Planning, Nature and Ecosystem Services
Smart City, Urban Planning for a Sustainable Future
Carmela Gargiulo  Corrado Zoppi

Editors

Planning, Nature and Ecosystem Services

INPUT aCAdemy 2019
Conference proceedings

Federico II Open Access University Press
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).

**Scientific Committee**

Dino Borri - Politecnico di Bari  
Marla Bottero - Politecnico di Torino  
Domenico Camarda - Politecnico di Bari  
Araldo Cecchini - Università degli Studi di Sassari  
Donatella Ciaide - Università del Molise  
Giovanni Colombo - ISMB Istituto Superiore Mario Boella  
Valentino Cutini - Università di Pisa  
Andrea De Montis - Università degli Studi di Sassari  
Romano Fostoli - Università degli Studi del Sannio  
Carmela Gargiulo - Università di Napoli "Federico II"  
Davide Gensett - University of Trento  
Roberto Gerundo - Università degli Studi di Salerno  
Paolo La Greca - University of Catania  
Daniele La Rosa - University of Catania  
Giuseppe Les Casas - University of Basilicata  
Antonio Leon - Tuscia University  
Sara Levi Sacedotti - SITI  
Gianpiero Lombardini - Università degli Studi di Genova  
Stefania Mauro - SITI  
Giulio Mondini - Politecnico di Torino  
Beniamino Murgante - University of Basilicata  
Silve Occelli - IRES Piemonte  
Rocco Papa - Università di Napoli "Federico II"  
Raffaele Pelosso - Tuscia University  
Alessandro Plaisant - Università degli Studi di Sassari  
Bernardino Romano - Università degli Studi dell'Aquila  
Francesco Scorza - University of Basilicata  
Mauro Tira - University of Brescia  
Angiolo Voghiera - Politecnico di Torino

**Local Committee**

Ginevra Ballo - Università di Cagliari  
Ivan Bledic - Università di Cagliari  
Michele Campagna - Università di Cagliari  
Ignazio Carnia - Università di Cagliari  
Anna Maria Colavito - Università di Cagliari  
Sebastiano Cuccoli - Università di Cagliari  
Maddalena Floris - Università di Cagliari  
Chiara Garau - Università di Cagliari  
Pederico Isola Università di Cagliari  
Sabrina Lai - Regione Autonoma della Sardegna  
Francesca Leccis - Università di Cagliari  
Federica Leone - Università di Cagliari  
Anania Mereu - Università di Cagliari  
Manuela Agostina Mosa - Regione Sardegna  
Salvatore Pirin - Università di Cagliari  
Cheti Pira - Università di Cagliari  
Daniele Ruggieri - Università di Cagliari  
Laura Santona - Regione Sardegna  
Corrado Zoppi - Università di 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
Published by FedOAPress • Federico II Open Access University Press
# Table of contents

**Introduction**  
Corrado Zoppi  

## Sessione 1 - Ecosystem services and spatial planning

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Danube Riverside Development in the Iron Gates Gorge, Serbia, between Socio-economic needs and Protected Ecosystem</td>
<td>17</td>
</tr>
<tr>
<td>Branislav Antonic, Aleksandra Djukić, Milica Cvetanović</td>
<td></td>
</tr>
<tr>
<td>From a species-centred to an ecosystem-based management approach, a case study of the saltmarshes of Hyères (Provence, France)</td>
<td>29</td>
</tr>
<tr>
<td>Patrick Astruch, Charles-François, Boudouresque, Thomas Changeux et al.</td>
<td></td>
</tr>
<tr>
<td>Spatial evolutions between identity values and settlements changes. Territorial analyses oriented to the landscape regeneration</td>
<td>39</td>
</tr>
<tr>
<td>Donatella Cialdea</td>
<td></td>
</tr>
<tr>
<td>Analyzing senior tourism. The role of ecosystem services to improve sustainable tourism destinations</td>
<td>52</td>
</tr>
<tr>
<td>Romano Fistola, Rosa Anna La Rocca</td>
<td></td>
</tr>
<tr>
<td>Carbon sequestration and land-taking processes. A study concerning Sardinia</td>
<td>66</td>
</tr>
<tr>
<td>Maddalena Floris, Corrado Zoppi</td>
<td></td>
</tr>
<tr>
<td>The impact of urbanization processes in landscape fragmentation. A comparison between coastal zones of Sardinia and Liguria</td>
<td>80</td>
</tr>
<tr>
<td>Giampiero Lombardini, Andrea De Montis, Vittorio Serra</td>
<td></td>
</tr>
<tr>
<td>Areas of considerable public interest, territorial common goods and ecosystem services: an application case for the city of Cagliari</td>
<td>86</td>
</tr>
<tr>
<td>Marzia Monttu, Alessandro Plaisant</td>
<td></td>
</tr>
<tr>
<td>A bottom up initiatives for biodiversity: ecologic representation for the inner areas of Sardinia</td>
<td>98</td>
</tr>
<tr>
<td>Giuseppe Roccasalva</td>
<td></td>
</tr>
<tr>
<td>The soil matter between eco-systemic performance and spatial planning in metropolitan areas</td>
<td>111</td>
</tr>
<tr>
<td>Saverio Santangelo, Paolo De Pascali, Annamaria Bagaini, Clara Musacchio, Francesca Perrone</td>
<td></td>
</tr>
<tr>
<td>Knowledge-building models for environmental planning: the case study of Bari Stefania Santoro, Domenico Camarda, Pasquale Balena</td>
<td>120</td>
</tr>
<tr>
<td>From Ecosystems to Ecosystem Services. A spatial methodology applied to a case study in Sardinia</td>
<td>130</td>
</tr>
<tr>
<td>Matilde Schirru, Simona Canu, Laura Santona, Sabrina Lai, Andrea Motroni</td>
<td></td>
</tr>
</tbody>
</table>
Session: 2 - Integrated management of marine protected areas and Natura 2000 sites

Organize the management of protected areas according to an optimal framework. 142
Experimental case
Aicha Bouradji

A methodological approach to build a planning environmental assessment framework in the context of marine protected areas 152
Ignazio Cannas, Daniela Ruggeri

An experimental methodology for the management of marine protected areas 165
Maddalena Fioris, Federica Isola, Cheti Pira

Marine Forests (Fucales, Ochrophyta) in a low impacted Mediterranean coastal area: current knowledge and future perspectives. A phycological review in Sinis Peninsula and the Gulf of Oristano (Sardinia Island, Italy) 176
Daniele Grech, Luca Fallati, Simone Farina, David Cabana, Ivan Guala

Assessing the potential Marine Natura 2000 sites to produce ecosystem-wide effects in rocky reefs: a case study from Sardinia Island (Italy) 185
Paolo Guidetti; Pierantonio Addis; Fabrizio Atzori et al.

Bottlenecks in fully implementing the Natura 2000 network in Italy. An analysis of processes leading to the designation of Special Areas of Conservation 201
Sabrina Lai

Urban pressure scenario on the protected areas systems. The case study of Teatina adriatic coast 212
Alessandro Marucci, Lorena Fiorini, Carmen Ulisse

Posidonia banquets on the Mediterranean beaches: To what extent do local administrators’ and users’ perceptions correspond? 225
Paolo Mosone, Ivan Guala, Simone Simeone

The ecosystem services cascade perspective in practice: a framework for cost-benefits analysis in Marine Protected Areas. The study case of Portofino Marine Protected Areas 235
Chiara Paoli, Paolo Povero, Giorgio Fanciulli et al.

The contribution of the assessment of policy consistency and coherence to the definition of the legislative provisions of marine protected areas. The examples of the regulations of “Tavolara-Punta Coda Cavallo” and “Isola dell’Asinara” 251
Salvatore Pinna, Francesca Leccis

Passive acoustics to monitor flagship species near boat traffic in the Unesco world heritage natural reserve of Scandola 260
Marion Poupard, Moxence Ferrari, Jan Schlüter et al.

Use of ecological indices to assess the health status of Posidonia oceanica meadows in the Eastern Liguria. Influence of ecological status on natural capital 271
Ilaria Rigo, Monica Montefalcone, Carla Morri et al.

Coastal governance and planning agreements for integrated management of marine protected areas in UE coasting project 281
Saverio Santangelo, Paolo De Pascali, Maria Teresa Cutri et al.
Innovative management tools to survey boat traffic and anchoring activities within a Marine Protected Area
Thomas Schohn, Patrick Astruch, Elodie Rouanet et al.

SHADES. Sustainable and holistic approaches to development in European seabords
Francesco Vita, Fortunato Cozzupoli

Session 3 - Rural development and conservation of nature and natural resources

New local projects for disadvantaged inner areas. From traditional model to bio-regional planning
Anna Maria Colavitti, Alessio Floris, Francesco Pes et al.

Inclusion of migrants for rural regeneration through cultural and natural heritage valorization
Elisa Conticelli, Claudia de Luca, Aitziber Egusquiza et al.

Environmental and social sustainability of the bioenergy supply chain
Sebastiano Curreli

Proposals on the Agricultural Land Use in According to the Features of the landscape: The case study of Sardinia (Italy)
Pasquale Mistretta, Giulia Desogus, Chiara Garau

Common land(cape): morphologies of a multifunctional rural landscape in the Isalle Valley, Sardinia
Roberto Sanna

SheepToShip LIFE: Integration of environmental strategies with rural development policies. Looking for an eco-sustainable sheep supply chain
Enrico Vagnoni, Alberto Atzori, Giovanni Molle et al.

Session 4 - Geodesign, planning and urban regeneration

The territorial planning of European funds as a tool for the enhancement and sustainable development of natural areas: the experience of the Strategic Relevance Areas of the ERDF OP 2014-2020
Stefania Aru, Sandro Sanna

The International Geodesign Collaboration: the Cagliari case study
Michele Campagna, Chiara Cocco, Elisabetta Anna Di Cesare

A geodesign collaboration for the mission valley project, San Diego, USA
Chiara Cocco, Bruce Appleyard, Piotr Jankowski

University and urban development: The role of services in the definition of integrated intervention policies
Mauro Francini, Sara Gaudio, Annunziata Palermo, Maria Francesca Viapiana
**Session 5 - Green and blue infrastructure**

Green infrastructure as a tool of urban regeneration, for an equitable and sustainable planning. An application case at l'Eixample, Barcelona  
*Clara Alva Morales, Tanja Congiu, Alessandro Plaisant*

The value of water: ecosystem services trade-offs and synergies of urban lakes in Romania  
*Denisa Lavinia Badiu, Cristian Ioan Ioiță, Alina Constantina Hossu et al.*

A blue infrastructure: from hydraulic protection to landscape design. The case study of the village of Ballao in the Flumendosa river valley  
*Giovanni Marco Chin, Pino Frau, Elisabetta Sanna et al.*

Municipal masterplans and green infrastructure. An assessment related to the Metropolitan Area of Cagliari, Italy  
*Sabrina Lai, Federica Leone, Corrado Zoppi*

The Ombrose river contract: A regional design practice for empowering river communities and envisioning basin futures  
*Carlo Pisano, Valeria Lingua*

Green infrastructures in the masterplan of Rome. Strategic components for an integrated urban strategy  
*Laura Ricci, Carmela Mariano, Irene Poli*

---

**Session 6 - Smart city planning**

Smart City Governance for Child-friendly Cities: Impacts of Green and Blue Infrastructures on Children's Independent Activities  
*Alfonso Annunziata, Chiara Garau*

Resilience, smartness and sustainability. Towards a new paradigm?  
*Sabrina Auci, Luigi Mundula*

Energy autonomy in symbiosis with aesthetics of forms in architecture  
*Pietro Currò*

Sharing governance and new technologies in smart city planning  
*Paolo De Pascalì, Saverio Santangelo, Annamaria Bagaini et al.*
Table of contents

Smart Mapping Tools for the Balanced Planning of Open Public Spaces in the Tourist Town of Golubac, Serbia
Aleksandra Djukić, Branislav Antonić, Jugoslav Joković, Nikola Dinkić
Towards a model for urban planning control of the settlement efficiency
Isidoro Fasolino, Francesca Coppola, Michele Grimaldi
Somerville: Innovation City
Luna Kappler
Urban regeneration for smart communities.
Caterina Pietra, Elisabetta Maria Venco
Energy autonomy as a structural assumption for systemic development and circular economy
Manlio Venditelli

Session 7 - Water resources, ecosystem services and nature-based solutions in spatial planning

Landscape and species integration for a nature-based planning of a Mediterranean functional urban area
Erika Bazzato, Michela Marignani
Tourism and natural disasters: integrating risk prevention methods into the Plan for tourism
Selena Candida, Francesca Pirlone
Integrated management of water resources. An operative tool to simplify, direct and measure the interventions
Vittoria Cugusi, Alessandro Plaisant
Application of NbS to the city plan of Segrate Municipality: spatial implications
Roberto De Lotto
Nature-Based Solutions impact assessment: a methodological framework to assess quality, functions and uses in urban areas
Claudia De Luca, Simona Tondelli
The recognition of the Aspromonte National Park ecosystem networks in the urban structure project of Metropolitan City of Reggio Calabria
Concetta Fallanca, Natalina Carrà, Antonio Taccone
Shaping the urban environment for breathable cities.
Michela Garau, Maria Grazia Badas, Giorgio Querzoli, Simone Ferrari, Alessandro Seoni, Luca Salvadori
Defense, adaptation and relocation: three strategies for urban planning of coastal areas at risk of flooding
Carmela Mariano, Marsia Marino
Thermal Urban Natural Environment Development
Francesca Moraci, Celestina Fazia, Maurizio Francesco Errigo
A network approach for studying multilayer planning of urban green areas: a case study from the town of Sassary (Sardegna, Italy)  
* Maria Elena Palumbo, Sonia Palumbo, Salvatore Manca, Emmanuele Farris  
723

Urban areas morphometric parameters and their sensitivity on the computation method  
* Luca Salvadori, Maria Grazia Badas, Michela Garau, Giorgio Querzoli, Simone Ferrari  
734

**Session 8 - Conservation and valorisation of architectural and cultural heritage**

Preservation and valorisation of small historic centers at risk  
* Maria Angela Bedini, Fabio Bronzini, Giovanni Marinelli  
744

Material and immaterial cultural heritage: identification, documentation, promotion and valorization. The courtyards and hallways of merit in the Murattiano district of Bari  
* Antonia Valeria Dlauro, Remo Pavone, Francesco Severino  
757

Planning of historic centers in Sardinia Region: conservation versus valorization of architectural and cultural heritage  
* Federica Isola, Federica Leone, Cheti Pira  
767

Approach towards the "self-sustainability" of ancient villages  
* Francesca Pirione, Ilenia Spadaro  
776

Fostering architecture efficiency through urban quality. A project for via Milano site in Brescia  
* Michela Tiboni, Francesco Botticini  
787

**Session 9 - Accessibility, mobility and spatial planning**

The role of community enterprises in spatial planning for low density territories  
* Cristian Cannaos, Giuseppe Onni  
800

Measuring multimodal accessibility at urban services for the elderly. An application at primary health services in the city of Naples  
* Gerardo Carpentieri, Carmen Guida, Housmand Masoumi  
810

Urban accessibility for connective and inclusive living environments. An operational model at support of urban planning and design practice  
* Tanja Congiu, Elisa Occhini, Alessandro Plaisant  
826

Improving accessibility to urban services for over 65: a GIS-supported method  
* Carmela Gargiulo, Floriana Zucaro, Federica Gaglione, Luigi Faga  
839

Cycle networks in Natura 2000 sites: the environmental assessment of the Regional Cycling Plan of Sardinia, Italy  
* Italo Meloni, Elisabetta Anna Di Cesare, Cristian Saba  
851
Improving regional accessibility through planning a comprehensive cycle network: the case of Sardinia (Italy)  
Italo Meloni, Cristian Saba, Beatrice Scappini et al.

Vehicle routing problem and car-pooling to solve home-to-work transport problem in mountain areas  
Antonio Pratelli, Massimiliano Petri

Session 10 - Tourism and sustainability in the Sulcis area

Wave, walk and bike tourism. The case of Sulcis (Sardinia -Italy)  
Ginevra Balletto, Alessandra Milesi, Luigi Mundula, Giuseppe Borruso  

Smart Community and landscape in progress. The case of the Santa Barbara walk (Sulcis, Sardinia)  
Ginevra Balletto, Alessandra Milesi, Stefano Naitza et al.

A Blockchain approach for the sustainability in tourism management in the Sulcis area  
Gavina Baralla, Andrea Pinna, Roberto Tonelli et al.

People and heritage in low urbanised settings: An ongoing study of accessibility to the Sulcis area (Italy)  
Nada Beretić, Tanja Congiu, Alessandro Plaisant

Place branding as a tool to improve heritage-led development strategies for a sustainable tourism in the Sulcis-Iglesiente region  
Anna Maria Colavitti, Alessia Usai

Walkability as a tool for place-based regeneration: the case study of Iglesiente region in Sardinia (Italy)  
Chiara Garau, Gianluca Melis

The use of recycled aggregates in the implementation of Municipal Masterplans and Coastal Land-Use Plans. A study concerning Sulcis (Sardinia, Italy)  
Federica Leone, Aania Mereu

Relationships between conservation measures related to Natura 2000 sites and coastal land use plans: a study concerning Sulcis (Sardinia, Italy)  
Federica Leone, Corrado Zoppi

A Smart Planning tools for the valorisation of the Carbonia's building heritage via an energy retrofitting based approach  
Stefano Pili, Francesca Poggi, Eusebio Loria, Caterina Frau

Special session 1 - Ecological networks and landscape planning

Resilient ecological networks. A comparative approach  
Andrea De Montis, Amedeo Ganciu, Maurizio Mulà et al.
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A complex index of landscape fragmentation: an application to Italian regional planning</td>
<td>1007</td>
</tr>
<tr>
<td>Andrea De Montis, Amedeo Ganciu, Vittorio Serra</td>
<td></td>
</tr>
<tr>
<td>Measuring landscape fragmentation in Natura 2000 sites. A quantitative and comparative approach</td>
<td>1017</td>
</tr>
<tr>
<td>Antonio Ledda, Andrea De Montis, Vittorio Serra</td>
<td></td>
</tr>
<tr>
<td>Regional ecological networks: theoretical and practical issues</td>
<td>1028</td>
</tr>
<tr>
<td>Giuseppe Modica, Salvatore Praticò, Luigi Laudari et al.</td>
<td></td>
</tr>
<tr>
<td>Comparative ecological network analysis. Target and vector species and other naturalistic issues</td>
<td>1038</td>
</tr>
<tr>
<td>Maurizio Mulas, Matteo Cabras, Andrea De Montis</td>
<td></td>
</tr>
<tr>
<td>Measuring connectivity in Natura 2000 sites. An application in Sardinia</td>
<td>1049</td>
</tr>
<tr>
<td>Vittorio Serra, Andrea De Montis, Antonio Ledda</td>
<td></td>
</tr>
</tbody>
</table>
WALKABILITY AS A TOOL FOR PLACE-BASED REGENERATION: THE CASE STUDY OF IGLESIENTE REGION IN SARDINIA (ITALY)

CHIARA GARAU, GIANLUCA MELIS

Department of Civil and Environmental Engineering and Architecture
University of Cagliari, Italy
E-mail: cgarau@unicas.it, gianlucamelis@uniss.it

ABSTRACT
The paper aims at exploring an extension of the concept of walkability to the rural contexts, focusing on the case study of the territory of Iglesiente, in Sardinia (Italy). The walkability paradigm is an operational framework of increasing interest in the field of urban planning, due to the intrinsic ability to read, in an innovative way, the accessibility approach and the mobility in the city between urban facilities. Nevertheless, it remains an open and slightly explored topic in rural and low-density contexts. The territory of the Iglesiente has a patrimony of nature and history of great interest for the peculiar relationship between the environmental and anthropic components related to the past mining activity: the city followed the production in the places where the mineral resources were present. Settlements in the Iglesiente area today appear poorly organized and fragmented both on the territorial and urban scale. In particular, each of the villages, which has undergone the strong impulse to grow by mining production, today shows an unresolved relationship with the places that were once dedicated to production, this even if many mining sites after long years of oblivion have recently restored and opened to the touristic fruition. The objective of this article is to focus the research on the inversion of the relationship between mining towns and places of production, rethinking and adapting the interpretative categories of walkability to rural contexts. The definition of paths inspired by the criterion of walkability to re-establish a relationship between Iglesiente area settlements and restored mining sites as urban facilities, appears to be a point of interest for a new interpretation of urban quality.

KEYWORDS
Walkability; Mining Landscape; Mining sites; Iglesiente; Sardinia
1 INTRODUCTION

In the regional and urban planning literature, walkability is a measure of how easy and safe it is to walk in the urban environment (Forsyth, 2015; Rattan et al, 2012). Walkability is also investigated through various variables such as urban density, land use mix, connectivity, and urban morphology in general (Zaninović et al., 2019).

Shengxiao et al. (2019) underline that "city planning agencies often aim to improve walkability through various design strategies, planning more services and recreational facilities [...], and improving the sense of community [...] by preserving [...] the urban landscape" (Shengxiao et al. 2019).

Thus, walkability is generally an urban concept, but, according to Giles-Corti et al. (2019) and Hajna (2015), can be adopted also in rural contexts and small regional cities.

For these reasons, the authors intend to deepen and explore the concept of walkability in Iglesiente area, a particular context in Sardinia where, an historical and powerful mining activity, left traces in the environment, in the social context, and in the morphology of rural settlements. The peculiarities of this settlement system, in which the development was driven by mining phenomenon, are in contrast with the pre-existing rural environment, strongly related to the environmental opportunities (Angelillo, 2018).

In fact, the mining towns of the Iglesiente region, were born as a subordinate element to the production and for this reason, at the time of the cessation of this activity, they found themselves substantially without their raison d’être. In other words, the condition for which the city pursued the development of the mine - and not vice versa - was happened, and the exhaustion of mineral deposits (as well as the changing economic conditions) marked the decline and, for some cases such as Montevecchio, the death of those cities born due to mining activity.

This has led and still leads to the need for reconstruction of the relationship between mining town and places of past production, reversing the hierarchy: the driving element must be the settlement with its territorial force and its critical mass of inhabitants. Thus, the places of production assume the semantic power of places full of history that inspire new forms of use and interpretation of the landscape.

Generally, the Iglesiente mining structure with its facilities follows the industrial organizational criteria. Its development is linked to a decontextualized culture, characterized by a condition of isolation, because of communication difficulties and based on specific technical and scientific principles. The construction of a mine, often distant and decentralized with respect to the city, imposes itself, in most cases, on the pre-existing rural livelihood economies.
In this regard, the starting point of this paper comes from the flow of workers who daily moved from the places of residence to the places of production, linking the settlement and mine in a unidirectional semantic relationship. Today, the trace of this flow can be re-read as the privileged path through which the mining past becomes the identity way on which to reconstruct, reversing, the relationship between the city and its territory.

The territorial analysis showed how the places of mining production, redeveloped and open to fruition, have become important centers of tourism promotion of the territory linked both to industrial archeology and to the intrinsic environmental and landscape value of the places. These centers, which today play an important role in the construction of a new identity for the whole territory, are however punctual and disconnected elements, lacking the direct relationship with the settlements to which they were historically linked.

These connections, if rethought to serve the historical settlement, show the potential to re-establish the relationship mine-mining village, reversing the semantic roles of the two elements. To this end, it is necessary that these connections have the typical characteristics of urban environments, to bring the restored mining sites at the role of urban places. The determination of these characteristics is one of the central elements of the present operational proposal that rethinks the variables used for walkability in urban environments according to the most natural contexts. Based on these premises, the article intends to propose a system of interpretative categories, based on GIS analysis and based on the paradigm of walkability as a tool for the development and rebalancing of the territory.

In other terms, the aim of this paper is to extend the concept of walkability particularly to low-density settlements, by adopting an operative framework that considers the environmental and anthropic components to be strictly correlated. This link is strongly true for the mining industries. In fact, as the industrial city born as a place of production in order to minimize the distance between the manpower and the factory sites (Mistretta & Garau, 2013; Talia, 2007), in the same way the genesis of the mining sites is represented by a first core of services to the complex and dangerous extraction activity, and then the same minining sites are constituted by also the settlements of workers with their families.

The study context, strongly characterized in its main components, is described in the first part in order to have the theoretical and conceptual bases for the subsequent development of the proposed methodology. The results obtained will first be discussed in general in the paragraph describing the results and subsequently interpreted in the conclusions.
2 THE CASE STUDY OF IGLESIENTE IN THE REGION OF SARDINIA (ITALY)

The Sulcis-Iglesiente region (Fig. 1), located in the south-west part of Sardinia (Italy) has mining basins that in the past were among the most important in Western Europe. In fact, the quantities of minerals produced reached world-wide levels, representing for almost two centuries one of the most important economic activities on the island.

Fig. 1 The Sulcis-Iglesiente area

The cultivation activities of the metalliferous veins ceased completely about thirty years ago (the formal closure of the last active mine dates back to 1991), and the disposal process left on the territory both an extraordinary heritage of industrial archeology (consisting of residential and industrial buildings, machinery, open-air excavations, tunnels, etc.) and a social and settlement system, now lacking its main raison d’être.

Therefore, the development of the Sardinian mining industry not only created wealth and employment for over a century (starting from 1848 with the extension to Sardinia of the mining law of June 30, 1840, already in force for all the other contexts of the Savoy kingdom);
but permanently raised the level of education and the class consciousness (the Buggerru motions of 1905 represent a significant case on the European scale).

However, it left as a inheritance the compromise of extensive portions of territory, in particular in the Sulcis-Iglesiente area, creating a settlement and identity "emptiness" that has inevitably led the areas under study to a today's phase of necessary strategic choice for the natural decadence of the environment (due to environmental dynamics, toxic residues, system fragility) and existing structures (Peghin, 2018).

In Sulcis-Iglesiente, as in the rest of the world, mining complexes settled where resources are present and this often leads them to distant places separated from the urban contexts, in places dominated by the natural component. This determines a condition of isolation, caused not only by the difficulties of communication, but also by the differential relationship with respect to the host context linked to the extraction processes in the environmental context. This led to the definition of the concept of mining habitat (Sanna, 2014), as a whole connected to the system of extractive infrastructures, and also to all the works and elements, including natural ones, functional to the cultivation process.

Considering the complexity of the entire mining system in Sulcis-Iglesiente, the authors analyse, as a case study, the historical region of the Iglesiente (constituted by the municipalities of Bugerru, Domusnovas, Fluminimaggiore, Gonnesa, Iglesias, Musei and Villamassargia). Fig. 2 shows how the territories of these municipalities were affected by the mining activity (a total of 12.3% of their overall extension) and the extension of the density of mining concessions (78%) not related to the coal extraction.

Fig. 2 The red border indicates the Iglesiente Region in Sardinia (Italy) with its envelope of mining area and its mining concessions
The area under study was therefore characterized by the mining of metalliferous minerals which characterized its settlement history. The infrastructure linked to the extraction process in the Iglesiente area had, in general:

- an industrial settlement (for example, constituted by castles of extraction, turner lathe areas, offices, laboratories, laundry, silos, storage, social places, power production and transformation plant, etc. etc.);
- landfills for tailings and muds;
- transport infrastructure for the mineral and its aggregates as well as for the water used for processing and processing plants;
- a civil settlement (workers' homes, shop, management).

The settlement components connected to the extraction and mining processes and their placement within wide reference territorial areas, have, over time, left an industrial and civil heritage, not very populated, with a non-functional connective - infrastructural network, but particularly significant for the relations with the environmental system. Dismissal, redevelopment, recovery and reclamation are therefore terms that identify this territory, which still today has profound environmental, social, economic and managerial effects (Peghin, 2006).

3 METHODOLOGY

The specific purpose of this contribution is to define a system of interpretative categories capable of extending the concept of walkability from the urban to the rural context as an operational tool to reconnect renewed mining sites, villages, and the environmental and natural contexts.

In this regard and considering the area under study, the authors refer to the application of the walkability concept to a micro urban level, working on the direct relationship between the individual and the context also through the concepts of perception, efficiency, sense of security, and pleasantness of the path. In particular, the literature indicates three main categories of interpretation for the definition of walkability in an urban context: 1) the number of destinations of urban interest/opportunities within walking distance; 2) their distance, and 3) the quality of pedestrian routes to these destinations (Blečić et al., 2015; Forsyth, 2015; La Riccia et al., 2019).

These categories are thus rethought by the authors, considering the peculiarities of the context under study: 1) the elements of cultural value in urban centers with a significant number of inhabitants present in the rural context (the number of inhabitants is important because is the critical mass on which to base the concept of the place-based city renewal to
which authors are referring) and the valuable elements of the mining habitat; 2) their distance, and 3) the quality of the path, taking into account both the comfort along it (slope) and the environmental richness (natural elements of value).

All the elements were analyzed in a GIS environment, due to a specific territorial information system organized on contents capable of relating both layers related to (1) the mining habitat (mining concessions, mining works, envelopes of the areas subjected to processing, historical mapping); (2) the natural heritage (rivers, coastline, protected areas, vegetation cover); (3) the anthropic dimensions (census analysis on the population in the time horizons of the censuses, mapping of the services present in the territory); and (4) accessibility with existing fruition infrastructures, such as roads, tourism and/or religious paths, such as the Mining path of Santa Barbara (Cammino Minerario di Santa Barbara).

4 RESULTS

The methodological criteria presented allowed the identification (1) of potential points of interest for each of the smaller villages with a significant resident population and (2) of a system of paths with the characteristics defined by the extension of the concept of walkability from the urban environment to the rural one (Fig. 3 and 4).
The analyzed villages were the most isolated but most populous ones in the Iglesiente area (Fluminimaggiore, Nebida and Buggerru). The main center of Iglesias was not considered in the present analysis for the differences in scale, in fact the resident population exceeds the others centers of an order of magnitude showing distinctly urban characters and a regenerative potential that the smaller centers do not possess.

Thinking about destinations, each of the selected centers showed, in its compact urban fabric, at least one valuable identity element linked to the mining context. The analysis around the centers in question - considering the elements of the mining heritage now redeveloped and open, able to be used as an element of the mining town to be reconnected with new meanings to the urban context - was limited to a distance of 3 km, because the literature identified it as the threshold beyond which the alternative of walking on foot loses interest compared to the use of cars (Lefebvre-Ropars et al., 2017).

It was thus possible to identify for the three centers in question an origin within the urban center and a destination of high interest at a distance of less than 3 km. This, together with the analysis of the connections historically present between the town and the elements of the mining heritage used by the workers and functional to the productive phenomenon, and to the comparison with the current state of the places and with the results of the environmental
analysis of the context, has produced the definition of a walkable itinerary of reconnection between urban and places of mining production now in the inverted meaning that these show of places of service to the city and no longer of only element for its existence. This - together with (1) the state of the art of the place, (2) the analysis of the environmental context and (3) the analysis of the historical connections between the town and the elements of the mining heritage (used by the workers and functional to the productive phenomenon) - produced the definition of a walkable path of reconnection between urban and places of mining production, now in the inverted meaning of places of service to the city and no longer of only element, important exclusively for its existence.

The last criterion - able to define the quality of the path in presence of valuable environmental elements - was the analysis of the path’s slope, calculated in a GIS environment. The analyses conducted (Table 1) showed that the paths of reconnection between Fluminimaggiore and Masua/Nebida with the respective elements of the mining heritage are the best in terms of slope, seen as traveling comfort, while in the third town (Buggerru) the slope was excessive for a structured path according to the paradigm of urban walkability.

<table>
<thead>
<tr>
<th>MINING PATHS</th>
<th>STARTING POINT</th>
<th>ARRIVAL POINT</th>
<th>LENGTH</th>
<th>SLOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buggerru</td>
<td>Miner’s Museum</td>
<td>Entrance to the Henry Gallery</td>
<td>1 km</td>
<td>11 %</td>
</tr>
<tr>
<td>Fluminimaggiore</td>
<td>Church of St. Anthony of Padua</td>
<td>su Zurfuru Mine</td>
<td>2,5 km</td>
<td>6-8 %</td>
</tr>
<tr>
<td>Nebida/Masua</td>
<td>Exhibition of Mine Machines</td>
<td>Porto Flavia</td>
<td>2,9 km</td>
<td>6-8 %</td>
</tr>
</tbody>
</table>

Tab. 1 Paths of reconnection of Buggerru, Fluminimaggiore and Masua/Nebida

5 CONCLUSION

The territory of the Iglesiente has a place-based system, inherited from the mining activity and constituted by networks of connection between elements and places of the landscape, which takes a particular semantic value in the context in question. The inversion of the relationship between mining villages and places of mining production, explicit in the proposed methodological approach, constituted the operational starting point and a possible interpretation for a territory, such as that of the Iglesiente area, which is reconstructing its identity on a new reading of the mining landscape.

The extension to the rural contexts of the system of interpretative categories, based on the paradigm of urban walkability, allowed to explore operationally some minor centers of the Iglesiente, enhancing the old mining paths, as detail elements of an existing macro-path (the Mining path of Santa Barbara - Cammino Minerario di Santa Barbara).
This has been pursued through the definition of privileged paths that bring the mining town closer to the places of production, reversing the consolidated relationship, of complete semantic dependence between the mining city and its production area. The reasoning on the planning and the descent of the scale remain open to make these connection lines as public spaces of use of the city. The future research proposal will start from this point, with the strategic planning of the identified paths seen as a new accessibility framework, so as to be able to include another small tourist connection to the more consolidated Mining path of Santa Barbara. In addition, the scale design descent will give authors the possibility of identifying other paths of tourist fruition.

AUTHOR CONTRIBUTIONS

This paper is the result of the joint work of the authors. ‘Results’, and ‘Conclusions’ were written jointly by the authors. Chiara Garau wrote the 'Introduction', and ‘Methodology’. Gianluca Melis wrote the 'The Case Study of Iglesiente in the Region of Sardinia (Italy)'. Chiara Garau revised the whole paper and checked for its comprehensive consistency.

ACKNOWLEDGMENTS

This study was supported by the MIUR (Ministry of Education, Universities and Research [Italy]) through a project entitled Governing the smart city: a governance-centred approach to SmarT urbanism – GHOST (Project code: RBSI14FDPF; CUP Code: F22I15000070008), financed with the SIR (Scientific Independence of Young Researchers) programme. We authorize the MIUR to reproduce and distribute reprints for Governmental purposes, notwithstanding any copyright notations thereon. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors, and do not necessarily reflect the views of the MIUR. This work was also supported by the the Regione Autonoma Sardegna (RAS) through the project entitled "TSulki: Turismo e Sostenibilità nel Sulcis" - Delibera Cipe n. 31 del 20.02.2015 e Deliberazione n. 52/36 del 28.10.2015 “Progetto strategico Sulcis” – progetti di ricerca pubblico-privati.

REFERENCES


**AUTHOR’S PROFILE**

**Chiara Garau** is Assistant Professor of Urban and Regional Planning at the DICAAR (Department of Civil and Environmental Engineering and Architecture) of the University of Cagliari, Italy. She was a member of the scientific and organizing committee of the YA AESOP (Young Academics—Association of European Schools of Planning, 2011–2013). She was a scientific and technical adviser for the Smart Cities Observatory of Rome (2013–2014), and in June 2015, she received the Best Paper award at ICCSA 2015 with a paper entitled Benchmarking Smart Urban Mobility: A Study on Italian Cities. In 2015, She won a national research competition (the SIR call proposal—Scientific independence of young researchers, Domain SH—of the Italian Ministry of Education, University and Research) with the GHOST project (“Governing the smart city: a governance-centred approach to smart urbanism”). She
is author of over 70 scientific publications, including monographs, conference proceedings, and articles in books and national and international journals.

Gianluca Melis, is an environmental engineer. He took his PhD in Architecture and Planning (2010), and mainly deals with territorial information systems applied to spatial planning, impact assessment and planning. In his work as an engineer he deals with the development of innovative models in the GIS environment, especially aimed at the assessment of environmental and landscape impacts but, in general, the spatial modeling of various anthropic and natural phenomena. His main fields of interest concern the tools and techniques of wide area territorial planning implemented operationally in GIS, he usually deals with Spatial Analysis, Territorial Analysis, Landscape, Parks and Protected Areas, Environmental and territorial planning, Support Systems to decisions, geographic information systems.