Peri-urban open spaces and sustainable urban development between value and consumption

Rovai, Massimo (1)*, Zetti, Iacopo (2), Lucchesi, Fabio (2), Rossi, Maddalena (2) & Andreoli, Maria (3)

(1) Department of Civil and Industrial Engineering (DICI), University of Pisa, Italy; (2) Department of Architecture (DIDA), University of Florence, Italy, (3) Department of Agricultural, Food and agro-Environmental sciences (DAFE), University of Pisa, Italy

* e-mail: massimo.rovai@unipi.it

Abstract Current rates in population growth and urbanization are threatening sustainability. Increasing soil consumption and dwellings with inadequate characteristics need to be counteracted to ensure well-being of present and future populations. Urban planning is currently characterized by an approach based on standards and restrictions, and, as such, is unable to cope with the above problems. An Ecosystem Service (ES) approach can be valuable in assessing current quality of life in urban settlements and in planning for its improvement. Green open spaces and relationships between urban, peri-urban and rural areas are very important in the provision of Ecosystem Services (ESs) to built-up areas. While many authors focus on approaches aiming to provide a monetary value for ESs, others are more interested in how to operationalize ES use in planning, without having to assess ES monetary value. The authors propose an integrated AMC-GIS approach aiming to improve planning by providing a three-dimensional spatial analysis of productive, protective and cultural-recreational ESs based on the integration of the three RGB channels. Resulting maps provide a spatial representation of the mix of the three ES categories and stress the multifunctional role of many open spaces. Although the model requires further refinement and testing, preliminary results show that this approach may represent an innovative tool both for urban planning and design and for monitoring and correcting urban projects that are already underway.

1. Introduction

The European Environmental Agency (EEA) has recently issued two reports (EEA, 2016a; EEA, 2016b) highlighting the contribution of urbanization to soil consumption and its increase. Scientists and citizens are increasingly aware that the destruction and alteration of peri-urban open spaces bring about negative effects in

terms of territory resilience and capacity to provide Ecosystem Services (ESs) and functions vital for the well-being of population living in the neighbouring built-up areas (MAE, 2005). Anthropization and urbanization are the main drivers of negative effects. Indeed, the role of anthropization on climate change and its impact cannot any longer be overlooked, as well as the challenges arising from globalization processes, e.g. ensuring food security and preventing depletion of territorial assets. Priority in the search of effective solutions should be given to cities, where are currently living about 74% of the European and 55% of the world population (UN, 2018).

In Italy, Ministerial Decree 1444/68[1] (Repubblica Italiana, 1968) addressed, but not solved, the problem of urban resident well-being by introducing Urban Standards, e.g. a maximum ratio between spaces used for residential and industrial settlements and other spaces. When urban standards were introduced, Italy was going through a process of intense urban growth aiming to accrue private rents. At the time, they represented an important innovation, shifting the focus from private to social interests, e.g. the need to guarantee public spaces and to build a "sense of citizenship".

In the current scenario, quantitative and restriction approaches such as the one of urban standards are no longer adequate. Complexity of issues asks for new planning instruments, based on a multi-dimensional definition of citizen well-being and paying greater attention to issues such as ecological debt of cities and health conditions of urban residents. Within the urban perimeter of many cities (Hansen et al., 2015) there are still significant green, both agricultural and non-agricultural, areas that fulfil important functions. Open spaces, e.g., as permeable land surfaces, improve resilience in the case of heavy rainfall allowing the natural drainage of water and its filtering. Green spaces, depending on their hosting natural or cultivated vegetation, provide a different mix of services, e.g. biodiversity conservation, provision of recreational and socialization spaces, and even places where urban dwellers can grow food. The potential of open spaces depends both on their specific characteristics and on the relationships - in terms of accessibility, closeness to specific urban context and functions, etc. - that they have with the context where they are located. Although open spaces can be considered as common goods, they are usually regarded as inert surfaces, whose potential or effective roles in providing services are neither understood nor acknowledged.

When dealing with a larger territorial scale, it is necessary to focus on the impacts caused by an urban continuum, i.e. the urban sprawl, that blurs the boundaries between city and countryside in terms of fragmentation of ecological connections,

[1] DM 1444/68 fixed urban standard, e.g fixed a maximum ratio between spaces used for residential and industrial settlements and other spaces, i.e. public spaces or spaces for collective uses, public green spaces, parking places. This resulted in a minimum amount of 18 square meters of public other spaces for each existing or future inhabitant.

increase of environmental costs generated by life-styles and services, etc. (Assennato, 2014).

In conclusion, a shift from the old urban standard approach to new planning approaches taking into account the provision of ESs, may constitute an important innovation in planning and guarantee a higher quality and resilience of urban settlements.

2. State of the art

Since the publication of MEA in 2005 (MEA, 2005) there have been many theoretical and methodological studies on the assessment of ESs, among which The Economics of Ecosystems and Biodiversity by Stanford University (Sukhdev, 2008), World Business Council For Sustainable Development (WBCSD, 2011), UK National Assessment, Ecosystem Services Partnership (ESP), and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), started in 2012 by the United Nations. In the European Union, an ES mapping has been provided by MAES (Mapping and Assessment of Ecosystems and their Services) (Maes et al., 2013) that utilized a Common International Classification of Ecosystem Services (CICES) (Costanza et al., 2014; Haines-Young & Potschin, 2013).

Despite the large scientific production already existing, the debate on how to apply the ES approach, e.g. on the spatial level and on the assessment model to be used, is still open. The main challenges in integrating the concept of ESs and values in landscape planning, management and decision-making have been described by de Grot et al. (de Groot, Alkemade, Braat, Hein, & Willemen, 2010). As regards ES valuing, some researchers focused on monetary methods (Braat & de Groot, 2012; Costanza et al., 1997, 2014), while others have preferred non-monetary evaluations (Kandziora, Burkhard, & Müller, 2013), evaluation by means of aggregate indicators or evaluation of thermodynamic and biophysical type. Usually the final outcome of a monetary evaluation is the Total Economic Value, namely the sum of use and non-use values associated with a resource or an aspect of the environment. However, monetary valuation will always capture only a part of the "true" or total value of an ecosystem or service (de Groot et al., 2010). Monetary evaluations have been used, e.g.: a) to increase the public decision-maker awareness on the environmental costs of anthropic activities; b) to highlight the degree of depletion of natural capital; and c) to verify the possibility of introducing tools for promoting ES provision by agents or territories, as in the case of Payments for Ecosystem Services (PES).

When evaluating ESs, an important aspect is the territorial scale on which one operates. A very large share of ESs is threatened by pressure on various levels, e.g. political, economic, and cultural level. For some ESs, such as climate regulation, the proper reference scale is the global one. Vice versa, when ESs are used for land

planning, many researchers consider an approach taking into account location specificity (MAE, 2005) as more appropriate to highlight significant aspects of ES multifunctionality (Potschin & Haines-Young, 2013). According to Cortinovis and Geneletti (Cortinovis & Geneletti, 2018), a main issue in the operationalization of the ES concept in planning is the one of multifunctionality, since the common assumption is that to each area corresponds one single function, and from this derives the current approach to ecosystem-based actions as solution to specific issues. This conflicts with the multifunctionality of urban green infrastructures. Indeed, these authors stress that, despite the exponentially-growing number of studies on urban ESs, a successful transfer is still lagging behind, and the operationalization of the ES concept is far from being in place.

Considering ES values when drafting planning tools may consent the development of a new vision of the territory where built-up areas complement open spaces, by integrating them into infrastructures and existing networks, with the aim to support and strengthen them. Moreover, a multifunctional approach may improve vertical and horizontal coherence among interventions, in order to promote social interaction, leisure, etc. The above approach is defined as "Rural Urbanism" (Buonanno et al., 2014) and it is based on the presence of a connective fabric made of open spaces; this fabric supports and sustains the city and makes it more sustainable and resilient. On a wider scale, Rural Urbanism may create a stronger relationship between agriculture and city through a design strategy in which agriculture takes a central role inside the processes of enhancement of open spaces. This implies a shift of perspective from the restriction of non-urbanized space consumption, by preventing new urban expansion, to the evaluation of ES provided by open spaces, in order to give them visibility, quality and social and productive values, in alternative to real estate value. According to Magnaghi (Magnaghi, 2013) "in the attempt to requalify structural factors in favour of self-sustainable development, the planning of open spaces assumes an all important role. This is because the process helps to reestablish a relation between the city and the rural world which, in turn, becomes instrumental if the tendency towards the degradation of urban, metropolitan, environmental and landscape systems is to be inverted".

The main challenge of the Rural Urbanism approach is to safeguard unbuilt land and to promote modern projects of environmental enhancement, of conservation and public fruition. Sustainable land management requires "experimental" urban designs based on settlement choices of *densification* that neither increase the urban sprawl nor present the typical characteristics of the compact city that reproduce the classic contrast between city and countryside. The increase of urban density by means of void elimination consents the realization of the so-called "agglomeration economies", e.g. wider distribution of infrastructure fixed costs, reduction of unitary costs, higher density of firms and workers, socio-economic and service qualification, improvement of public transports, energy saving. Nevertheless, densification can result in a further impoverishment of the city itself, as a consequence of the progressive elimination of permeable areas that are a resource to be safeguarded.

In conclusion, urban standards should be innovatively redesigned as flexible and dynamic performance standards, able to reflect evolving human needs. In other words, it is necessary to focus on quality rather than on quantity, e.g. on the immaterial services provided rather than on the physical infrastructures through which they are provided; this for promoting a more rational use of urban space, meeting the social needs of urban residents (Garzarelli, 2014).

In this framework, we present a model of geographic multicriteria analysis (AMC-GIS) for a non-monetary evaluation of ESs provided by open spaces. Thanks to this model it was possible to define the value of some ESs provided by each unit of open space located within an urban context. Aim of the model is to evaluate the opportunity/potentiality/suitability of open spaces, on which tailored strategies for the integration between urban spaces and rural and peri-urban spaces may be based, in order to promote processes of urban regeneration. The model may also be useful for monitoring and improving urban planning schemes and projects, which are already in the process of implementation.

2. Methodology

Most of the services and benefits provided by open spaces are not exchanged on markets and, as such, they are difficult to be evaluated in monetary terms. Besides, the value of an ES is strongly dependent on the relations it has with the space and context where it is produced. The model presented in this chapter, unlike other studies dealing with ESs in planning, e.g. LIFE-SAM4CP project (Giaimo, Regis, & Salata, 2016), uses a spatial non-monetary approach based on Geographic Multicriteria Aiding Techniques (GIS-MCA), ranking spatial alternatives according to their specific and often conflicting evaluation criteria, represented by standardized map layers (Malczewski, 1999, 2006a, 2006b; Malczewski and Rinner, 2015). MCA techniques consider an area as homogeneous and use a single value, usually either the average or the sum, to describe the impacts caused by a transformation. However, the hypothesis of invariance in space of criteria value is scarcely realistic. Through the integration of MCA and GIS it is possible to build models of spatialized MCA based on small units, as the one that we propose, taking into account the variability of values in space.

Among the several multicriteria analysis techniques available (Beinat & Nijkamp, 1998; Malczewski & Rinner, 2015; Roy, 1996) the Saaty's Analytic Hierarchy Process (AHP) has been chosen (Saaty, 1980) since it allows to segment a complex decision-making problem into smaller and simpler sub-problems composing a hierarchical structure, within which it is always possible to measure the influence each part has on the whole system. Moreover, there are a number of studies demonstrating the process of hierarchical structuring of spatial decision problems using the concept of AHP in GIS-MCDA. The hierarchical structure is organized in three levels, namely goals, criteria, and alternatives. Criteria are described through

attributes and sub-attributes, in order to reach elementary indices represented by cardinal or ordinal values that can be reliably measured or assessed (Malczewski & Rinner, 2015; Rovai & Andreoli, 2018).

In this model, criteria represent the three categories into which ESs are classified by CICES (Haines-Young & Potschin, 2013), namely productive, protective and recreational-cultural ESs. Attributes characterizing each criterion were chosen based on literature, previous researches, specific features of the case-study area and spatial data availability. Alternatives are spatial and are represented by units which contain the attribute values.

The following Fig. #1 describes in detail the steps of the assessment of ESs.

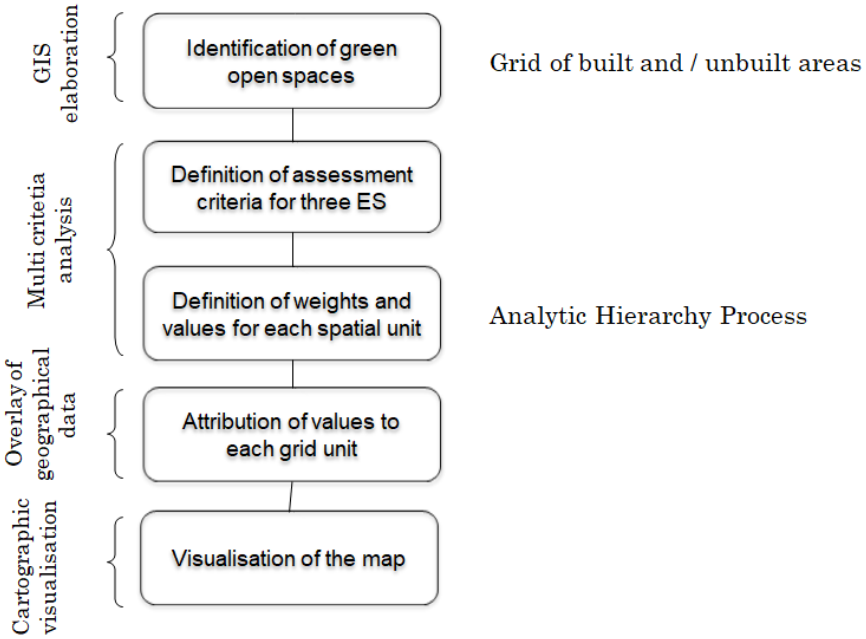

Fig. #1 – Steps in the assessment of Ecosystem Services provided by open spaces and land-locked areas.

In the first step of the analysis (see Fig. #1), the identification of urban and peri-urban green open spaces has been carried out by superimposing a regular grid to the Regional Technical Map (CTR) at a scale of 1:10,000 and to aerial photographs. Three grids have been tested, namely 180x180 m, 60x60 m and 30x30 m, among which the smaller was chosen to allow greater detail (Fig. #2). For each unit, represented by a square of the 30x30 m grid, built-up areas have been measured both in terms of surface and in terms of share on the total area. The units characterized by a share of built-up areas higher than 30% have been considered as “built-up areas” and discarded as well as clusters smaller than 5 squares, i.e. 4.500 square meters.

Attributes have been based on the information gathered from "GEOscopio"[2] geoportal, a webGIS tool that allows accessing, querying and displaying geographical data about Tuscany (Italy). From GEOscopio one may access the Regional Technical Map (CTR), aerial photos starting from 1954 and maps about several themes that are relevant for planning.

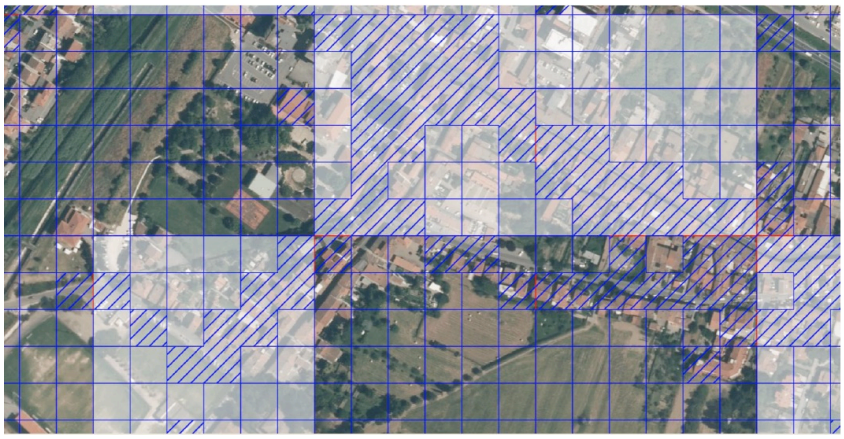

Fig. #2 – Identification of urban and peri-urban green open spaces

In the next step, for each criterion related to an ES category, the attributes characterizing it have been defined. These attributes are described in Fig. #3 and in the following paragraphs.

Productive services include ESs related to open space capacity to produce agricultural and food goods, and thus are mainly related to the production of an economic value. Attributes included in this criterion are the following: a) land suitability for cultivation; b) type of management, i.e. professional, semi-professional, hobby, abandonment, and c) crop category.

Protective services are mainly related to open space capacity to ensure the conservation and reproduction of environmental and ecological resources. This criterion has been described through the following attributes: a) soil permeability and groundwater recharge capacity; b) habitat maintenance and protection; and c) ecological connectivity.

Recreational-cultural services are mainly related to the capacity of a natural and rural context to contribute to the psychological and physical well-being of inhabitants. The relevant attributes for this criterion are the following: a) distance from areas characterized by high population density, that gives an estimate of people who can benefit from these ESs; b) distance from environmental detractors, whose presence and closeness decrease the value of other positive ESs; c) persistence of

[2] http://www.regione.toscana.it/-/geoscopio

elements and structures of the historical agrarian fabric, e.g. dense road and water distribution networks, tree rows, small plot size, etc. and, d) panoramic view from walking and cycling paths, mainly related to landscape fruition.

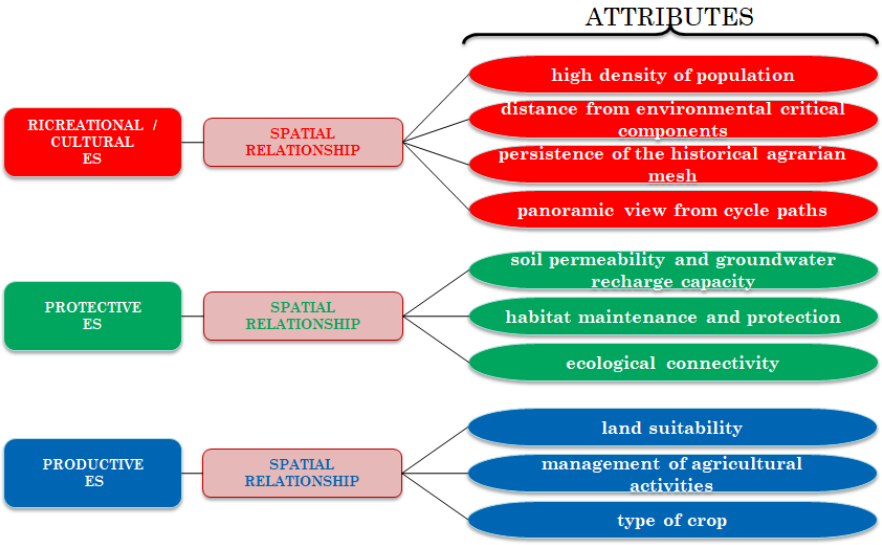

Fig. #3 – Criteria and attributes for the assessment of Ecosystem Services provided by urban and peri-urban green open spaces

Some of the attributes have been built on the base of sub-attributes, as in the case of "environmental detractors" attribute, that takes into account the presence of motorways, highways, airports, railways, disposal installations, commercial zones, industrial zones, parking places and landfill of waste.

Criteria and attributes have been evaluated through pair-wise comparison and standardized according to the Analytic Hierarchy Process method, by implementing the following steps:

a) Hierarchical segmentation of the problem, where the classification of ESs into categories (criteria) and the attributes through which they are assessed have been decided (see Fig. #3);

a) Pair-wise comparison by using the method of "paired comparison technique". In this preliminary test, pair-wise comparison has been performed by interviewing a panel of experts, including some of the authors and their fellow researchers. Attribute scores have been normalized to a 0-1 range using linear transformation;

b) Consistency analysis with the aim of verifying that evaluations are consistent;

c) Hierarchical recomposition of attributes. In this step a value for each attribute was assigned to each 30x30 m unit;

d) Computation of criterion values. The total score for each criterion was computed as a weighted sum of the scores assigned to each attribute (see step d) characterizing that criterion. Weights have been obtained by pairwise comparison involving the same group of experts;
e) Spatial representation on maps of the values attributed to ESs.

The vector grid was overlapped to the data about attributes used to define the three ES categories and evaluated by using information taken from topographic databases. Each unit or cell inherited, for each of the "n" characteristics describing each attribute, the value computed through the Analytic Hierarchy Process.

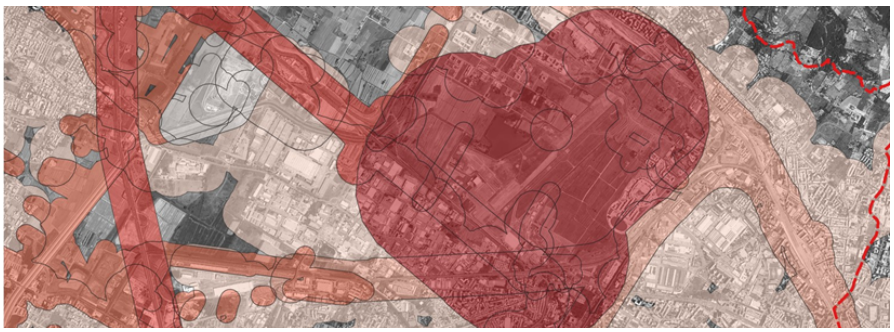

Fig. #4 – Recreational-Cultural Criterion. Extract from the map of the value of environmental detractors located on the area under analysis

Fig. #4 represents the spatial distribution of one of the attributes belonging to recreational-cultural ESs, namely "Environmental detractors". This attribute describes the reduction in value open spaces suffer when they are located in proximity of an infrastructure, such as a major road or an airport, having negative effects in terms of visual impacts, emissions and noise. The methodology for assessing the value of this attribute required the assignment of weights to all the type of detractors by means of a pairwise comparison, and the definition of the zone within which open spaces are negatively affected by each environmental detractor. Darker red shadows in Fig. #4 identify the areas where open spaces are mostly suffering for the presence of detractors. Since this attribute represents a "cost" or "negative effect" for society, when producing the aggregate map of recreational-cultural ESs provided by open spaces, it has been normalized according to an inverse scale.

Then, for each ES criterion attribute values were aggregated according to the scheme described in Fig. #3. Tab. #1 shows the weight used to compute criteria value.

Each aggregated value represents the capacity of each land unit to provide a specific ES. In order to avoid the ambiguity that may result from adding very heterogeneous services, authors decided not to sum up the values of the three criteria. Indeed, the total value of all the ESs provided may not be able to highlight in a proper way the role of some ESs in specific spatial areas. Moreover, a mono-dimensional gradient of ES provision might even be wrongly interpreted as an inverse

indicator of artificialization suitability. For the above reasons, the authors propose as the final step of the analysis a map providing a three-dimensional evaluation of ES categories. This map describes the mix of main functions provided by each unbuilt cell belonging to the case-study area.

Table #.1. Weight used to compute criteria values starting from attribute values

Criterion	Attribute	Weight
Productive ESs	Land suitability for cultivation	0.50
	Type of management	0.30
	Crop category	0.20
Protective ESs	Soil permeability and groundwater recharge capacity	0.25
	Habitat maintenance and protection	0.25
	Ecological connectivity	0.50
Cultural-recreational ESs	Distance from highly populated areas	0.25
	Distance from environmental detractors	0.25
	Persistence of the historical agrarian fabric	0.25
	Panoramic view from walking and cycling paths	0.25

The three-dimensional evaluation has been obtained by using a chromatic gradient with three components built through the integration of the RGB channels of a 24-bit image. In other words, the values of the maps describing each ES category, after being standardized into a 0-256 gradient, have been utilized as channel of an RGB image, where red represents recreational-cultural services, green protective services and blue productive services (see Fig. #5).

The proposed model has been tested on some areas located in the Tuscany Region (Italy). Although the results are only preliminary and further research and tests should be carried out, the authors deem the model they propose to be an innovative and potentially useful tool for integrating ESs in planning. Some of the results are presented and discussed in the next section.

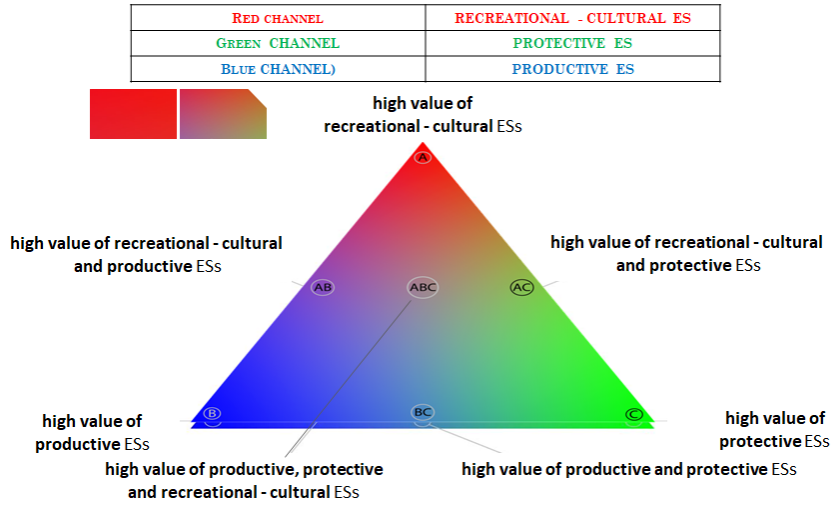

Fig. #5– Explanation of the chromatic representation of the three Ecosystem Service categories

3. Case study. Description, results and discussion of preliminary tests

3.1 Case-study area description

As case-study area has been chosen the Florence-Prato valley, namely an intermontane basin of alluvial origin that is surrounded by a range of hills with an extraordinary value in naturalistic, agricultural, and landscape terms. This territory was deemed as highly suitable for testing our model since it was shaped by significant, both synergic and conflictual, interactions between modernization trends and the permanence of historical roots and geophysical features, interactions that resulted in very complex settlement patterns, characterized by intense fragmentation.

Aerial photographs from 1954 show a well-balanced agricultural landscape, marked by easily recognised typical elements. In the following years, the urban expansion surrounded in a compact way major and minor historical centres, although at different times and with different intensity. Then urban areas expanded more and more up to give raise to two big conurbations, the first one to the north, the second one to the south. Besides, many significant linear settlements arose at the sides of

the main road networks, while smaller ones developed alongside historical roads (Paba, Perrone, Lucchesi & Zetti, 2017) (Rossi & Zetti, 2018). This urban expansion brought about a new residential fabric with wide meshes and varying density, which has deeply transformed the old settlement pattern. Many industrial plants, storage facilities and commercial activities were then born, creating a new productive fabric (Regione Toscana, 2015) (Zetti, 2013). Moreover, the case-study area was interested by a progressive increase of several types of infrastructures such as linear transport infrastructures (e.g. A1/E35 motorway, railways, etc.), energy infrastructures, airport infrastructures, that taken together resulted in a very high infrastructure density.

In summary, the case-study area was affected by intense processes of soil consumption that have especially influenced rural landscape of lowlands, and caused: a) fragmentation of the agricultural fabric; b) marginalization of agriculture; c) depletion of landscape characteristic elements such as historic drainage systems, minor road networks and tree lined roads; and d) loss of habitats and species typical of lowland agricultural areas (Regione Toscana, 2015).

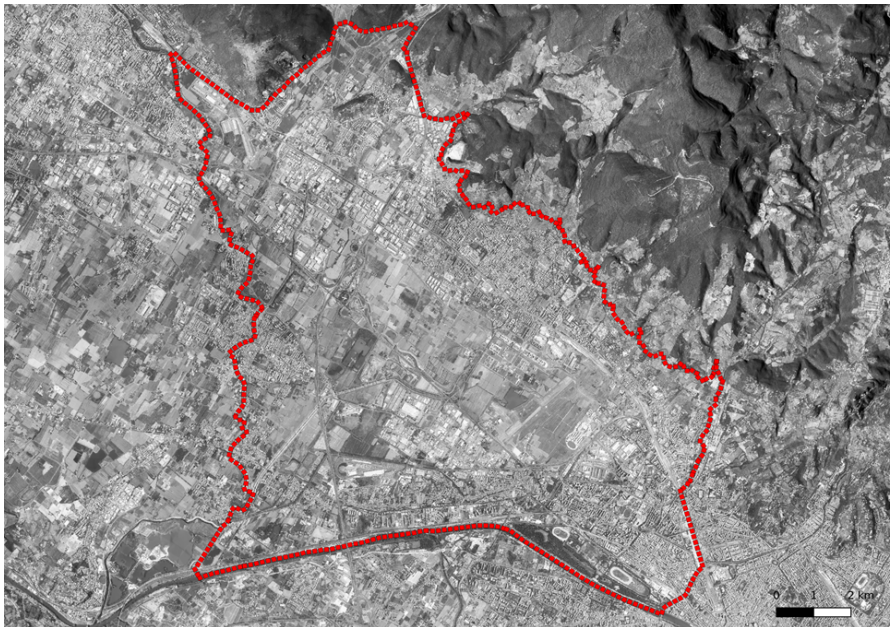

Fig. #6 – Map of the case-study area

The evaluation of ES provision focused on the area described in Fig. #6, which was delimited on the base of aims and parameters characterizing the research project, rather than on the base of administrative boundaries. The area is bounded, on the south by Arno river, on the north by the foot of the surrounding hills, on the west by Bisenzio river and on the east by the consolidate part of Florence city. Seven municipalities are partly included in the case-study area; Florence, Sesto Fiorentino,

Calenzano and Campi Bisenzio with a significant share of their total surface, while Prato, Scandicci and Signa only with a low share. The case-study area has a size of 6,800 hectares, 3,053 of which - accounting for 45% - are built-up areas, i.e. areas covered by some sort of artificial element. Unbuilt areas are heavily fragmented and have surfaces going from a few thousand square meters to more than 500 hectares, as in the case of the central part of the case-study area, which is intercluded among motorways, airport and main cities on the northern side.

3.2 Case-study results and discussion

The final outcome of the research is a map (see Fig. #7) obtained by overlapping the maps related to the three ES categories according to the chromatic gradient described in Fig. #5. This map, in the authors' opinion, describes and visually represents the specific functions provided by the open spaces located inside the case-study area. Fig. #7 should be interpreted as a description of the spatial distribution, rather than of the intensity, of the three categories of ESs provided by open spaces.

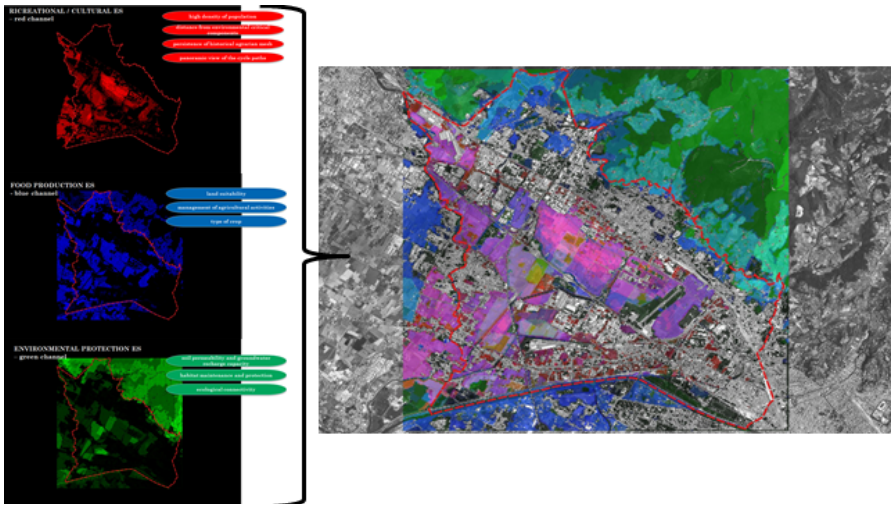

Fig. #7 – Map of Ecosystem Services mix provided by each spatial unit of the case-study area

Fig. #7 shows that in the central part of the case-study area there is a prevalence of open spaces providing both recreational-cultural and productive ESs, with an increase of productive in respect to recreational-cultural functions when moving from north-east to south-west. This area represents a sort of central island that is fundamental in ensuring the resilience of the whole territory and as such, it is suited to the creation of an agricultural park. The north-western part is characterized by the

presence of many small islands survived to the urban sprawl, which have mainly a productive function and are usually characterized by the presence of olive groves and vegetable orchards.

The above short considerations arise from a general analysis of Fig. #7 but, if zooming on specific locations and focusing on specific functions, the map is able to provide for each specific area a deeper knowledge on which tailored interventions may be based.

In conclusion, although the model needs further research, refinement and tests, in the authors' opinion preliminary results show that it has the potential to produce maps able to accommodate open spaces multifunctionality and to provide decision-makers with a useful knowledge framework for planning and design decisions, with the aim to go beyond or at least to complement the approach of urban standards. Indeed, as Pulighe et al (Pulighe, Fava, & Lupia, 2016) argue, mapping ecosystem services would allow urban designers and planning practitioners to help and inform policymakers during the decision process and management of urban landscapes.

The case study focused on three categories of ESs in order to test and calibrate the model in terms of interpretation and evaluation and the results where shortly described only in terms of criteria. Nevertheless, in practical applications, the analysis could be organized to provide additional and more detailed information.

ES spatial analysis may represent a support for a better localization of policy interventions, such as agricultural aid, programmes for the conservation and enhancement of ecological connectivity, actions for the promotion of the social and cultural role of rural spaces, aiming to enhance open spaces and the functions they provide. In summary, unbuilt land should be considered as an active subject in the production of well-being and not as a void inert space. Indeed, in the authors' opinion, planning can no longer neglect the role of unbuilt areas, either if currently abandoned and going through renaturalization processes.

4. Conclusion

The Ecosystem Service approach makes apparent the fundamental role that open spaces play in providing functions and services useful for city sustainability and resilience and the consequent need for policies aiming to open space safeguard and enhancement.

Starting from the debate on the effectiveness of urban standards in ensuring population well-being, this study has tried to evaluate the suitability of ES assessment as an approach to go beyond, or at least to complement, the current use of urban standards in planning. Urban standards state only a minimum ratio between residential and industrial areas and other areas and, as such, consider a parking place or a public park as having the same effect on resident well-being. In the authors' opinion, a planning approach that do not consider open space features and spatial relationship with built-up area, may no longer be considered as adequate. The model

may overturn the current approach to counteract soil consumption, based on standards and constraints, by emphasizing the multifunctional role of open spaces and contribute to slow down urban sprawl and to prevent agricultural land abandonment.

The innovativeness of the proposed spatial multicriteria model lays in a representation of open space multifunctionality, that do not requires monetary evaluation and the definition of trade-off among Ecosystem Services, as in the case of additive methods. Although the model is still experimental and needs further testing and refinements, it nevertheless allowed the authors to:

- Represent spatially located results with the aim to provide an immediate and intuitive picture of the ES evaluation;
- Identify areas with minor or major suitability/capability to provide Ecosystem Services and the areas that demand for urgent interventions in terms of conservation, redevelopment, etc.

Moreover, it allows conducting scenario analyses, by changing weights given to attributes according to stakeholders' demands.

Thanks to the spatial analysis of area suitability in providing Ecosystem Services, the proposed model may represent an important decision-aid tool: a) when planning the introduction or the implementation of integrated environmental and territorial policies or b) to steer public–private partnerships, e.g. among farmers and public administrations, in order to reproduce and enhance ES provision at local level.

The model is an attempt to innovate planning approaches and instruments by introducing systems that may evaluate the opportunities/capabilities/suitability of open agricultural and non-agricultural spaces and assess specific intervention strategies between peri-urban rural spaces and urban spaces, with a view to urban regeneration. The aim is to promote the coexistence and synergy between urban functions and rural functions, thus ensuring the provision of ecosystem services that are critical for urban dweller well-being.

Results highlight the high value of a mapping technique based on the above described principles in terms not only of ex-ante evaluation of planning choices, but also as a monitoring tool for planning instruments that are already underway, in order to adequately correct urban designs, when necessary.

5. References

Assennato F. (2014). Consumo di suolo, servizi ecosistemici e resilienza: un quadro da comporre nella pratica. VIII Giornata di Studi INU "Una politica per le città italiane". Napoli, 12-13 Dicembre 2014. http://www.inu.it/convegni-nazionali-2/viii-giornata-di-studi-inu-una-politica-per-le-citta-italiane/

Beinat, E., & Nijkamp, P. (Eds.). (1998). Multicriteria analysis for land-use management. Dordrecht; Boston, Mass.: Kluwer Academic Publishers.

Braat, L. C., & de Groot, R. (2012). The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and

public and private policy. Ecosystem Services, 1(1), 4–15. http://doi.org/10.1016/j.ecoser.2012.07.011

Buonanno D., Terracciano A. (2014). Ruralurbanism. Una visione per la città diffusa. VIII Giornata di Studi INU "Una politica per le città italiane". Napoli, 12-13 Dicembre 2014. http://www.inu.it/convegni-nazionali-2/viii-giornata-di-studi-inu-una-politica-per-le-citta-italiane/

Cortinovis, C., & Geneletti, D. (2018). Ecosystem services in urban plans: What is there, and what is still needed for better decisions. Land Use Policy, 70 (November 2017), 298–312. https://doi.org/10.1016/j.landusepol.2017.10.017

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. Nature.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Turner, R. K. (2014). Changes in the global value of ecosystem services. Global Environmental Change. http://doi.org/10.1016/j.gloenvcha.2014.04.002

de Groot, R. S., Alkemade, R., Braat, L., Hein, L., & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecological Complexity, 7(3), 260–272. https://doi.org/10.1016/j.ecocom.2009.10.006

Development, W. B. C. F. S. (2011). Guide to Corporate Ecosystem Valuation About the World Business Council for Sustainable Development (WBCSD). Inform.

European Environment Agency (EEA) (2016a). Soil resource efficiency in urbanised areas. Analytical framework and implications for governance, Report n 7/2016 retrieved from https://www.eea.europa.eu/publications/soil-resource-efficiency.

European Environment Agency (EEA) (2016b). Urban sprawl in Europe Joint EEA-FOEN report. Report n 11/2016 retrieved from https://www.eea.europa.eu/publications/urban-sprawl-in-europe.

Garzarelli F. (2014). Verso una riconfigurazione qualitativa-prestazionale delle dotazioni territoriali. Una possibile reinterpretazione della città esistente. VIII Giornata di Studi INU "Una politica per le città italiane". Napoli, 12-13 Dicembre 2014. http://www.inu.it/convegni-nazionali-2/viii-giornata-di-studi-inu-una-politica-per-le-citta-italiane/.

Giaimo C., Regis, D., & Salata, S. (2016). Ecosystem services and urban planning. NEWDIST.

Haines-Young, R., & Potschin M. (2013). International Classification of Ecosystem Services (CICES). Report to the European Environment Agency. http://doi.org/10.1038/nature10650.

Hansen, R., Frantzeskaki, N., McPhearson, T., Rall, E., Kabisch, N., Kaczorowska, A., … Pauleit, S. (2015). The uptake of the ecosystem services concept in planning discourses of European and American cities. Ecosystem Services, 12, 228–246. https://doi.org/10.1016/j.ecoser.2014.11.013

Kandziora M., Burkhard B., & Müller, F. (2013). Mapping provisioning ecosystem services at the local scale using data of varying spatial and temporal resolution. Ecosystem Services. http://doi.org/10.1016/j.ecoser.2013.04.001.

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., … Bidoglio, G. (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Brussels: Publications office of the European Union, Luxembourg. Retrieved from http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

Magnaghi, A. (2013). The Role of Historical Rural Landscapes in Territorial Planning. In M. Agnoletti (Ed.) Italian Historical Rural Landscapes. Cultural Values for the Environment and Rural Development (pp. 131–139). Springer. https://doi.org/10.1007/978-94-007-5354-9_3

Malczewski, J. (1999). GIS and multicriteria decision analysis. John Wiley & Sons. Apr 5. 1999. Science. 392 pages.

Malczewski, J., (2006a). GIS-based multicriteria decision analysis: a survey of the literature. International Journal of Geographical Information Science, 20(7), pp.703–726. Available at: http://www.tandfonline.com/doi/abs/10.1080/13658810600661508.

Malczewski, J., (2006b). Ordered weighted averaging with fuzzy quantifiers: GIS-based multicriteria evaluation for land-use suitability analysis. International Journal of Applied Earth Observation and Geoinformation. 8(4). pp. 270 - 277.

Malczewski J. & Rinner C. (2015). Multicriteria Decision Analysis in Geo-graphic Information Science. Springer, Berlin, Heidelberg. http://doi.org/https://doi.org/10.1007/978-3-540-74757-4.

Millenium Ecosystem Assessment. (2005). Ecosystem and Human Well-Being: Synthesis. Island Press, 1–59. http://doi.org/http.//www.maweb.org/.

Paba, G., Perrone, C, Lucchesi, F., & Zetti, I., (2017). Territory matters. A re-gional portrait of Florence and Tuscany. In: Balducci, A., Fedeli, V., Curci, F. (eds). Post-Metropolitan Territories: Looking for a New Urban-ity, Routledge Advances in Regional Economics, Science and Policy, vol. 21, Routledge, Oxon.

Potschin, M., & Haines-Young, R. (2013). Landscapes, sustainability and the place-based analysis of ecosystem services. Landscape Ecology. https://doi.org/10.1007/s10980-012-9756-x

Pulighe, G., Fava, F., & Lupia, F. (2016). Insights and opportunities from mapping ecosystem services of urban green spaces and potentials in planning. Ecosystem Services, 22, 1–10. https://doi.org/10.1016/j.ecoser.2016.09.004

Regione Toscana (2015). Piano di indirizzo territoriale con valenza di piano paesaggistico, (in Italian) retrieved from http://www.regione.toscana.it/enti-e-associazioni/pianificazione-e-paesaggio.

Repubblica Italiana, Decreto Ministeriale 2 aprile 1968, n. 1444, G.U. 16 aprile 1968, n. 97 (in Italian), retrieved from: http://www.camera.it/temiap/2014/12/09/OCD177-705.pdf

Rossi, M., & Zetti, I. (2018). In mezzo alle cose. Città e spazi interclusi. Dip. di Architettura (Firenze).

Rovai M., Andreoli M. (2018). Integrating AHP and GIS Techniques for Rural Landscape and Agricultural Activities Planning. Multiple Criteria Decision Making, in Berbel, J., Bournaris, T., Manos, B., Matsatsinis, N., & Viaggi, D. (eds) Multicriteria Analysis in Agricolture. Current Trends and Recent Applications, Springer

Roy, B. (1996). Multicriteria Methodology for Decision Aiding (Vol. 12). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4757-2500-1

Saaty, T.L., (1980). The Analytic Hierarchy Process. Education, pp.1–11. Available at: http://www.mendeley.com/research/the-analytic-hierarchy-process/.

Sukhdev, P. (2008). The economics of ecosystems and biodiversity: an interim report. European Communities. http://doi.org/10.1093/erae/jbr052

World Business Council for Sustainable Development (WBCSD). (2011). Guide to Corporate Ecosystem Valuation: A Framework for Improving Corporate Decision-making. World Business Council for Sustainable Development.

Zetti, I., (2013). Campagna Urbanizzata or Sprawl? Images from the Florentine Conurbation. In: Living Landscapes - Landscapes for living, Firenze, Febbraio - Giugno 2012, Planum Association - The Journal of Urbanism - ISSN 1723-0993, vol. 2/2013, pp. 5-13.