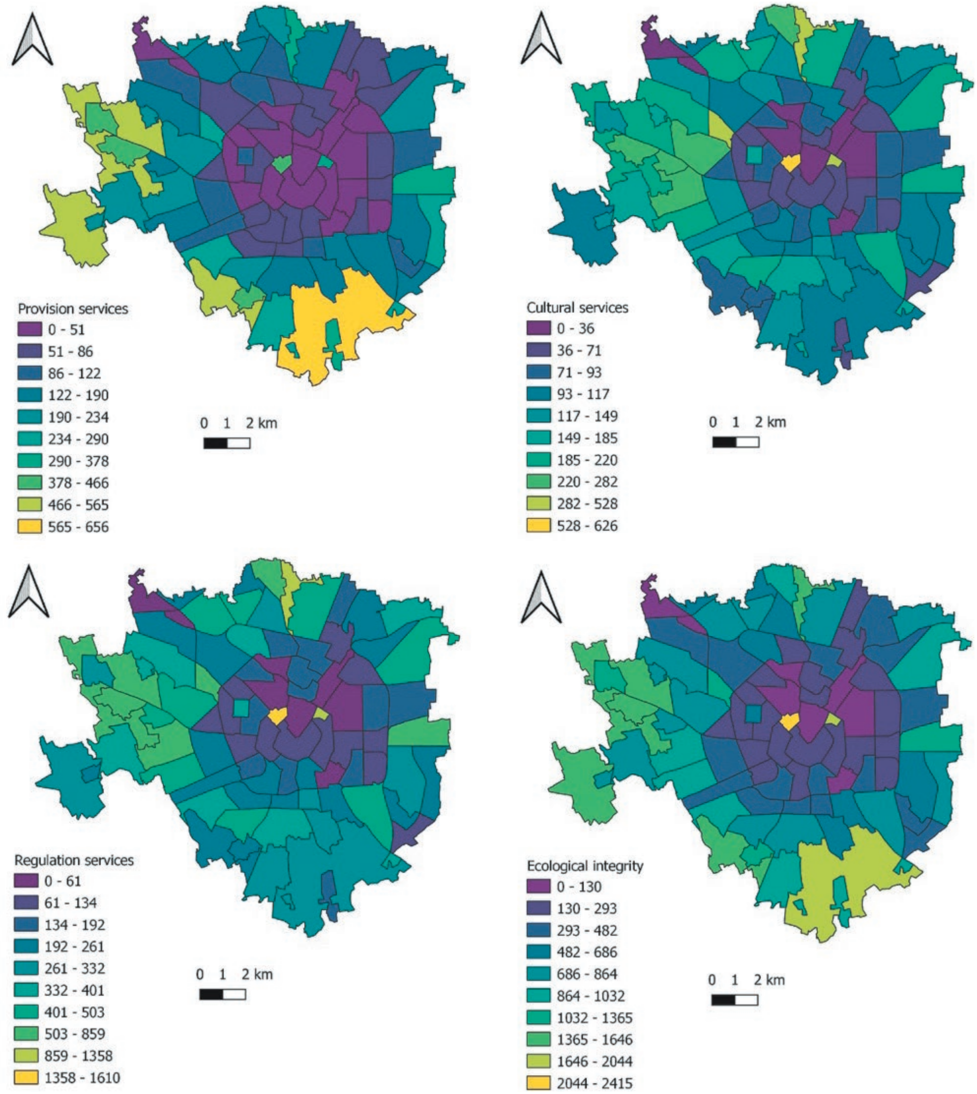
Table 2. Matrix for the assessment of the different green areas.

	Agricultural area	Garden	Uncultivated	Vegetable garden	Public park	Traffic island	Highway - infrastructure green
Provision services	**8**	**5**	**3**	**5**	**5**	**1**	**1**
food	5	0	0	3	0	0	0
genetic resource	2	1	3	2	2	1	1
ornamental resources	1	4	0	0	3	0	0
Cultural services	**1**	**7**	**0**	**1**	**7**	**1**	**1**
aesthetic	1	3	0	0	3	1	1
recreation	0	4	0	1	4	0	0
Regulation services	**3**	**10**	**6**	**0**	**18**	**3**	**0**
local climate regulation	2	3	2	0	5	1	0
global climate regulation	1	2	1	0	4	1	0
air quality regulation	0	2	1	0	4	1	0
nutrient regulation	0	1	1	0	1	0	0
erosion protection	0	2	1	0	4	0	0
Ecological integrity	**21**	**18**	**17**	**15**	**27**	**6**	**4**
abiotic heterogeneity	3	3	2	2	3	2	2
biodiversity	2	3	3	2	4	2	2
biotic water flows	3	2	2	2	4	0	0
metabolic efficiency	3	1	1	2	3	0	0
exergy capture (radiation)	5	4	4	4	5	0	0
reduction of nutrient loss	1	3	3	1	3	1	0
storage capacity (SOM)	4	2	2	2	5	1	0
ES tot	**33**	**40**	**26**	**21**	**57**	**11**	**6**

ESs for the different NIL, all the green elements present have been scored considering the values illustrated in Table 2 and summed together. Values have been elicited by considering the four classes of ESs further divided according to the definition provided by MEA (2005).

The mapping of green areas, together with the value assignment for the different classes, allowed to understand for each NIL the partial provision of ESs considering the four categories (supporting services, provisioning services, regulating services and cultural services) (Figure 4) and the overall provision of ESs (Figure 5). Synthetizing the process, the green areas have been detected and weighted considering their cover percent on the NIL. The final value has been cal-

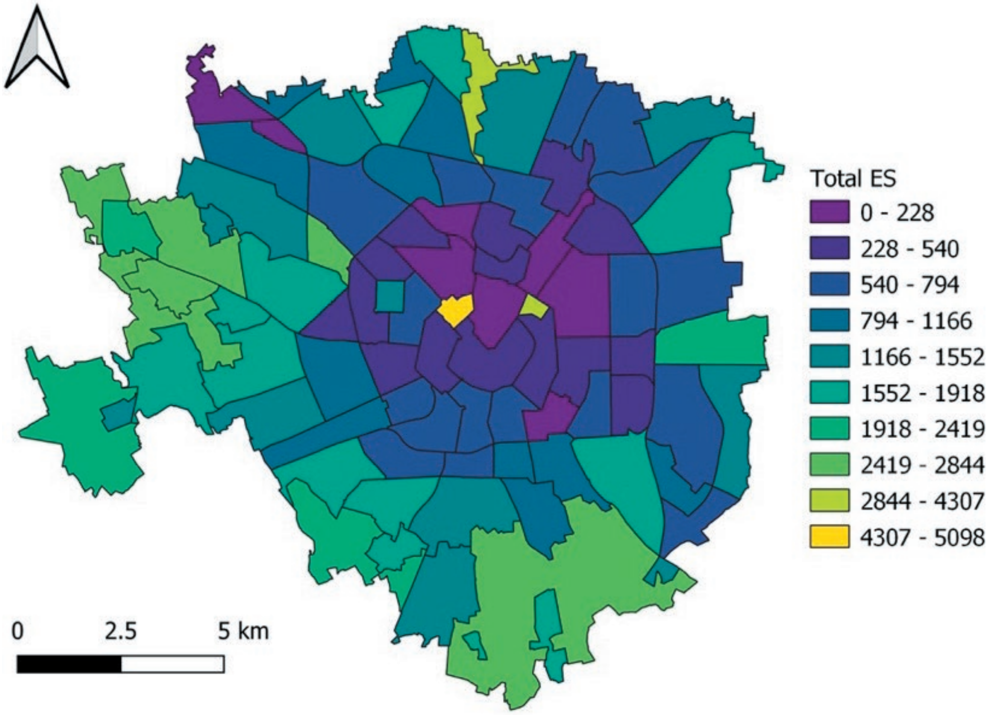
Figure 4. ESs provisions according to the four categories.



culated by summing up the results of the multiplication between the ES value and the percentage of the category of green present in the area under investigation.

For what concerns the provision of services, related to the capability of a green area to supply not only comestibles but also ornamental and genetic resources, the higher values are in the periphery, where the agricultural areas are present, and where domestic vegetable gardens are more widespread thanks to the availability of space. For the cultural services, connected to how humans per-

Figure 5. ESs total provisions.



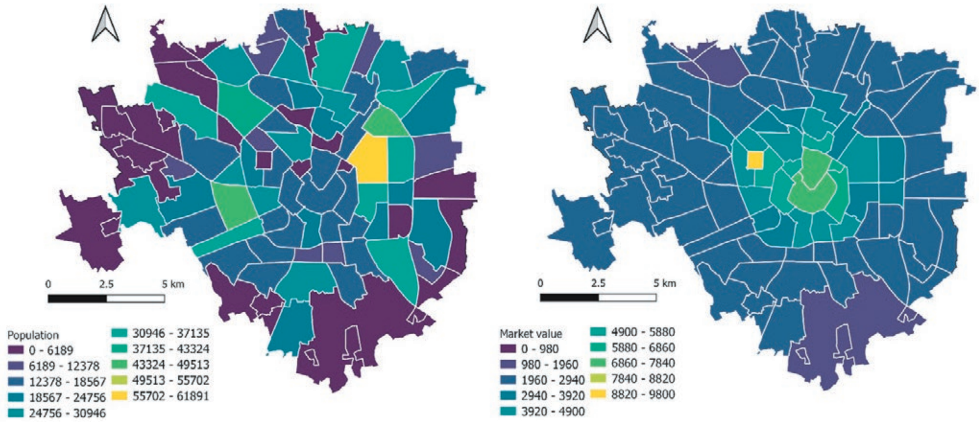
ceive the urban environment, their performances are strictly associated with the presence of public parks and garden. In the regulation of services, aimed at understanding how human being are manipulating the natural environment, uncultivated / abandoned areas have a central role since allow the growth of spontaneous vegetation, essential for the survival and the spread of life of insects and small animals, mammals and reptiles. On the other side, traffic islands negatively affect the climate change and the air quality compromising this ES. The ecological integrity, which involves all the biodiversity aspects and the capability to support and preserve different organisms, also in this case, it is guaranteed where different typologies of green areas coexist.

By reading Figure 5, which shows the total provision of ESs in each NIL analyzed, it is clear how the higher values are scored by areas located in the periphery while the performances decrease by moving to the city center since characterized by a highly urbanized environment.

4.2 *Second phase*

This second part of analysis involves the investigation of extrinsic characteristics that could influence the liveability and the daily life of the neighbourhood.

Figure 6. Population density (left) and market value (right) maps.



In detail, issues that could be affected or could affect green areas have been selected to understand if potential correlations exist and could determine the choice of possible design strategies. In fact, the provision of public services and the easy accessibility can improve the quality of urban spaces while information about the market value of houses could confirm the studies about the increment of price due to the presence of green areas (D'Acci, 2014).

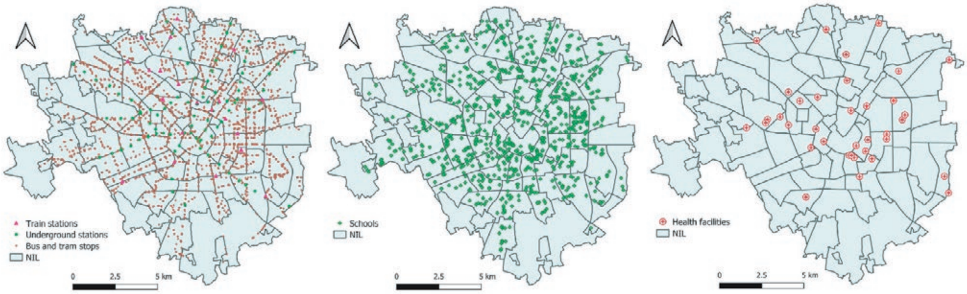
As it has been already mentioned in the methodological framework section, in this context it has been judged as suitable to study the population density, the market value and the social value, meant as the presence of specific services. Figure 6 shows on the left side the map concerning the concentrations of population while on the right the average market value for residential buildings.

For what concerns the population density maps, the most populated areas in the Municipality of Milan are those located around the city centre, where are present neighbourhoods undergoing economic and social development such as Isola-Garibaldi and Loreto while those located at the outskirts are characterised by a low urbanized context. Considering the market value, as it was predictable, central dwellings present a higher price than those at the border of the city.

For the social value (Figure 7), the presence of three different services have been detected, and in detail, public transport stops, schools and health facilities. In fact, to contextualise the ESs produced by each NIL these points of interests have been considered.

The analysis consists in calculating the square meters of green areas present in a buffer of 500 m from the different points and then for each of these three indicators a final mean of the green areas has been performed (for each NIL) to obtain a single result. This distance has been chosen because can be covered within 10 minutes of walk and it was also previously used to study the role of the urban green on the life quality (Klompmaker et al., 2018; McMorris et al., 2015). The selection of these indicators has been guided by the objective of mapping public services which enhance the urban quality of a neighbourhood (Oppio et al., 2018).

Figure 7. Social value maps: public transport stops (left); schools (centre); health facilities (right).



5. Discussion of the results

5.1 Descriptive statistics

To compare results obtained by the different indicators analysed and understanding possible correlations, performances have been standardized in a scale from 0 (worst value) to 1 (best value) in relation to the maximum values scored within each rank.

Among the aggregation procedures available within the MCDA, it is it possible to mention three main categories: compensatory, partially compensatory, and non-compensatory methods. By applying the first one, a weak score obtained in one criterion is compensated by a good score obtained in another one, for the second method the process is composed by two phases where the role of the DM is important in order to get supplementary judgements about the evaluation, while the third methodology is based on the generation of decision rules (Dell'Ovo et al., 2020). Within this context, since it has been judged as not necessary to define specific thresholds of acceptability or rules, a compensative method has been selected. In fact, values standardized have been aggregated by using the Weighted Sum Model (WMS) and by performing a neutral scenario, i.e. by assigning the same influence to the different indicators:

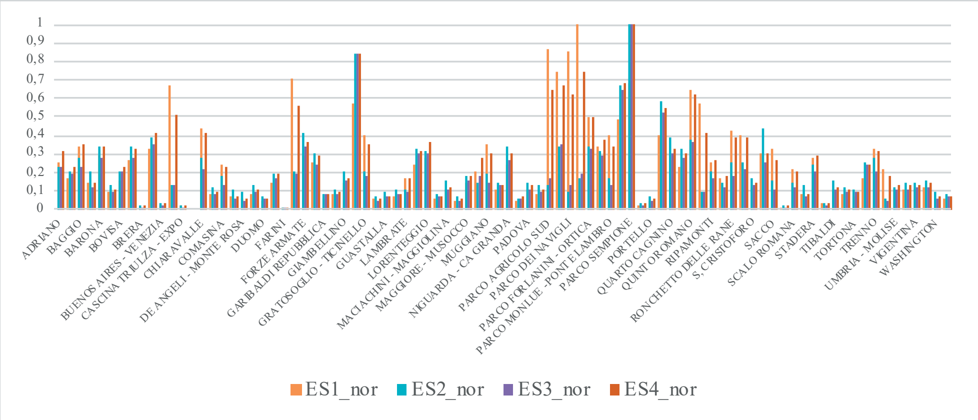
$$V = \Sigma W_i X_i \tag{1}$$

where:
V value represents the total score obtained in the final rank;
W_i is the normalized weight of i-th objective;
X_i is the standardized score (Fishburn, 1967).

Figure 8 shows scores obtained by each NIL for the four categories of ESs analysed and, except for few sporadic cases, they grow and decrease evenly and this trend detects a correlation among the factors under investigation.

By combining partial values of the four categories of ESs and comparing the results with the population density and the market value it is possible to observe

Figure 8. Standardized values for the four categories of ESs.



how there are no correlations or proportion among data investigated (Figure 9). The high score obtained under one characteristic does not determine the increment of the others, indeed, areas with a high population density, usually are those with a lower market value and a medium provision of ESs.

On the contrary by reading the results obtained by Figure 10, on average, NIL with a greater presence of services close to green areas also provide a higher value of ESs.

The analysis offers a visualization of the combinations among all the indicators and to obtain good conditions for the life quality in a NIL the best integration between the presence of a) quality green areas, b) high provisions of ESs, c) facili-

Figure 9. Comparison between population density (pop_nor), market value (OMI_nor) and total provision of ESs (ES_tot).

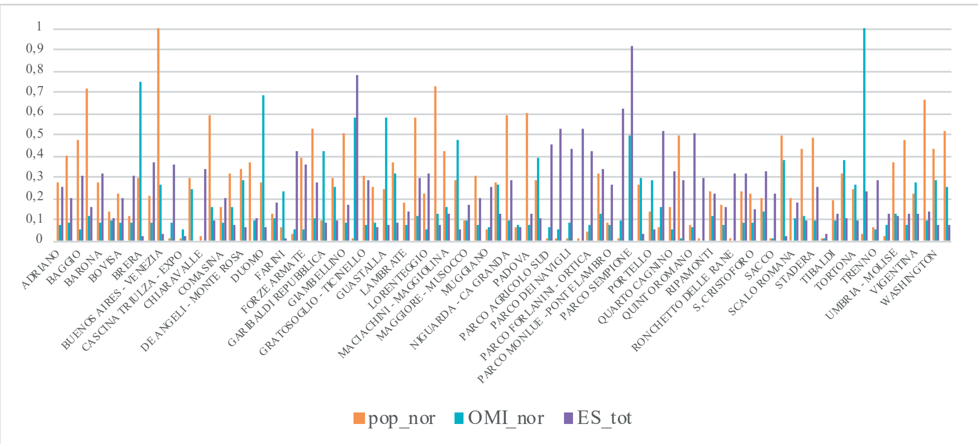
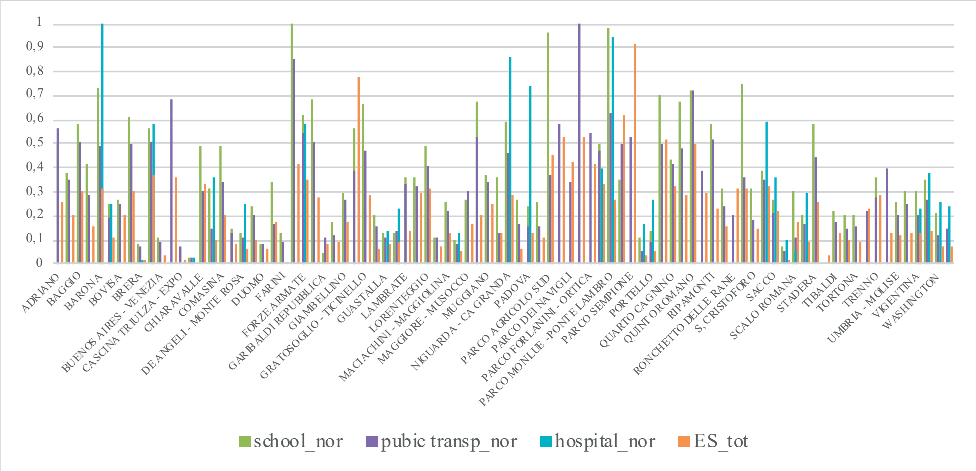


Figure 10. Comparison between presence of services and total provision of ESs.



ties for the population, d) density of the people living there and e) their economic status should be guaranteed.

5.2 Aggregation of the results

Even if the partial results allow to have an overall picture of the situation in each NIL, the final aggregated value could help in understanding which are the more critical areas and how it is better to intervene to plan design actions. In detail Figure 11 shows a comparison between the first phase of analysis and the second phase presented in the methodological framework. Here, more than in other graphs previously presented, it is clear how a gap exists between the provision of social value and the provision of ESs, in fact where intrinsic characteristics perform with a high value, the extrinsic ones obtained a low value and the opposite. This final result could strongly support the allocation of resources and the planning of strategies to implement most critical issues.

In order to complete the analysis, Figure 11 shows moreover the final total value concerning the quality of each NIL obtained by aggregating the two phases performed where, among the 88 NIL, the worst value ranked is 0,02 while the best one is 0,57.

6. How to support the design process

Considering the previous results and the analysis performed, it is possible to both understand criticalities and strengths of each NIL. Within this context planners, architects and policy makers can be supported and guided in providing new

Figure 11. Comparison between the first and the second phase presented in the methodological framework and total quality.

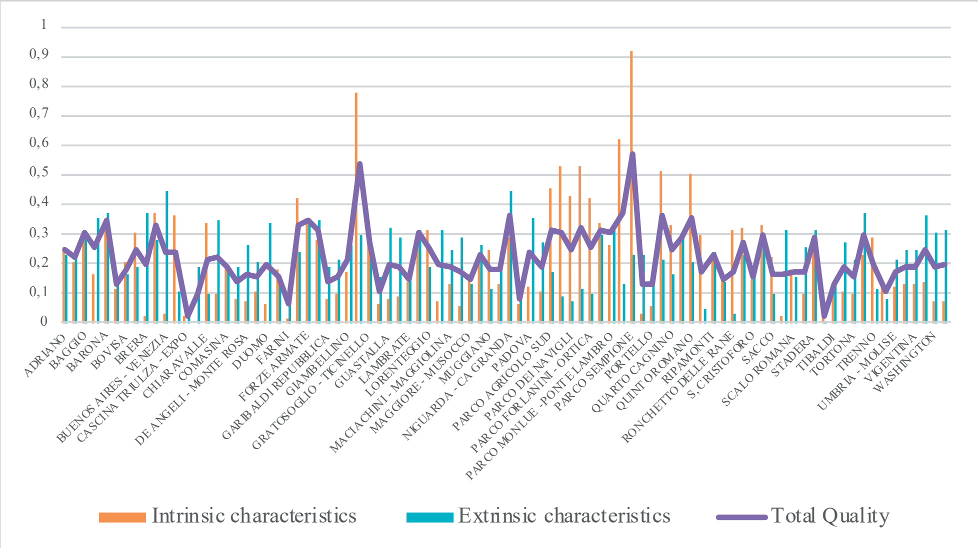
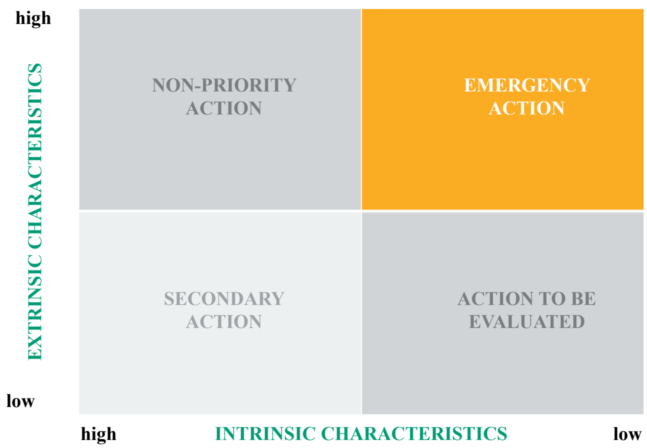


Figure 12. Priority matrix.



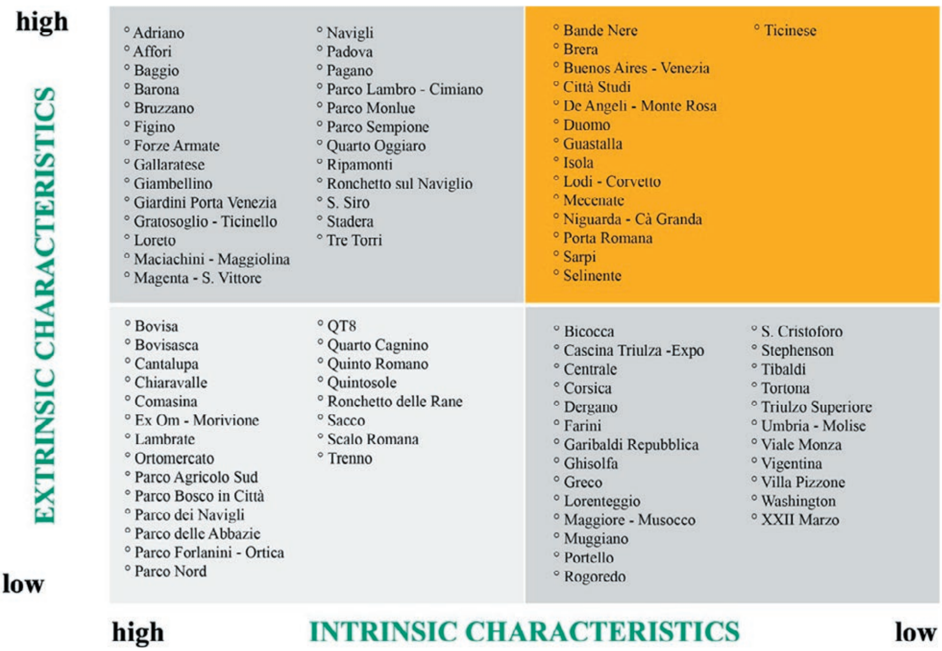
strategies and design actions aimed at improving the overall quality of the city. In fact, given the idea of having good quality conditions when both extrinsic and intrinsic characteristics perform a high value, it is possible to structure a priority matrix aimed at understanding when it is urgent to intervene and when an action is secondary. Figure 12 provides an example and a support with the objective to order and structure all the results previously stated.

The matrix has been framed by considering intrinsic characteristics (horizontal axis), resulted from the first phase of analysis concerning the provision of ESs and extrinsic characteristics (vertical axis) resulted from the second phase and concerning the aggregation of the population density, the market value and the social value. As it is possible to see, for the horizontal axis values are descending (high-low) while for the vertical one are growing (low-high). The matrix has been further divided in four quadrants aimed at defining the priority of the actions. The high value obtained by the extrinsic characteristics and the low value obtained by the intrinsic ones determine a situation where strategies and actions are urgent, while when both performs with a low score the priority should be evaluated case by case according to the context. When both perform with high value the design is not priority while when the provision of ESs is high and the extrinsic features are low, the action is of secondary importance.

The matrix, in this specific case could be used to evaluate the overall quality of each NIL and in understanding which should be improved, while more in general could be useful in supporting the decision and design phase for the development of urban plans or projects aimed at implementing the provision of green spaces.

Figure 13 tries to synthetise the first results obtained by classifying the 88 NIL considering the matrix previously presented and in detail how they behave against to the extrinsic and the intrinsic characteristics. For what concerns the classification in high and low for each axis it has been evaluated the median value for both characteristics investigated in order to define a threshold relative to the case

Figure 13. NIL classified by considering the priority matrix.



study analysed and not absolute one. For the extrinsic the median value is 0,22, it means that NIL with a score ≥ of it are classified as high while < are classified as low, while for the intrinsic the median value is 0,17.

This first analysis can help DMs in understanding which area of the city deserves to be rethought and possibly improved. The limits of the study are given by the analysis developed on the screen with all the criticalities given by the lack of survey on the site and questionnaires aimed at understanding the real perceptions of citizens. Moreover, the framework defined, and the aspects considered could be implemented in order to have a further and deeper awareness of strengths and weakness of the context under a multidimensional perspective. By the way this first attempt of classifying NIL in level of priority for a possible design actions could be at the base of a preliminary analysis aimed at providing a general overview of the city.

6. Conclusions

In the last years, an increasing number of papers has focused on ESs by analysing different features, methodologies, and environment where they are generated. The paper contributes to the scientific debate by applying the UESs concept in the definition of the ESs in the Municipality of Milan. Furthermore, the UESs have been measured with the approach developed by Burkhard et al (2009), mapped and aggregated in in the MCDA environment.

The UESs allow to encompass in an unique set both natural and human-derived services and enhance the effectiveness of the measurement of the ecosystem services in the urban environment where the trade-off and the combined impacts of natural factors and human activities describe the liveability of the cities. The paper focuses on the public and private services, including housing, education and health care, but the contribution of the social activities (e.g. bottom up initiatives, social innovations, citizens' associations) is missing. Nevertheless, they are key elements of the social cohesion and might be token over in the list of ESs. The approach should be implemented by including them in the set of indicators.

Second, the Burkhard, et al. (2009) method is useful, effective and easy to apply. Although it risks trivializing the complexity of the UESs, on the other hand it incisively simplifies the process and allows to compare the results with other case studies analysed under the same approach.

Moreover, the MCDA, based on the concept and method described above, provided a sound support to the decision process and the landscape design at NIL and municipal scale.

Finally, the findings suggest that our approach can help DMs in defining the targeted and tailored strategies to rethink and improve the urban environment by focusing on the most strategic areas, according to levels of priority.

New research perspectives would be aimed at addressing the approach to the design action. The general overview, based on secondary data, might be enforced by primary data collected on the site aimed at understanding the real perceptions of citizens.

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