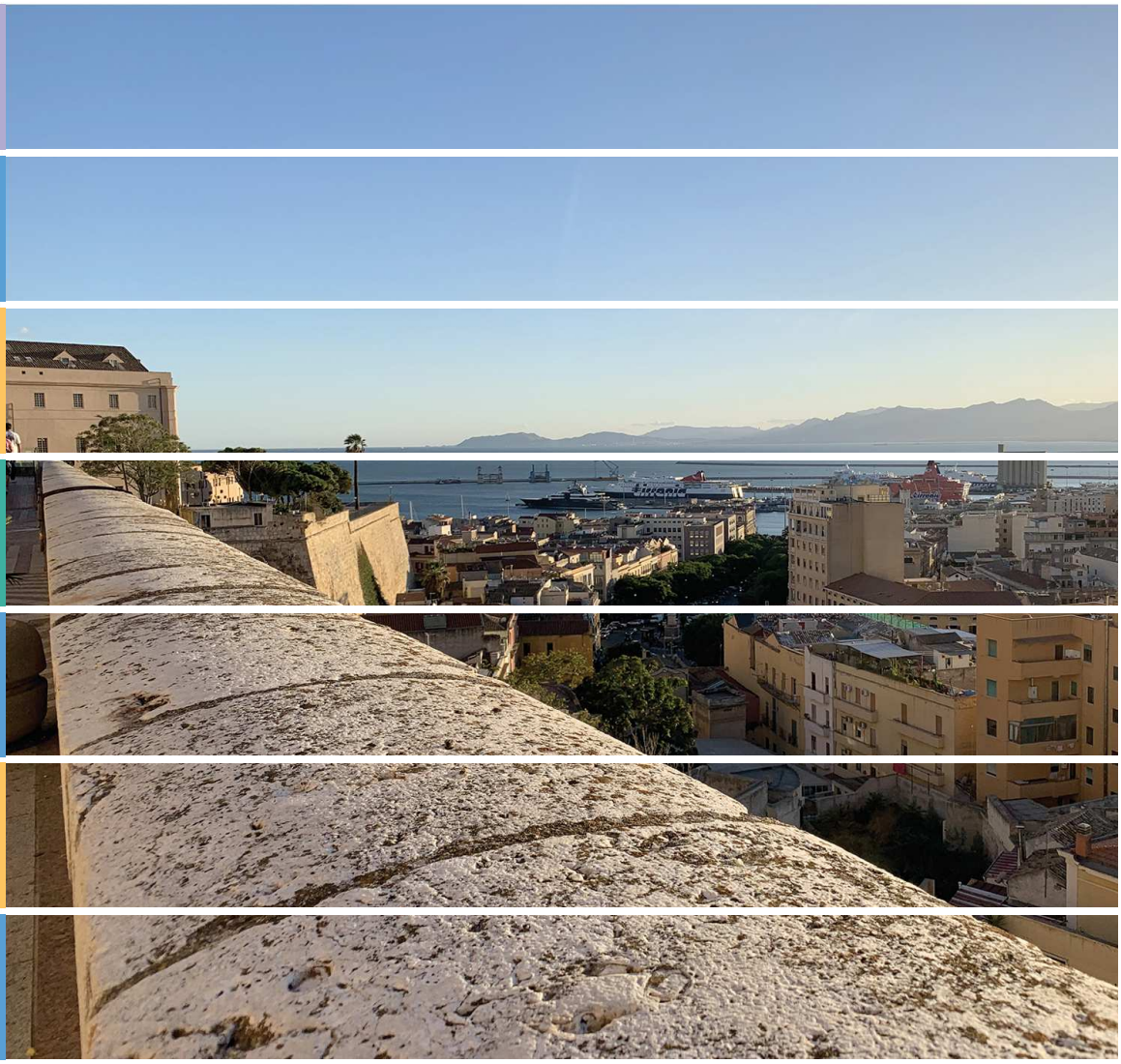
Carmela Gargiulo Corrado Zoppi
Editors

Planning, Nature and Ecosystem Services



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Università degli Studi di Napoli Federico II
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Smart City, Urban Planning for a Sustainable Future

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Carmela Gargiulo Corrado Zoppi

Editors

Planning, Nature and Ecosystem Services

INPUT aCAdemy 2019

Conference proceedings

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This book collects the papers presented at INPUT aCAdemy 2019, a special edition of the INPUT Conference hosted by the Department of Civil and Environmental Engineering, and Architecture (DICAAR) of the University of Cagliari.

INPUT aCAdemy Conference will focus on contemporary planning issues with particular attention to ecosystem services, green and blue infrastructure and governance and management of Natura 2000 sites and coastal marine areas.

INPUT aCAdemy 2019 is organized within the GIREPAM Project (Integrated Management of Ecological Networks through Parks and Marine Areas), co-funded by the European Regional Development Fund (ERDF) in relation to the 2014-2020 Interreg Italy – France (Maritime) Programme.

INPUT aCAdemy 2019 is supported by Società Italiana degli Urbanisti (SIU, the Italian Society of Spatial Planners), Istituto Nazionale di Urbanistica (INU, the Italian National Institute of Urban Planning), UrbIng Ricerca Scientifica (the Association of Spatial Planning Scholars of the Italian Schools of Engineering) and Ordine degli Ingegneri di Cagliari (OIC, Professional Association of Engineers of Cagliari).

This book is the most recent scientific contribution of the "Smart City, Urban Planning for a Sustainable Future" Book Series, dedicated to the collection of research e-books, published by FedOAPress - Federico II Open Access University Press. The volume contains the scientific contributions presented at the INPUT aCAdemy 2019 Conference. In detail, this publication, including 92 papers grouped in 11 sessions, for a total of 1056 pages, has been edited by some members of the Editorial Staff of "TeMA Journal", here listed in alphabetical order:

- Rosaria Battarra;
- Gerardo Carpentieri;
- Federica Gaglione;
- Carmen Guida;
- Rosa Morosini;
- Floriana Zucaro.

The most heartfelt thanks go to these young and more experienced colleagues for the hard work done in these months. A final word of thanks goes to Professor Roberto Delle Donne, Director of the CAB - Center for Libraries "Roberto Pettorino" of the University of Naples Federico II, for his active availability and the constant support also shown in this last publication.

Rocco Papa
Editor of the Smart City, Urban Planning for a Sustainable Future" Book Series
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INTRODUCTION

This e-book contains the Proceedings of the INPUT aCAdemy 2019 Conference held at the University of Cagliari on 24-26 June 2019, titled "Planning, nature and ecosystem services."
Input aCAdemy follows the tenth INPUT Conference, held in September 2018 at Tuscia University, in Viterbo and, in some way, it breaks the biennial tradition of the INPUT Conferences. The reason for the frequency increase of the INPUT Conferences is that the Department of Civil and Environmental Engineering and Architecture of the University of Cagliari is involved in a project funded by the Programme INTERREG Marittimo–Italia France–Maritime 2014–2020, Axis 2.
In the context of the project, entitled "GIREPAM–Integrated Management of Ecological Networks through Parks and Marine Areas", the Department and the Office for Nature Protection and forest policies of the Regional Autonomous Administration of Sardinia are studying and defining an experimental methodology to integrate conservation measures concerning Natura 2000 Sites into marine protected areas regulations. The methodology is implemented to build the new regulations of two marine protected areas of Sardinia, namely the Island of Asinara and of the Island of Tavolara and Cape Coda Cavallo.
Since GIREPAM allocates a considerable amount of funds to the organization of an international conference on protection of nature and natural resources, ecosystem services and their relationship with spatial planning processes and practices, green infrastructure, and integrated management of protected areas and Natura 2000 Sites, and these funds must be spent by December 2019, the research group at the Department proposed to the INPUT Community, during the 2018 Viterbo Conference, a 2019 INPUT Conference focussing on these themes. The INPUT Community responded enthusiastically and, that being so, the research group has made every effort to make the event come true.
The Conference develops through plenary sessions and parallel tracks. The scope of the plenary sessions is to propose distinguished points of view concerning research and implied planning ideas and policies on important and significant issues which feature the ongoing scientific and technical debate on nature and natural resources.
The questions proposed and discussed in the Conference are three central topics which are characterized by several studies available in contemporary literature, and by vibrant debates as well, both from the theoretical and technical points of view. These questions are presented and discussed in the three plenary sessions which are the starting points of the three days of the Conference. Each plenary session is organized as follows: first, a speaker, a distinguished scholar, proposes the findings of his theoretical and/or applied research work and derived implications for spatial policy; secondly, a discussant, a distinguished

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scholar as well, critically analyzes the positions expressed in the first place and identifies open or unresolved questions and outstanding issues; thirdly, the public enters the discussion, through questions, observations, critical positions. Finally, the speaker replies to the discussant's and to the public's statements.

The first plenary session is on "Valuing ecosystem services in money: A necessary evil for protecting biodiversity?"; the speaker is Erik Gomez-Baggethun (Faculty of Landscape and Society, Norwegian University of Life Sciences); the discussant is Andrea Arcidiacono (Department of Architecture and Urban Studies, Polytechnic University of Milan).

The second plenary session concerns "Managing urban ecosystems for goods and services"; the speaker is Kevin Gaston (Environment and Sustainability Institute, University of Exeter); the discussant is Bernardino Romano (Department of Civil, Building-Architecture and Environmental Engineering, University of L'Aquila).

The third plenary session is related to "Mapping and modeling ecosystem services: A cascade ES modeling approach applied to the Flemish Natura 2000 Network"; the speaker is Jan Staes (Department of Biology, University of Antwerp); the discussant is Beniamino Murgante (School of Engineering, University of Basilicata at Potenza).

The topics presented in the plenary sessions are the background of the discussions which characterize the parallel tracks. These tracks are featured by studies which consider protection of nature and natural resources, ecosystem services and their relationship with spatial planning processes and practices, as regards the following topics:

1. Ecosystem services and spatial planning;
2. Integrated management of marine protected areas and Natura 2000 sites;
3. Rural development and conservation of nature and natural resources;
4. Geodesign, planning and urban regeneration;
5. Green and blue infrastructure;
6. Smart city planning;
7. Water resources planning, ecosystem services and nature-based solutions in spatial planning;
8. Conservation and valorisation of architectural and cultural heritage;
9. Accessibility, mobility and spatial planning;
10. Tourism and sustainability in the Sulcis area;
11. Ecological networks and landscape planning.

The closing plenary session of the Conference proposes a roundtable discussion on "Planning Nature 2000 Network and protected areas: The integration of conservation measures into regulations." The roundtable will involve panelists from several institutions who participate in the GIREPAM Project.

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Carmela Gargiulo is full professor of Urban Planning Techniques at the University of Naples Federico II. Since 1987 she has been involved in studies on the management of urban and territorial transformations. Since 2004, she has been Member of the Researcher Doctorate in Hydraulic, Transport and Territorial Systems Engineering of the University of Naples "Federico II". She is Member of the Committee of the Civil, Architectural and Environmental Engineering Department of the University of Naples "Federico II". Her research interests focus on the processes of urban requalification, on relationships between urban transformations and mobility, and on the estate exploitation produced by urban transformations. On these subjects she has co-ordinated research teams within National Project such as Progetto Finalizzato Edilizia - Sottoprogetto "Processi e procedure" (Targeted Project on Building – Subproject "Processes and procedures), from 1992 to 1994; Progetto Strategico Aree Metropolitane e Ambiente, (Strategic Project Metropolitan Areas and Environment) from 1994 to 1995; PRIN project on the "Impacts of mobility policies on urban transformability, environment and property market" from 2011 to 2013. Principal investigator of the Project Smart Energy Master for the energy management of territory financed by PON 04A2_00120 R&C Axis II, from 2012 to 2015. Scientific Responsible Unit Dicea Project by Fondazione Cariplo "MOBILAGE. Mobility and aging: daily life and welfare supportive networks at the neighborhood level" 2018-2020. Scientific Responsible Unit TeMALab Dicea ERASMUS+ Key Action2: Project "Development of a Master Programme in the Management of Industrial Entrepreneurship for Transition Countries" (MIETC), partners: University of Santiago de Compostela (leading organization), University of Ljubljana, Academy of Science of Turkmenistan, Karaganda Economic University of Kazpotrebsouz (2020-2022). Author of more than 130 publications. Since 2008 Associate Editor of TeMA Journal of Land Use, Mobility and Environment.

Corrado Zoppi, Civil engineer, is Doctor of Philosophy in Economics (Northeastern University, Boston, Massachusetts, United States, 1997), Doctor of Research in Territorial Planning (University of Reggio Calabria, 1992), and Master of Science in Economic Policy and Planning (Northeastern University, 1990). Since October I 2015 he is Professor (Full Professor, Scientific Disciplinary Sector ICAR/20 Urban and Regional Technique and Planning)) at the Department of Civil, Environmental Engineering and Architecture. In the past, he taught at the Faculty of Engineering of the University of Cagliari, and at the Faculties of Architecture of the Universities of Rome "La Sapienza" and Sassari-Alghero. He is presently the Official Professor of the Module of Strategic Planning of the Integrated Course of Strategic Environmental Planning and of the Course of Regional and Urban Planning at the Faculty of Engineering of the University of Cagliari, and the Coordinator of the Undergraduate and Magisterial Degree Programs at the Faculty of Engineering and Architecture of the University of Cagliari. He was the Coordinator of the Panel for the Assessment and Evaluation of Public Investments of the Sardinian Regional Administration in the period 2007-2013. He was the Coordinator of the Graduate Committee of Environmental and Territorial Engineering of the University of Cagliari in the period 2012-2015. He is the President of the Faculty Committee of Engineering and Architecture of the University of Cagliari.

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MUNICIPAL MASTERPLANS AND GREEN INFRASTRUCTURE

AN ASSESSMENT RELATED TO THE METROPOLITAN AREA OF CAGLIARI, ITALY

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ABSTRACT

Recent research has proposed a GIS-based methodology to map a regional green infrastructure (RGI) by assessing patches' suitability to be included in the RGI on the basis of four components as follows: natural value, conservation value, landscape value, and recreational value. This study builds upon such research with the aim to identify planning policies that can foster the enhancement of the RGI by increasing one or more of its components at the sub-regional scale. To this end, the RGI suitability map is overlaid with the planning schemes of the municipal master plans of three towns belonging to the Metropolitan City of Cagliari (Italy), and multiple linear regressions are performed. Results from this analysis show to which extent the zoning types identified in the city masterplan are related to high or low RGI suitability values, hence allowing for detecting those zoning types that should be targeted by the metropolitan city plan, if the RGI is to be improved, and for identifying appropriate planning actions to pursue this goal. The outcomes of the study imply that the eligibility of a land parcel to be part of the RGI depends on a number of factors strictly related to planning policies entailed by the zoning schemes of the municipal masterplans, such as presence and spreading of conservation and safeguard areas within the urban fabrics, improved accessibility of historic and natural landmarks, planned use of nature-based solutions within the regulating codes of municipal masterplans, improvement of habitat quality in the spatial context of rural areas. Main limitations of the proposed methodology can be recognized in the fragile theoretical foundations concerning the assessment of the value of recreational areas, and in the need for structured integration of nature-based solutions into the assessment of eligibility of land parcels to be included in the RGI.

KEYWORDS
Green Infrastructure; Ecosystem Services; Natura 2000 Network; Environmental Planning

1 INTRODUCTION

The concept of green infrastructure (GI) arises within the international debate at the end of the 1990s as a distinctive approach to landscape planning (Mell, 2016). GI is considered as a reference category in the contexts of several disciplines, e.g., landscape ecology (Jongman & Pungetti, 2004), greenway planning (Fábos, 2004), and management of water resources (Ahern, 2007). Moreover, different functions of GI are identified, e.g., biodiversity conservation (Benedict & MacMahon, 2006), or benefits provided to local communities and to civil society as a whole (Kambites & Owen, 2006). Therefore, several definitions of GI are available in the literature. Among many, Benedict and McMahon's (2006), Wright's (2011), Weber et al.'s (2006) and the European Commission's (European Commission, 2013) are the most relevant. Benedict and McMahon (2006) define GI as the ecological system that supports environmental, social and economic health, emphasizing the socio-economic approach to GI. According to Wright (2011), although connectivity, multifunctionality and green areas represent the core ideas as regards the category of GI, a deterministic definition is somewhat questionable because, on the one hand, such definition would be inconsistent with a progressively evolving conceptual framework concerning GI, and, on the other hand, its intrinsic interoperability would imply the opportunity of using the GI conceptual framework in a number of research and technical fields related to environmental and spatial studies, which would entail a preference to a flexible, non-deterministic definition. Weber et al. (2006) stress the environment-related character of the GI concept, conceived as a system of natural and semi-natural areas spread over the landscape. Broadly speaking, from the above-cited literature GI can be understood as a network of natural and semi-natural areas that play a key role in supporting ecological, social and economic activities.

Under this perspective, this study aims at proposing a methodological approach to include and implement GI within spatial planning at the city level, hence it addresses an outstanding gap concerning scientific and technical research on GI.

The study builds upon a few recent articles, related to Sardinia, concerning the identification of a spatial taxonomy of areas eligible to be part of a regional green infrastructure (RGI) (Cannas et al., 2018; Lai et al., 2018) on the basis of four factors, namely the natural, conservation, landscape and recreational values.

It aims at defining and analyzing the relationship between the RGI, identified through the implementation of the methodology proposed in the above-cited articles, and the rules of municipal masterplans (MMPs).

In order to achieve this goal, a methodology based on the overlay mapping of the spatial taxonomy of areas eligible to be part of the RGI and the zoning layouts of MMPs, and on the

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analysis of correlations between the spatial taxonomy and the zoning rules, is proposed. Correlations are identified through regression analysis. The methodology is applied to the MMPs of three municipalities belonging to the Metropolitan City of Cagliari (MCC; Sardinia, Italy). The outcomes of the study offer important suggestions as regards the definition and implementation of the planning policies of the MCC, based on the general goal of strengthening the GI-related characteristics of the towns located within the metropolitan boundaries, with a view to a future expansion of the RGI within the MCC.

This study is structured as follows. Section 2 describes the proposed methodological approach and the spatial context for the implementation of the case study, that is, the towns of Cagliari, Assemini and Capoterra.

The results coming from the regression analysis which explores and detects correlations between the RGI and the spatial zoning rules of the MMPs of the three towns are presented in Section 3. In Section 4, implications for spatial planning policies related to the urban contexts of the MCC are discussed. Finally, directions for future research and concluding remarks are proposed and discussed.

2 MATERIALS AND METHODS

2.1 CASE STUDY

Municipalities are, in Italy, in charge of programs and plans, ruling on land development and land-use changes, hence they draft, adopt and approve their own MMPs, which simultaneously lay down a strategic policy for the concerned territory and provide the setting for the management of small-scale land-use transformation (Commission of the European Communities (CEC), 2000).

Due to the hierarchic nature of the Italian planning system (CEC, p. 35), MMPs must conform to a number of higher-level plans, the most prominent of which are regional plans, and especially the Regional Landscape Plan (RLP).

This study takes the towns of Assemini, Cagliari and Capoterra, in Sardinia (Italy) as case studies. Each town is a municipality, with its own elected local government and mayor, and it is also part of the MCC, recently established under national law no. 2014/56 and regional law no. 2016/2 (Fig. 1).

Cagliari, with its approximately 150,000 inhabitants and 85 km^2 in size, is the regional capital and the metropolitan center; Assemini (having around 27,000 inhabitants and 118 km^2 in size) and Capoterra (with about 23,000 inhabitants and 69 km^2 in size) are two medium-sized towns both geographically and economically close to the regional capital, since they belong

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to the same travel-to-work area, in that a good share (approximately 30 percent (ISTAT, 2019)) of their populations commutes to Cagliari on a daily basis.

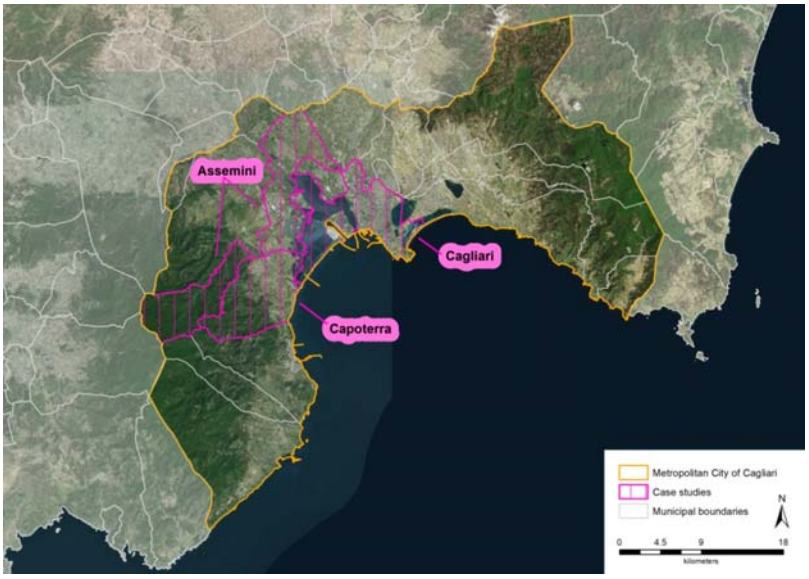

Fig. 1 The study area

Within both the municipalities of Assemini and Capoterra, an MMP recently approved and compliant with the Sardinian RLP is in force; their planning documents and zoning schemes, approved in August 2015 and May 2016, respectively, are available on the municipalities' official web pages[1,2].

As for the municipality of Cagliari, a much older MMP, dating back to 2004, is in force; such plan was approved under the former landscape planning system, hence the complex and conflictual process of adjustment to the RLP (Zoppi & Lai, 2010) has not taken place yet. The planning documents and zoning scheme for the municipality of Cagliari are available on its official webpage[3] and geoportal[4].

[1] The MMP of Assemini is in force since 27 August 2018. The documents are available online at https://comune.assemini.ca.it/amministrazione/amministrazione-trasparente/pianificazione-governo-del-territorio/piani-programmi-16.

[2] The MMP of Capoterra was published on the Official Journal of the Regional Administration of Sardinia on 26 May 2016. The documents are available online at https://www.comune.capoterra.ca.it.

[3] Available online at https://www.comune.cagliari.it/portale/it/at18_puc.page.

[4] Available online at https://sit.comune.cagliari.it/?filtro=puc#13/39.2238/9.0906.

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2.2 ZONING SCHEMES

For each of the three municipalities, the zoning schemes were retrieved and analyzed in the light of their respective technical implementation norms. Next, the schemes were simplified on the basis of the provisions contained in the norms, so as to reduce as much as possible the number of zone types, for instance, by joining together sub-zones belonging to the same zone type, or by merging zones with similar planning or building rules. This simplification led to identifying ten types of planning zones; out of the ten types, listed in Tab. 1, type "E" is not included in Cagliari's zoning scheme, while types "GS" and "IC" are not included in Assemini's and Capoterra's ones.

ZONE TYPE	DESCRIPTION
A	Historic districts
B	Residential completion zones
C	Residential expansion zones
D	Industrial and commercial zones
E	Agricultural zones
G	Collective service zones
GS	Collective service zones: green parks significant at the city level
H	Conservation and safeguard zones
EZ	Enterprise zones, named "IC" in the MMP of Cagliari
S	Public spaces reserved for collective activities, green areas, or parking lots at the district level

Tab. 1 Homogeneous zones identified by the zoning rules of the municipal masterplans of Cagliari, Assemini and Capoterra: simplified zone types

2.3 METHODOLOGY

This study builds upon a methodology applied in previous studies (Cannas et al., 2018; Lai et al., 2018; Arcidiacono et al., 2016; Lai & Leone, 2017) where a potential RGI is mapped taking an Italian region as a case study: Lombardy in Arcidiacono et al. (2016), and Sardinia in Cannas et al. (2018), Lai et al. (2018) and Lai and Leone (2017). In the Sardinian case, the suitability of each patch of land to belong to an RGI is assessed based upon four factors expressing as many functions provided by a GI, as follows:

- natural value (NatVal), which represents habitats' quality notwithstanding pressures and threats exerted on biodiversity;
- conservation value (ConVal), which accounts for the fact that green infrastructures are, in the definition provided by the European Commission (2013) and quoted in Section 1, "a …. network of high quality natural and semi-natural areas";

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- recreation value (RecVal), which provides an indication of the extent to which landscapes are attractive for recreational uses and hence provide recreational ecosystem services;
- landscape value (LandVal), which accounts for the quality of landscapes as implied in the RLP's normative framework.

The suitability of each patch of land to belong to an RGI is then assessed by summing up the above four values, which all vary in the range (0–1), and it is therefore represented by the total value (TotVal): the higher TotVal, the greater the suitability.

The suitability map representing the Sardinian RGI (Fig. 2) is next overlaid with the zoning schemes of the MMPs provided in Fig. 3. Through a spatial intersection between the two layers, for each resulting polygon a vector having components (Zone, NatVal, ConVal, RecVal, LandVal, TotVal) is produced, where "Zone" represents the zone type assigned by the MMP and can take one of the ten values listed in Tab. 1.

Next, for each of the three municipalities here taken as case studies a multiple linear regression is performed:

$$TotVal_k = \beta_{0,k} + \beta_{1,k}A + \beta_{2,k}B + \beta_{3,k}C + \beta_{4,k}D + \beta_{5,k}E + \beta_{6,k}G + \beta_{7,k}GS + \beta_{8,k}H + \beta_{9,k}EZ + \beta_{10,k}Area \quad (1)$$

where

"k" is the municipality;

explanatory variables representing the zoning scheme ("A" to "EZ", see Tab. 1) are dichotomous, or Boolean, variables; each dichotomous variable can take only two values, 1 or 0, according to the following rule: if a patch is classed under the A zone type, the variable A equals 1, otherwise it equals 0; if a patch is classed under the B zone type, the variable B equals 1, otherwise it equals 0, and so on; each coefficient estimated by regression (1), β_i, i = 1, …, 9, identifies the change in TotVal related to a patch in case it is classed under the zone type identified by the variable associated to the coefficient β_i (i.e., A, B, etc.) with respect to the basic condition that the parcel of land under consideration was classed as "S" zone type; the coefficients estimated by regression (1), β_i, i = 1, …, 9, define a taxonomy of the zone types based on the quantitative contribution to TotVal expressed by the values of β_i, i = 1, …, 9;

"Area" is the size of the parcel of land under consideration, resulting from the spatial intersection between the zoning map and the RGI suitability map; results from the multiple linear regression are finally used to develop, for each municipality, an ordered list of the planning zones; for each municipality, the order depends on the value of the coefficients β_i, i = 1, …, 9, of regression (1).

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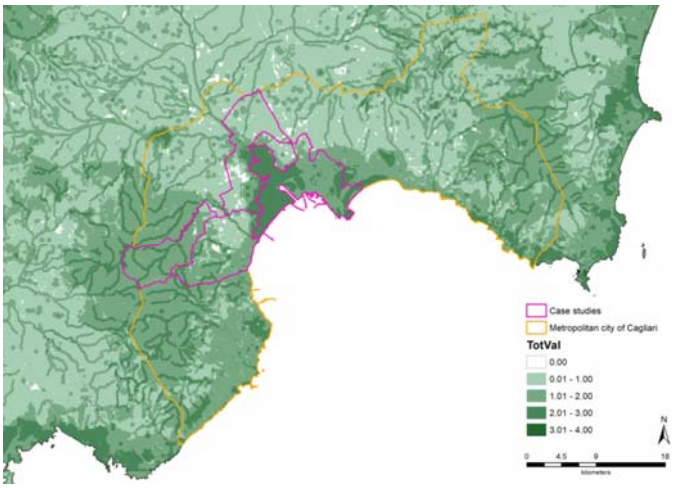

Fig. 2 Map of the total value, which identifies the eligibility of patches to be included in the Regional green infrastructure

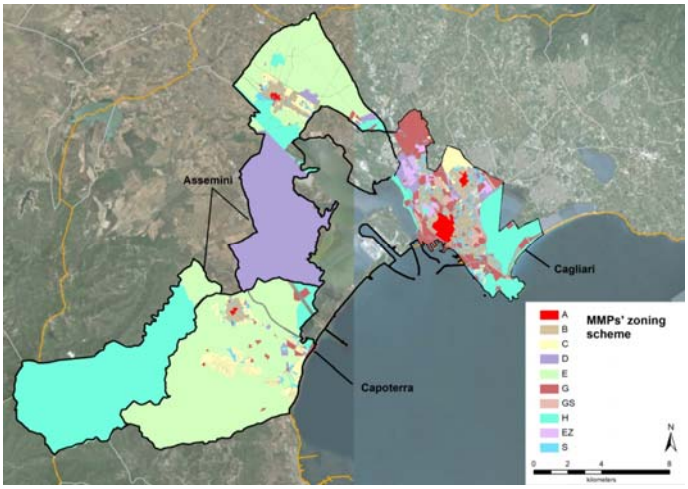

Fig. 3 The zoning layout of the MMPs of Assemini, Cagliari and Capoterra

3 RESULTS

The estimates of the regressions related to Cagliari, Assemini and Capoterra define the features of the effects of a zone type on the eligibility of a patch to be included in the RGI. Indeed, each coefficient of the dichotomous variables estimated in the regressions identifies the effect on the eligibility of a patch to be included in the RGI as a consequence of it being classified as a homogeneous zone type from "A" to "H," or as "EZ" or "GS" (only for the MMP

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of Cagliari, which does not show any "E" zone type) types, with respect to the basic situation of a patch being classified as "S" homogeneous zone type.

This estimated effect equals the difference in TotVal, everything else being equal. Accordingly, a ranking of the homogeneous zone types can be defined, on the basis of the estimated effects, from the highest to the lowest.

The zone types which mainly help to characterize a patch as being eligible to be part of the RGI are (i) the "A" type, that is, historic and artistic center, featured by environmental values related to the built environment, with the exception of Capoterra, whose "A" zone is, by the way, less attractive and valuable than Cagliari's and Assemini's corresponding areas; (ii) the "E" type, which identifies rural and agricultural areas, characterized by the lowest levels of soil sealing and land take (this type of zone is not present in the zoning layout of the MMP of Cagliari); and, above all, (iii) the "H" type, which is characterized by patches which the MMPs identify as worth protecting because of their environmental and landscape-related features. The effect on the eligibility of the "GS" zone type, which identifies open spaces and recreational areas, that is, almost-totally unbuilt areas, and which is only included in the zoning layout of the MMP of Cagliari, is consistent with the effect of the "H" zone type as well. Tab. 2 highlights the ranking of the zone types as regards their influence on the eligibility of patches to be included in the RGI, and the corresponding means of NatVal, ConVal, LandVal and RecVal, in order to identify the factors' influence in a comparative way.

With reference to the "A" and "H" (and "GS," in the case of Cagliari) zone types, the average values of LandVal are comparatively high, since they are always higher than 0.6. The average values of NatVal of the "E" zones are lower than the "A" and the "H" zones' values, even though they are higher than the remaining zones. Moreover, the "H" zones show the highest average values of ConVal in all of the three cases, although there is room for improvement, since they are never higher than 0.3.

On the other hand, the conservation value on average equals zero as regards patches located in the "A" zones, whereas it is very close or equal to zero in already-urbanized areas or in areas characterized by ongoing advanced urbanization processes, such as "B," "C," "D," "G," "EZ" and "S", which is consistent with expectations, since it is very unlikely that habitats protected under the provisions of European Union rules can be found in these areas.

The results of the regressions show that the "A," "E" and "H" zone types are the most important in terms of impact on the eligibility of patches to be part of the RGI.

Moreover, Tab.2 stresses that there is still large room for improvement as regards all the zone types. For example, the almost-totally urbanized areas classed as "B,", "C," "D," "G, "EZ" and "S" zone types show non-null NatVal and RecVal, and often comparatively not so low, in each of the three MMPs, especially with reference to the recreational profile (RecVal), which gives

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credit to possible scope for improving RGI-related features of areas located in the three towns of the MCC.

ZONE TYPE	CAGLIARI					ASSEMINI					CAPOTERRA				
	Rank	Average Values				Rank	Average Values				Rank	Average Values			
		NatVal	ConVal	LandVa	RelVal		NatVal	ConVal	LandVal	RelVal		NatVal	ConVal	LandVal	RelVal
A	2	0.432	0.000	1.000	0.573	4	0.000	0.000	0.722	0.087	NS				
B	6	0.030	0.000	1.000	0.261	6	0.038	0.000	0.200	0.065	5	0.049	0.000	0.027	0.068
C	NS					NS					NS				
D	7	0.233	0.000	0.952	0.039	2	0.644	0.162	0.636	0.010	NS	NS	NS	NS	NS
E	NP					3	0.482	0.028	0.352	0.006	3	0.529	0.061	0.523	0.010
G	NS					NS					2	0.448	0.057	0.639	0.019
GS	3	0.607	0.024	1.000	0.262	NP					NP				
H	1	0.675	0.204	1.000	0.195	1	0.748	0.187	0.647	0.005	1	0.696	0.282	1.000	0.038
EZ	4					NP					NP				
S	5	0.101	0.001	1.000	0.225	5	0.316	0.000	0.258	0.030	4	0.288	0.022	0.513	0.034

Tab. 2 Ranking of the homogenous zones based on the contribution to TotVal implied by the regression results, and average values of the four factors which determine TotVal, related to each homogeneous zone (NP: the homogeneous zone is not present in the MMP's zoning rules; NS: the regression p-value entails that the coefficient is non-significant)

Particularly relevant is the improvement margin related to agricultural areas ("E" zone type) and to the protection areas ("H" zone type) as regards all of the four values.

This implies that the ruling framework related to these zone types would be worth exporting to other parts of the municipal land in order to increase the eligibility of patches to be included in the RGI.

4 DISCUSSION AND CONCLUSIONS

The study analyzes the relations between the land uses, defined in the MMPs of three local municipalities included in the MCC, and the RGI whose identification is based on the methodology proposed by Lai and Leone (2017).

According to the results presented in Section 3, the "H" zones are the areas that mainly positively affect the eligibility of patches to be part of the RGI in the three study areas. In

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particular, in relation to "H" zones, the average values of the four factors show the following similar trends (i) NatVal is higher than 0.5; (ii) ConsVal and RecVal are lower than 0.5; and (iii) LandVal equals 1 (maximum value) in the case of Cagliari and Capoterra and is lower than 0.7 in the case of Assemini. As a consequence, there is plenty of room for improving two out of the four factors (ConVal and RecVal).

ConVal is mainly influenced by the presence of habitat of community interest. "H" zone types are conceived as areas of particular environmental and natural interest; thus, they may represent buffer zones to protect high-quality sites, such as Natura 2000 sites, or steppingstones along migration routes. A possible policy recommendation aims at extending the environmental protection regimes related to habitats and species beyond the boundaries of protected areas by identifying those patches that, in relation to their characteristics, could be suitable for species and habitats. Therefore, advancements of scientific knowledge related to habitats and species within "H" zones and awareness-raising activities are preliminary necessary steps in order to increase the size of protected areas. In line with this recommendation, Maiorano et al. (2007) suggest that integrated management of Natura 2000 sites and of their neighboring areas may improve the effectiveness of conservation measures within protected areas due to control over human-induced activities in the surrounding areas.

Acting on elements that influence RecVal shows more room for improvement than ConVal due to its lower values in relation to "H" zones in the three study areas. RecVal is calculated on the basis of geotagged information retrieved from the social media Flickr, representing the attractiveness of a certain area to visitors in a defined time period. Several studies (Heagney et al., 2018; Amoako-Tuffour & Martinez-Espineira, 2007; Font, 2000) show that recreational attractiveness of an area, conceived of as the demand for recreational activities, is influenced by different factors, such as accessibility and accommodation availability. Therefore, a possible recommendation concerns making these areas more accessible through infrastructures that, on the one hand, support slow mobility (such as cycle and pedestrian paths) and, on the other hand, do not increase habitat fragmentation. In fact, increased fragmentation of habitats is likely to result in decreasing values of ConVal and NatVal.

In relation to NatVal, although its average values are quite high (between 0.67 and 0.75) in all of the three case studies, there is still some room for improvement. NatVal is mainly influenced by land uses and threats to habitats, identified through standard data forms of regional Natura 2000 sites. From this standpoint, two types of policy actions should be taken into account as particularly effective: reduction of threat and mitigation of land-taking processes. Both these actions can include measures aiming at restoring ecosystems, also through the use of nature-based solutions (NBSs). The concept of NBSs was coined by the European Commission (2015) to define techniques and solutions based on the use of nature

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in urban areas. NBSs are designed to address effectively several social challenges in terms of effective resources management, and, at the same time, to provide economic, social and environmental benefits. NBSs are more efficient and cost-effective solutions than traditional approaches (Lafortezza et al., 2018). The European Commission (2015) identifies a series of NBSs to make cities more livable and sustainable, such as the restoration of abandoned and degraded areas, the use of permeable surfaces and of rain gardens to manage and control rainwaters within urban settlements. For example, in the city of Cagliari a significant and troubling phenomenon, represented by agricultural uses and informal settlements, characterizes a particular "H" zone type, called "AR—Is Arenas" within the regional "Molentargius-Saline" park. In these areas, specific measures to mitigate threats caused by urban settlements are necessary.

Moreover, due to the positive influence of "H" zones on the eligibility of patches to be part of the RGI, both the increase of the existing "H" zones and the definition of new "H" zones at the expense of other zones could represent a possible policy action.

In relation to Capoterra and Assemini, "E" zones also influence positively the eligibility of patches to be part of the RGI. The average values of NatVal, ConVal, LandVal and RecVal are lower than those that can be found in "H" zones and, for this reason, there might be more room for improvement, in particular in relation to NatVal and ConVal. Natural value is mainly influenced by the quality of land covers, frequently threatened by intensive agricultural use and by habitat fragmentation due to rural settlements and infrastructure. He et al. (2017)in a recent work, where they study the impacts of land covers on habitat quality, suggest improving habitat quality through agricultural policies that promote a more sustainable use of land, with particular attention to isolated rural settlements. In relation to ConVal, as promoted by the 2014–2020 Sardinian regional Rural Development Program, a possible policy could include sustaining agri-environment-climate commitments, comprising, among others, incentives to support those farmers who allocate part of their farmland for wildlife (e.g., establishing grass swards along wetlands, keeping unharvested conservation lands for wildlife, or maintaining hedgerows and drywalls for small vertebrates).

In conclusion, the proposed methodology can be regarded as a tool in support of decision-makers that can be exported to other European contexts, where Natura 2000 Network is established in compliance with the Habitat Directive. The main advantage of the proposed methodology is its flexibility, which makes it possible to add new values in order to include normative, social and economic aspects that characterize other European contexts. A first most significant limitation concerns the assessment of place attractiveness (RecVal) based on social media only, although some research has argued that social-media retrieved information can be used as a reliable proxy for visitation data (see, for instance: Heikinheimo et al., 2017;

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Wood et al., 2013; Sessions et al., 2016). A second limitation stems from the fact that the methodology for assessing natural value (NatVal) does not take NBSs (such as green roofs or green walls) into account, hence possibly underestimating the natural value in built-up areas. These limits could be addressed in future research.

NOTES

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