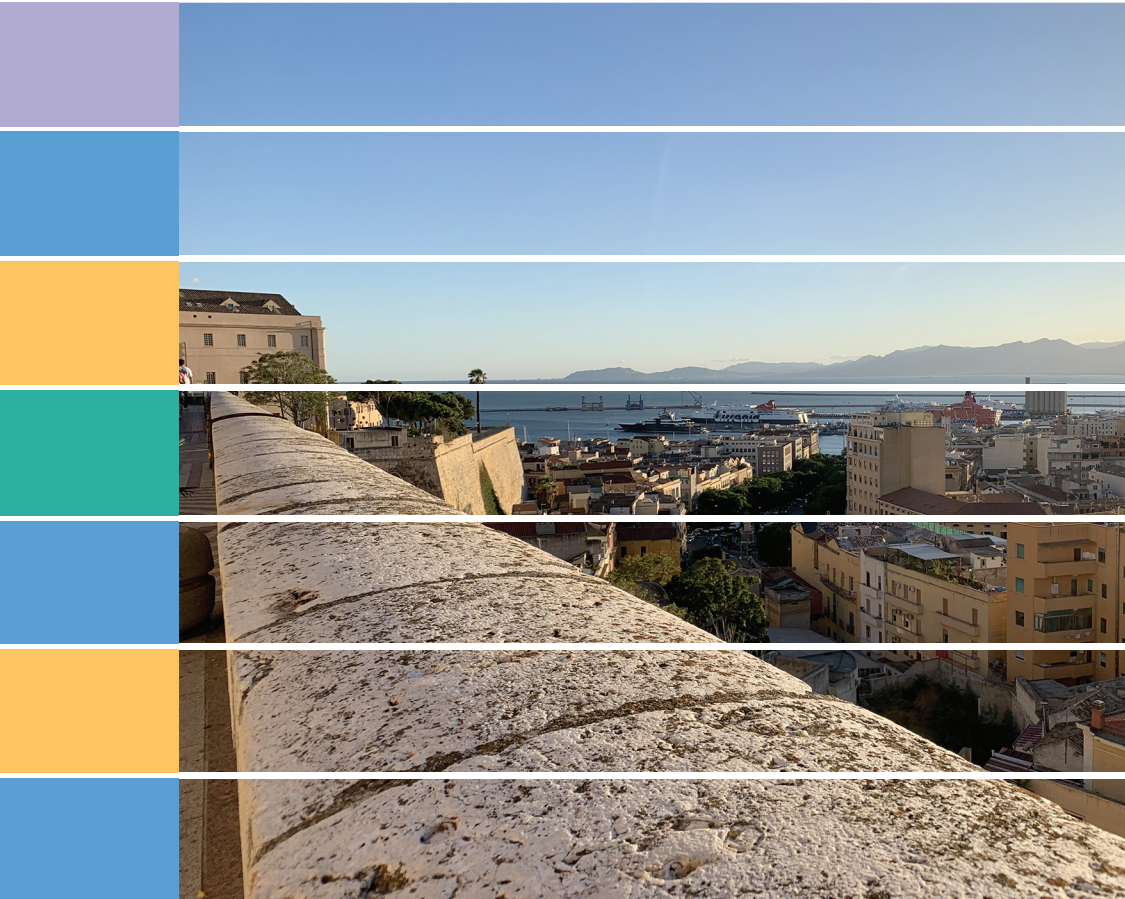


Carmela Gargiulo Corrado Zoppi  
*Editors*

# Planning, Nature and Ecosystem Services



**INPUT** TeMA Lab Dicaa UniNA

Federico II Open Access University Press







Università degli Studi di Napoli Federico II  
*Scuola Politecnica e delle Scienze di Base*

Smart City, Urban Planning for a Sustainable Future

**5**





Carmela Gargiulo Corrado Zoppi

*Editors*

## **Planning, Nature and Ecosystem Services**

INPUT aCademy 2019

*Conference proceedings*

Federico II Open Access University Press



*Planning, nature and ecosystem services* / editors Carmela Gargiulo, Corrado Zoppi - Napoli: FedOAPress. 2019 - (Smart City, Urban Planning for a Sustainable Future. 5).

Web link:

<http://www.tema.unina.it/index.php/tema/Monographs>

ISBN: 978-88-6887-054-6

DOI: 10.6093/978-88-6887-054-6

*Editor*

Rocco Papa, University of Naples Federico II, Italy

*Editorial Advisory Board*

Mir Ali, University of Illinois, USA - Luca Bertolini, Universiteit van Amsterdam, Paesi Bassi - Luuk Boelens, Ghent University, Belgium - Dino Borri, Politecnico di Bari, Italia - Enrique Calderon, Universidad Politécnica de Madrid, Spagna - Roberto Camagni, Politecnico di Milano, Italia - Derrick De Kerckhove, University of Toronto, Canada - Mark Deakin, Edinburgh Napier University, Scotland - Aharon Kellerman, University of Haifa, Israel - Nicos Komninos, Aristotle University of Thessaloniki, Grecia - David Matthew Levinson, University of Sydney, Australia - Paolo Malanima, Magna Græcia University of Catanzaro, Italy - Agostino Nuzzolo, Università degli Studi di Roma Tor Vergata, Italia - Rocco Papa, Università degli Studi di Napoli Federico II, Italia - Serge Salat, Urban Morphology and Complex Systems Institute, France - Mattheos Santamouris, National Kapodistrian University of Athens, Greece - Ali Soltani, Shiraz University, Iran

**Selection and double blind review under responsibility of INPUT aCademy 2019 Conference Committee**

© 2019 FedOAPress - Federico II Open Access University Press

Università degli Studi di Napoli Federico II

Centro di Ateneo per le Biblioteche "Roberto Pettorino"

Piazza Bellini 59-60 - 80138 Napoli, Italy

<http://www.fedoapress.unina.it>

Published in Italy

Gli E-Book di FedOAPress sono pubblicati con licenza

Creative Commons Attribution 4.0 International

Cover and graphic project: TeMALab

This book collects the papers presented at INPUT aCA<sup>d</sup>emy 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 aCA<sup>d</sup>emy 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 aCA<sup>d</sup>emy 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 aCA<sup>d</sup>emy 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  
Marta Bottero - Politecnico di Torino  
Domenico Camarda - Politecnico di Bari  
Arnaldo Cecchini - Università degli Studi di Sassari  
Donatella Cialdea - Università del Molise  
Giovanni Colombo - ISMB Istituto Superiore Mario Boella  
Valerio Cutini - Università di Pisa  
Andrea De Montis - Università degli Studi di Sassari  
Romano Fistola - Università degli Studi del Sannio  
Carmela Gargiulo - Università di Napoli "Federico II"  
Davide Geneletti - University of Trento  
Roberto Gerundo - Università degli Studi di Salerno  
Paolo La Greca - University of Catania  
Daniele La Rosa - University of Catania  
Giuseppe Las Casas - University of Basilicata  
Antonio Leone - Tuscia University  
Sara Levi Sacerdotti - SITI  
Giampiero Lombardini - Università degli Studi di Genova  
Stefania Mauro - SITI  
Giulio Mondini - Politecnico di Torino  
Beniamino Murgante - University of Basilicata  
Silvie Occelli - IRES Piemonte  
Rocco Papa - Università di Napoli "Federico II"  
Raffaele Pelorosso - Tuscia University  
Alessandro Plaisant - Università degli Studi di Sassari  
Bernardino Romano - Università degli Studi dell'Aquila  
Francesco Scorza - University of Basilicata  
Maurizio Tira - University of Brescia  
Angioletta Voghera - Politecnico di Torino

#### LOCAL COMMITTEE

Ginevra Balletto - Università di Cagliari  
Ivan Blečić - Università di Cagliari  
Michele Campagna - Università di Cagliari  
Ignazio Cannas - Università di Cagliari  
Anna Maria Colavitti - Università di Cagliari  
Sebastiano Curreli - Università di Cagliari  
Maddalena Floris - Università di Cagliari  
Chiara Garau - Università di Cagliari  
Federico 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  
Marianna Agostina Mossa - Regione Sardegna  
Salvatore Pinna - Università di Cagliari  
Cheti Pira - Università di Cagliari  
Daniela Ruggeri - 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 <i>Corrado Zoppi</i>	15
<b>Sessione 1 - Ecosystem services and spatial planning</b>	
The Danube Riverside Development in the Iron Gates Gorge, Serbia, between Socio-economic needs and Protected Ecosystem <i>Branislav Antonić, Aleksandra Djukić, Milica Cvetanović</i>	17
From a species-centred to an ecosystem-based management approach, a case study of the saltmarshes of Hyères (Provence, France) <i>Patrick Astruch, Charles-François, Boudouresque, Thomas Changeux et al.</i>	29
Spatial evolutions between identity values and settlements changes. Territorial analyses oriented to the landscape regeneration <i>Donatella Cialdea</i>	39
Analyzing senior tourism. The role of ecosystem services to improve sustainable tourism destinations <i>Romano Fistola, Rosa Anna La Rocca</i>	52
Carbon sequestration and land-taking processes. A study concerning Sardinia <i>Maddalena Floris, Corrado Zoppi</i>	66
The impact of urbanization processes in landscape fragmentation. A comparison between coastal zones of Sardinia and Liguria <i>Giampiero Lombardini, Andrea De Montis, Vittorio Serra</i>	80
Areas of considerable public interest, territorial common goods and ecosystem services: an application case for the city of Cagliari <i>Marzia Morittu, Alessandro Plaisant</i>	86
A bottom up initiatives for biodiversity: ecologic representation for the inner areas of Sardinia <i>Giuseppe Roccasalva</i>	98
The soil matter between eco-systemic performance and spatial planning in metropolitan areas <i>Saverio Santangelo, Paolo De Pascali, Annamaria Bagaini, Clara Musacchio, Francesca Perrone</i>	111
Knowledge-building models for environmental planning: the case study of Bari <i>Stefania Santoro, Domenico Camarda, Pasquale Balena</i>	120
From Ecosystems to Ecosystem Services. A spatial methodology applied to a case study in Sardinia <i>Matilde Schirru, Simona Canu, Laura Santona, Sabrina Lai, Andrea Motroni</i>	130

## Session: 2 - Integrated management of marine protected areas and Natura 2000 sites

Organize the management of protected areas according to an optimal framework. Experimental case <i>Aicha Bouredji</i>	142
A methodological approach to build a planning environmental assessment framework in the context of marine protected areas <i>Ignazio Cannas, Daniela Ruggeri</i>	152
An experimental methodology for the management of marine protected areas <i>Maddalena Floris, Federica Isola, Cheti Pira</i>	165
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) <i>Daniele Grech, Luca Fallati, Simone Farina, David Cabana, Ivan Guala</i>	176
Assessing the potential Marine Natura 2000 sites to produce ecosystem-wide effects in rocky reefs: a case study from Sardinia Island (Italy) <i>Paolo Guidetti; Pierantonio Addis; Fabrizio Atzori et al.</i>	185
Bottlenecks in fully implementing the Natura 2000 network in Italy. An analysis of processes leading to the designation of Special Areas of Conservation <i>Sabrina Lai</i>	201
Urban pressure scenario on the protected areas systems. The case study of Teatina adriatic coast <i>Alessandro Marucci, Lorena Fiorini, Carmen Ulisse</i>	212
Posidonia banquettes on the Mediterranean beaches: To what extent do local administrators' and users' perceptions correspond? <i>Paolo Mossone, Ivan Guala, Simone Simeone</i>	225
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 <i>Chiara Paoli, Paolo Povero, Giorgio Fanciulli et al.</i>	235
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" <i>Salvatore Pinna, Francesca Leccis</i>	251
Passive acoustics to monitor flagship species near boat traffic in the Unesco world heritage natural reserve of Scandola <i>Marion Poupard, Maxence Ferrari, Jan Schlüter et al.</i>	260
Use of ecological indices to assess the health status of Posidonia oceanica meadows in the Eastern Liguria. Influence of ecological status on natural capital <i>Iliara Rigo, Monica Montefalcone, Carla Morri et al.</i>	271
Coastal governance and planning agreements for integrated management of marine protected areas in UE coasting project <i>Saverio Santangelo, Paolo De Pascali, Maria Teresa Cutri et al.</i>	281

Innovative management tools to survey boat traffic and anchoring activities within a Marine Protected Area <i>Thomas Schohn, Patrick Astruch, Elodie Rouanet et al.</i>	292
SHADES. Sustainable and holistic approaches to development in European seabords <i>Francesco Vita, Fortunato Cozzupoli</i>	302
 <b>Session 3 - Rural development and conservation of nature and natural resources</b>	
New local projects for disadvantaged inner areas. From traditional model to bio-regional planning <i>Anna Maria Colavitti, Alessio Floris, Francesco Pes et al.</i>	312
Inclusion of migrants for rural regeneration through cultural and natural heritage valorization <i>Elisa Conticelli, Claudia de Luca, Aitziber Egusquiza et al.</i>	323
Environmental and social sustainability of the bioenergy supply chain <i>Sebastiano Curreli</i>	333
Proposals on the Agricultural Land Use in According to the Features of the landscape: The case study of Sardinia (Italy) <i>Pasquale Mistretta, Giulia Desogus, Chiara Garau</i>	345
Common land(scape): morphologies of a multifunctional rural landscape in the Isalle Valley, Sardinia <i>Roberto Sanna</i>	356
SheepToShip LIFE: Integration of environmental strategies with rural development policies. Looking for an eco-sustainable sheep supply chain <i>Enrico Vagnoni, Alberto Atzori, Giovanni Molle et al.</i>	366
 <b>Session 4 - Geodesign, planning and urban regeneration</b>	
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 <i>Stefania Aru, Sandro Sanna</i>	375
The International Geodesign Collaboration: the Cagliari case study <i>Michele Campagna, Chiara Cocco, Elisabetta Anna Di Cesare</i>	385
A geodesign collaboration for the mission valley project, San Diego, USA <i>Chiara Cocco, Bruce Appleyard, Piotr Jankowski</i>	399
University and urban development: The role of services in the definition of integrated intervention policies <i>Mauro Francini, Sara Gaudio, Annunziata Palermo, Maria Francesca Viapiana</i>	410

Urban environment. An analysis of the Italian metropolitan cities <i>Giuseppe Mazzeo</i>	419
Recycled aggregates. Mechanical properties and environmental sustainability <i>Luisa Pani, Lorena Francesconi, James Rombi et al.</i>	431
Geodesign fast-workshops evidences. On field applications of collaborative design approach for strategic planning and urban renovation <i>Francesco Scorza</i>	443

## 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 <i>Clara Alvau Morales, Tanja Congiu, Alessandro Plaisant</i>	453
The value of water: ecosystem services trade-offs and synergies of urban lakes in Romania <i>Denisa Lavinia Badiu, Cristian Ioan Iojă, Alina Constantina Hossu et al.</i>	465
A blue infrastructure: from hydraulic protection to landscape design. The case study of the village of Ballao in the Flumendosa river valley <i>Giovanni Marco Chiri, Pino Frau, Elisabetta Sanna et al.</i>	476
Municipal masterplans and green infrastructure. An assessment related to the Metropolitan Area of Cagliari, Italy <i>Sabrina Lai, Federica Leone, Corrado Zoppi</i>	488
The Ombrone river contract: A regional design practice for empowering river communities and envisioning basin futures <i>Carlo Pisano, Valeria Lingua</i>	502
Green infrastructures in the masterplan of Rome. Strategic components for an integrated urban strategy <i>Laura Ricci, Carmela Mariano, Irene Poli</i>	513

## Session 6 - Smart city planning

Smart City Governance for Child-friendly Cities: Impacts of Green and Blue Infrastructures on Children's Independent Activities <i>Alfonso Annunziata, Chiara Garau</i>	524
Resilience, smartness and sustainability. Towards a new paradigm? <i>Sabrina Auci, Luigi Mundula</i>	539
Energy autonomy in symbiosis with aesthetics of forms in architecture <i>Pietro Currò</i>	549
Sharing governance and new technologies in smart city planning <i>Paolo De Pascali, Saverio Santangelo, Annamaria Bagaini et al.</i>	563

Smart Mapping Tools for the Balanced Planning of Open Public Spaces in the Tourist Town of Golubac, Serbia <i>Aleksandra Djukić, Branislav Antonić, Jugoslav Joković, Nikola Dinkić</i>	573
Towards a model for urban planning control of the settlement efficiency <i>Isidoro Fasolino, Francesca Coppola, Michele Grimaldi</i>	587
Somerville: Innovation City <i>Luna Kappler</i>	595
Urban regeneration for smart communities. <i>Caterina Pietra, Elisabetta Maria Venco</i>	605
Energy autonomy as a structural assumption for systemic development and circular economy <i>Manlio Venditelli</i>	619
<b>Session 7 - Water resources, ecosystem services and nature-based solutions in spatial planning</b>	
Landscape and species integration for a nature-based planning of a Mediterranean functional urban area <i>Erika Bazzato, Michela Marignani</i>	630
Tourism and natural disasters: integrating risk prevention methods into the Plan for tourism <i>Selena Candia, Francesca Pirlone</i>	640
Integrated management of water resources. An operative tool to simplify, direct and measure the interventions <i>Vittoria Cugusi, Alessandro Plaisant</i>	649
Application of NbS to the city plan of Segrate Municipality: spatial implications <i>Roberto De Lotto</i>	660
Nature-Based Solutions impact assessment: a methodological framework to assess quality, functions and uses in urban areas <i>Claudia De Luca, Simona Tondelli</i>	671
The recognition of the Aspromonte National Park ecosystem networks in the urban structure project of Metropolitan City of Reggio Calabria <i>Concetta Fallanca, Natalina Carrà, Antonio Taccone</i>	679
Shaping the urban environment for breathable cities. <i>Michela Garau, Maria Grazia Badas, Giorgio Querzoli, Simone Ferrari, Alessandro Seoni, Luca Salvadori</i>	692
Defense, adaptation and relocation: three strategies for urban planning of coastal areas at risk of flooding <i>Carmela Mariano, Marsia Marino</i>	704
Thermal Urban Natural Environment Development <i>Francesca Moraci, Celestina Fazia, Maurizio Francesco Errigo</i>	714

A network approach for studying multilayer planning of urban green areas: a case study from the town of Sassari (Sardegna, Italy) <i>Maria Elena Palumbo, Sonia Palumbo, Salvatore Manca, Emmanuele Farris</i>	723
Urban areas morphometric parameters and their sensitivity on the computation method <i>Luca Salvadori, Maria Grazia Badas, Michela Garau, Giorgio Querzoli, Simone Ferrari</i>	734

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

Preservation and valorisation of small historic centers at risk <i>Maria Angela Bedini, Fabio Bronzini, Giovanni Marinelli</i>	744
Material and immaterial cultural heritage: identification, documentation, promotion and valorization. The courtyards and hallways of merit in the Murattiano district of Bari <i>Antonia Valeria Dilauro, Remo Pavone, Francesco Severino</i>	757
Planning of historic centers in Sardinia Region: conservation versus valorization of architectural and cultural heritage <i>Federica Isola, Federica Leone, Cheti Pira</i>	767
Approach towards the "self-sustainability" of ancient villages <i>Francesca Pirlone, Ilenia Spadaro</i>	776
Fostering architecture efficiency through urban quality. A project for via Milano site in Brescia <i>Michela Tiboni, Francesco Botticini</i>	787

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

The role of community enterprises in spatial planning for low density territories <i>Cristian Cannaos, Giuseppe Onni</i>	800
Measuring multimodal accessibility at urban services for the elderly. An application at primary health services in the city of Naples <i>Gerardo Carpentieri, Carmen Guida, Housmand Masoumi</i>	810
Urban accessibility for connective and inclusive living environments. An operational model at support of urban planning and design practice <i>Tanja Congiu, Elisa Occhini, Alessandro Plaisant</i>	826
Improving accessibility to urban services for over 65: a GIS-supported method <i>Carmela Gargiulo, Floriana Zucaro, Federica Gaglione, Luigi Faga</i>	839
Cycle networks in Natura 2000 sites: the environmental assessment of the Regional Cycling Plan of Sardinia, Italy <i>Italo Meloni, Elisabetta Anna Di Cesare, Cristian Saba</i>	851

Improving regional accessibility through planning a comprehensive cycle network: the case of Sardinia (Italy) 859  
*Italo Meloni, Cristian Saba, Beatrice Scappini et al.*

Vehicle routing problem and car-pooling to solve home-to-work transport problem in mountain areas 869  
*Antonio Pratelli, Massimiliano Petri*

## **Session 10 - Tourism and sustainability in the Sulcis area**

Wave, walk and bike tourism. The case of Sulcis (Sardinia -Italy) 881  
*Ginevra Balletto, Alessandra Milesi, Luigi Mundula, Giuseppe Borruso*

Smart Community and landscape in progress. The case of the Santa Barbara walk (Sulcis, Sardinia) 893  
*Ginevra Balletto, Alessandra Milesi, Stefano Naitza et al.*

A Blockchain approach for the sustainability in tourism management in the Sulcis area 904  
*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) 920  
*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 928  
*Anna Maria Colavitti, Alessia Usai*

Walkability as a tool for place-based regeneration: the case study of Iglesias region in Sardinia (Italy) 943  
*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) 955  
*Federica Leone, Anania Mereu*

Relationships between conservation measures related to Natura 2000 sites and coastal land use plans: a study concerning Sulcis (Sardinia, Italy) 971  
*Federica Leone, Corrado Zoppi*

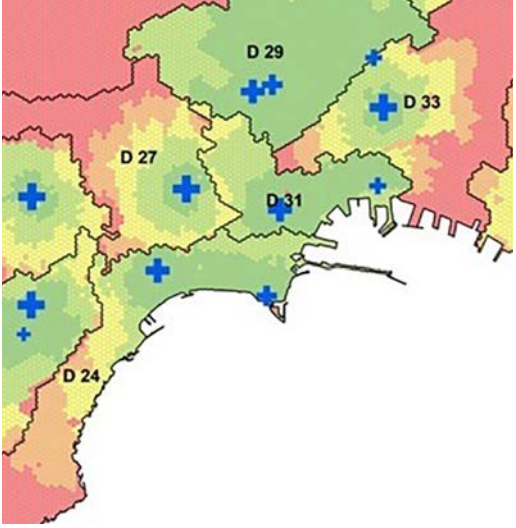
A Smart Planning tools for the valorisation of the Carbonia's building heritage via an energy retrofitting based approach 983  
*Stefano Pili, Francesca Poggi, Eusebio Loria, Caterina Frau*

## **Special session 1 - Ecological networks and landscape planning**

Resilient ecological networks. A comparative approach 995  
*Andrea De Montis, Amedeo Ganciu, Maurizio Mulas et al.*

A complex index of landscape fragmentation: an application to Italian regional planning <i>Andrea De Montis, Amedeo Ganciu, Vittorio Serra</i>	1007
Measuring landscape fragmentation in Natura 2000 sites. A quantitative and comparative approach <i>Antonio Ledda, Andrea De Montis, Vittorio Serra</i>	1017
Regional ecological networks: theoretical and practical issues <i>Giuseppe Modica, Salvatore Praticò, Luigi Laudari et al.</i>	1028
Comparative ecological network analysis. Target and vector species and other naturalistic issues <i>Maurizio Mulas, Matteo Cabras, Andrea De Montis</i>	1038
Measuring connectivity in Natura 2000 sites. An application in Sardinia <i>Vittorio Serra, Andrea De Montis, Antonio Ledda</i>	1049





# MEASURING MULTIMODAL ACCESSIBILITY TO URBAN SERVICES FOR THE ELDERLY

AN APPLICATION AT PRIMARY HEALTH SERVICES  
IN THE CITY OF NAPLES

**GERARDO CARPENTIERI<sup>a</sup>, CARMEN GUIDA<sup>a</sup>  
HOUSHMAND MASOUMI<sup>b</sup>**

<sup>a</sup> Department of Civil, Architectural and  
Environmental Engineering  
University of Naples Federico II, Italy  
e-mail: gerardo.carpentieri@unina.it  
carmen.guida@unina.it

<sup>b</sup> Center for Technology and Society of  
Technische Universität Berlin, Germany  
e-mail: masoumi@ztg.tu-berlin.de

*How to cite item in APA format:*

Carpentieri, G., Guida, C. & H. Masoumi (2019). Measuring Multimodal Accessibility at Urban Services for Elderly. An application at primary health services in the city of Naples. In C. Gargiulo & C. Zoppi (Eds.), *Planning, nature and ecosystem services* (pp. 810-825). Naples: FedOAPress. ISBN: 978-88-6887-054-6, doi: 10.6093/978-88-6887-054.6

## ABSTRACT

*In Europe, the share of people aged 65 years and over is expected to increase exponentially, and for the first time in human history, in 2050, the number of older people will be greater than the number of children under 15 years old. At the same time, aging is associated to an increased vulnerability and dependence on medical care services. An ageing population poses various challenges to a society and improvements in the medical and transportation systems are needed to maintain and to improve the quality of life of the elderly population. From the perspective of social equity, everyone should have the opportunity to access such services equally, but because of economic and geographical issues, it is a challenge to achieve such level of equity. The aim of this study is to fill the gap between scientific and real practices through an accessibility measure able to evaluate urban accessibility to primary healthcare services and to support decision-makers to better allocate resources, in local welfare policies restructuring. The accessibility measure was designed considering both the land-use and the transportation components, taking into account the local healthcare supply system and a multimodal transportation network. The methodology was applied for the city of Naples, considering Local Health Agency (ASL) healthcare services to elderly population. The supply consists of 17 buildings used by nearly 200,000 of old people. The outputs show that entire neighbourhoods' elderly population suffer from a very poor accessibility to primary health services, especially in the city suburbs, and that the methodology could be effective in urban planning strategies to achieve a high quality of life for elderly people.*

## KEYWORDS

*Accessibility; Elderly; GIS*

## 1 INTRODUCTION

Demographic ageing is an increasing phenomenon in urban areas and its economic and social consequences are comparable to the industrial revolution (ARUP, 2015). In Europe, the share of people aged 65 years and over is expected to increase from 19.4% in 2017 to 30% of the total population in 2060 and for the first time in human history, in 2050, the number of older people will be greater than the number of children under 15 years old (Eurostat, 2018). Moreover, in the European context, the demographic shift would be dramatic for Germany, Portugal, Spain and Italy, where the most aged major cities are located. The Italian Institute of Statistics (ISTAT) forecasts a significant reduction of the total population, from over 60 million people in 2018 to 46 million in 2065, and at the same time a noteworthy increase in the over-65 population (from 22.7% in 2019 to 30.5% in 2065). This means that Italy would be an even older nation.

Considering their significant increase in number and their health condition, the elderly represent an essential group of interest: due to improvements in nutrition, sanitation and medical care older people are healthier than previous generation but, at the same time, aging is also associated to an increased vulnerability and dependence on medical care services. From the perspective of social equity, everyone should have the opportunity to access such services equally, but because of economic and geographical issues, it is a challenge to achieve such level of equity (Kim et al., 2018). Local authorities should prioritise the implementation of policies to promote higher life-quality standards for this increasing portion of population and the accessibility approach can be useful to achieve this aim. It takes into account both the land-use system, consisting of the amount, quality and spatial distribution of supply and demand of activities, and the transport system, considering individual needs, abilities and opportunities (Geurs & van Wee, 2004; Papa et al., 2017). Since studies showed that mobility and accessibility trends of the elderly are a critical trial to transport systems (Aceves-González et al., 2015; Buehler & Nobis, 2010; Currie & Delbosc, 2010; Voss et al., 2016) the provision of a sustainable transport system, designed for the elderly's mobility needs, is both urgent and necessary (O'Neill, 2016). On the other hand, the activity system needs to be shaped and organized in order to gain a uniform level of access within the same city. It is crucial to provide decision support tools to local administrator to evaluate and assess the accessibility level to medical care services in urban areas (Papa et al., 2018b).

The aim of this paper is to measure the number of elderly people that suffer from a poor accessibility to public primary health care services according to the active accessibility paradigm. The procedure was applied for the public primary health services in the city of

Naples, Italy, and it can be taken for other similar cities in case of urban size and socio-demographics.

The project is targeted to develop strategies and decision-making tools for improving the location of services for the elderly and their accessibility using public transport. The structure of the paper is organised into four different parts. Following this introduction, in section 2, a GIS-based methodology is proposed in order to compute the urban accessibility in urban areas; in section 3, we discuss the application to the city of Naples; in section 4, we analyse the results and discuss further research developments.

## 2 BACKGROUND

Due to the increasing political and scientific interest on the topic, several methods and approaches were produced for determining healthcare accessibility and, based on the application context, these measures vary a lot in terms of theoretical basis, operationalisation, interpretability and communicability (Geurs & Van Wee, 2004). The simplest way to assess healthcare accessibility is to use contour measures (or opportunity measures), defining catchment areas by drawing one or more travel time contours around a node and measuring the number of opportunities within each contour. This measure is easy to compute and understand but suffers of a poor theoretical basis, since different distances within the same area have no weight to evaluate accessibility. Moreover, in a metropolis where many alternatives exist the distance to the nearest primary care service does not match people demand. In order to define catchment areas by measuring travel impediment on a continuous scale, gravity measures were introduced: even though they are more accurate representations of travel resistance than contour measures, they tend to be less legible and neglect the variation across individuals living in the same area (Scheurer & Curtis, 2007). Utility-based accessibility measures are the link between infrastructure provision and perceived individual and societal benefits, assuming that people select the healthcare alternative with the highest utility. Although the strong theoretical basis (McFadden, 1975), it could be difficult to compute and interpret these measures.

In order to contribute to these debates, this paper proposes a GIS-based procedure to evaluate public primary health care accessibility, considering a multimodal transport network (walking streets, bus lines, metro lines and urban rail lines) and through the lens of social equity. The aim is to quantify elderly people that suffer from a poor accessibility to public primary health care services according to the active accessibility paradigm. The procedure was applied for the public primary health services in the city of Naples, Italy.

### 3 METHODOLOGY

In this study, we develop a GIS-based procedure to evaluate the level of accessibility to elderly urban services considering the demographic characteristics of potential users, the multimodal transport service (characteristics of walking street, frequency of service and localization of urban transport stops) and characteristics of health services.

The proposed GIS-based procedure is organised in the following three steps: data collection, GIS spatial analysis and representation of results. Methodologically, our approach integrates the use of open data (spatial and alphanumeric) and organizational capability, analysis and representation of Geographic Information Systems (GIS) software. According to GIS Model Builder tool of ArcGIS Pro 2.2 software, we defined a geoprocessing workflow to execute operations that organize and analyze the alphanumeric and spatial data (Fig. 1).

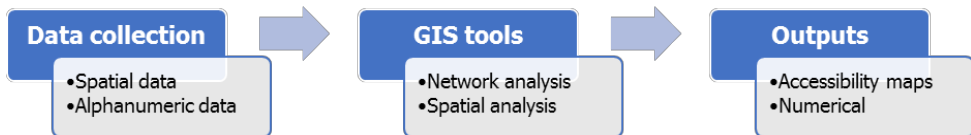


Fig. 1 The phases of GIS-based procedure to evaluate the multimodal accessibility of elderly at urban services

In the procedure first step, it is necessary to create a geodatabase using a GIS software, containing different types of data (spatial and alphanumeric). To improve the data output accuracy of the GIS-based procedure, we introduced a regular spatial grid to divide the area of analysis into small spatial units. The use of grid frames is very important for experimental and observational science, as well as providing the most common framework for spatially explicit models. The hexagonal cell, which is the minimum spatial unit in which the study area is divided, has mainly hexagonal and square shapes, which side may have dimensions previously selected by the user based on the area to be analysed (Papa et al., 2018a). In literature, the use of a hexagonal cell rather than a square one is best advised for dealing with areas that have problems related to the connectivity of different space units and the identification of shorter paths for calculating travel distances (Kibambe Lubamba et al., 2013). For this GIS-based procedure, we used as a spatial unit a regular hexagonal cell with a side length of 50m that provides greater aesthetic attraction but above all a greater accuracy in the calculation and visualization of numerical data. According to the previous studies, to assign the census tracks socio-economic data to hexagonal cells, it used a proportional function that considered the buildings footprint located in each cell (Papa et al., 2018b; Carpentieri & Favo, 2017).

In the second step, geoprocessing, joint data and network analysis operations elaborate the data to evaluate the travel time and accessibility level to health services for the elderly people. In order to evaluate travel times from each hexagonal cell to the main local health buildings, we created a multimodal transport network. We considered the network as the combination of both walkable streets and local public transport lines (bus and metro) to better simulate elderly mobility habits. The ArcGIS Pro 2.2 Network Analysis tool was used to compute the OD travel matrix. We run four different analysis during morning peak-hour (9:00), for an average adult, for a 65-69-aged person, for a 70-74-aged person and for an over-75-aged person, considering four different walking speeds for each age category (Papa et al., 2018b). In the third step, maps and tables were produced to quantify, numerically and spatially, the results of the GIS-based procedure and support the planning process of decision-policy makers. The results of this procedure can be easily used also by elderly, in order to choose a more comfortable dwelling neighbourhood.

Tab. 1 provides the list of alphanumeric and spatial data (vector and raster) requests for the application of the GIS-based procedure.

DATA	CATEGORY OF DATA	TYPE OF GEOMETRY	SOURCE
Population	Alphanumeric	-	Statistics Institute
Transport schedules	Alphanumeric	-	Transport companies
Primary health services	Vector / Alphanumeric	Point	Local Health Agency
Walking street network	Vector	Polyline	Open Street Map
Transport network	Vector	Polyline	Transport companies
Census tracts	Vector	Polygon	Statistics Institute
Buildings	Vector	Polygon	Geoportal
Digital Terrain Model	Raster	-	Geoportal

Tab. 1 Data selected for the implementation the GIS-based procedure

The accessibility level was measured for each hexagonal cell, using the following formulas:

$$Acc_{j|d,i} = \frac{\sum_{k=1}^n S_{k|d}}{P_j * t_{travel j,i}} \tag{1}$$

$$Acc_{j|d} = \sum_{i=1}^m Acc_{j|d,i} \tag{2}$$

Equation 1 is used to compute the accessibility of each cell j to the nearest health service i, within the same district d. It is the ratio between the sum of primary health services (surgeries) offered in i,  $S_k$ , and the dwelling population in each cell j multiplied with the total travel time, in minutes, to reach the primary health building i from the barycentre of each

hexagonal cell  $j$ . Equation 2 represents the second step of the accessibility measurement: for every hexagonal cell, we summed the accessibility of each health building within the same administrative health district. According to the literature (Bauer & Groneberg, 2016; Kim et al., 2018), we identified five different accessibility classes for this case study considering the minimum number of primary health services useful to elderly ( $S_k$ ) and travel time thresholds (15, 30, 45 and 60 minutes).

According to the literature review (Bauer & Groneberg, 2016; Kim et al., 2018), we identified five different accessibility classes for this case study considering a minimum number of primary health services useful to elderly (eleven services) and travel time thresholds (15, 30, 45 and 60 minutes). These levels of accessibility have also been applied in this study.

LEVEL OF ACCESSIBILITY	TRAVEL TIME [min]	$A_j$
VERY GOOD	<15	>0.73
GOOD	15-30	0.73 – 0.37
LOW	30-45	0.37 – 0.24
POOR	45-60	0.24 – 0.18
VERY POOR	>60	< 0.18

Tab. 2 Accessibility thresholds

The proposed GIS-based procedure is applied to the city of Naples to evaluate the urban accessibility at public primary health services for the elderly people. We selected this case study because it represents one of the most interesting examples of a complex southern European city with high population density, non-uniform urban structure and the absence of a specific plan to satisfy the elderly people's needs.

The city of Naples has 970,185 inhabitants (ISTAT, 2017) within 117.27 km<sup>2</sup> and is the fifth Italian city in terms of population density. In the last decade, the city was affected by a gradual increase in the elderly population: from 2008 to 2018, the elderly population of the city increased of 20,052 inhabitants (ISTAT, 2018). The Naples Local Health Agency (ASL) is responsible for the primary healthcare supply in the city boundary and it has a very complex structure due to the numerous demand (nearly one million units) and the socio-economic and health heterogeneity within the competence area. The Naples ASL has eighteen hospital institutions spread all over the city but, in order to better program and allocate resources, to monitor and manage medical care and treatments, health districts would have a significant and strategic role.

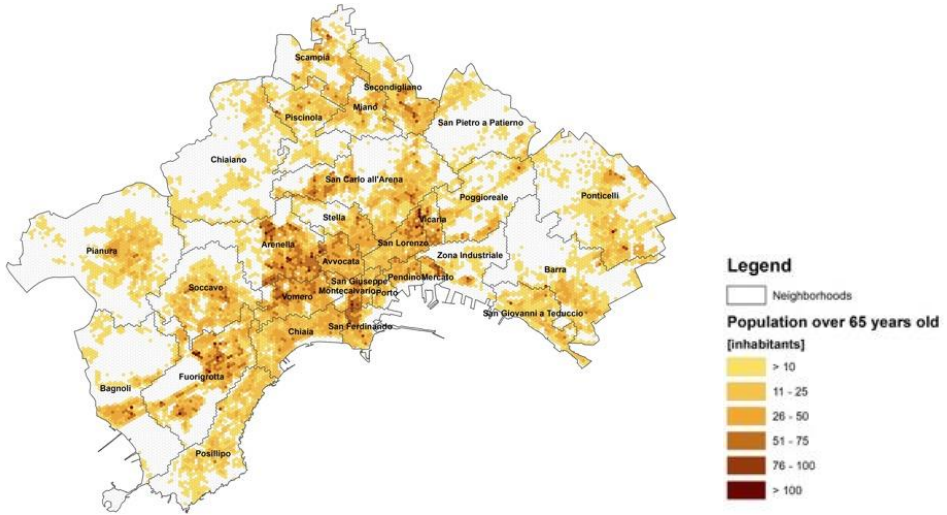


Fig. 2 The distribution of over 65-years-old population

The Italian law (D.Lgs. 229/1999 Art. 3) regulates health districts functions and identify them as territorial joints of ASL, the closest health supply for citizens. A programmatic document of health services supply at local level organizes the Districts activities and the ones belonging to upper health public levels and equivalent private services. Hence, Health Districts have a strategic role in the present welfare system whose aim is to integrate this form of assistance to more institutionalized solutions, such as physicians and voluntary organizations.

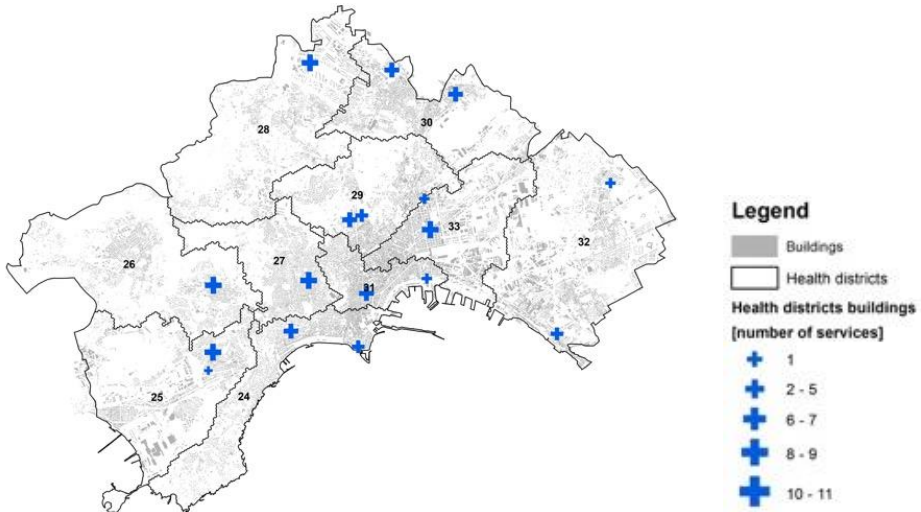


Fig. 3 The location of primary health buildings for each district

They represent a significant tool in order to limit social exclusion in urban areas.

For the first application of this methodology, we selected local health primary services supplied by Naples ASL.



Fig. 4 The multimodal transport network

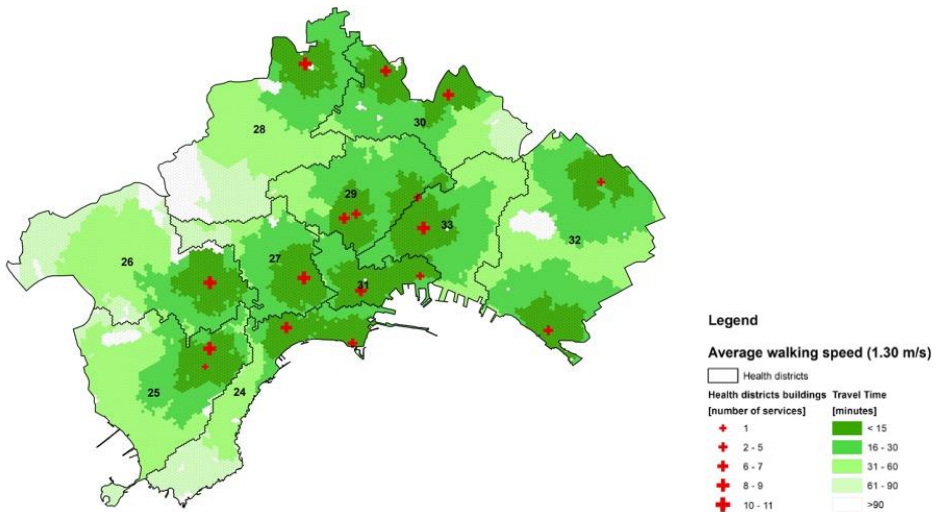


Fig. 5 The travel time to primary health centers

In particular, the municipality of Naples is divided in ten health districts, whose administrative boundaries overlap one or more neighbourhoods' borders, as reported in Tab. 2. Their structures are spread in the whole city territory and they offer the following primary services



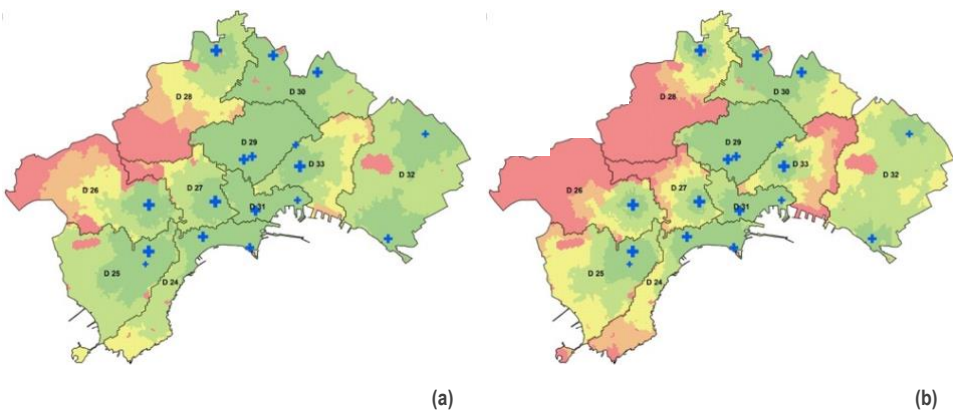
to elderly people: Cardiology, Geriatrics, Dermatology, Urology, Neurology, Pulmonology, Orthopaedics, Dentistry, Otolaryngology, Ophthalmology and Diabetology. They are managed by Campania Region and Naples ASL. A preliminary reading of the data reported in the Tab. 2 would suggest some interesting issues related to the spatial distribution of elderly and health services within the city of Naples. For instance, District 29 is the richest in health resources (building and surgeries) and its elderly inhabitants in between 65-69 years-old are the most numerous.

Moreover, District 27 (Arenella and Vomero) has the highest total and over-75-elderly (the oldest old) population, but just one health building. This initial analysis is not sufficient to investigate on social equity and it was used just as an input for the following evaluations.

According to the literature review (Bauer & Groneberg, 2016; Kim et al., 2018), we identified five different accessibility classes for this case study considering a minimum number of primary health services useful to elderly (eleven services) and travel time thresholds (15, 30, 45 and 60 minutes). In Tab. 4, 5 and 6 below, the number of elderly (65-69, 70-74 and over 75) in Naples Districts have been reported.

LEVEL OF ACCESSIBILITY	TRAVEL TIME [min]	$A_i$
VERY GOOD	<15	>0.73
GOOD	15-30	0.73 – 0.37
LOW	30-45	0.37 – 0.24
POOR	45-60	0.24 – 0.18
VERY POOR	>60	< 0.18

Tab. 3 Accessibility thresholds



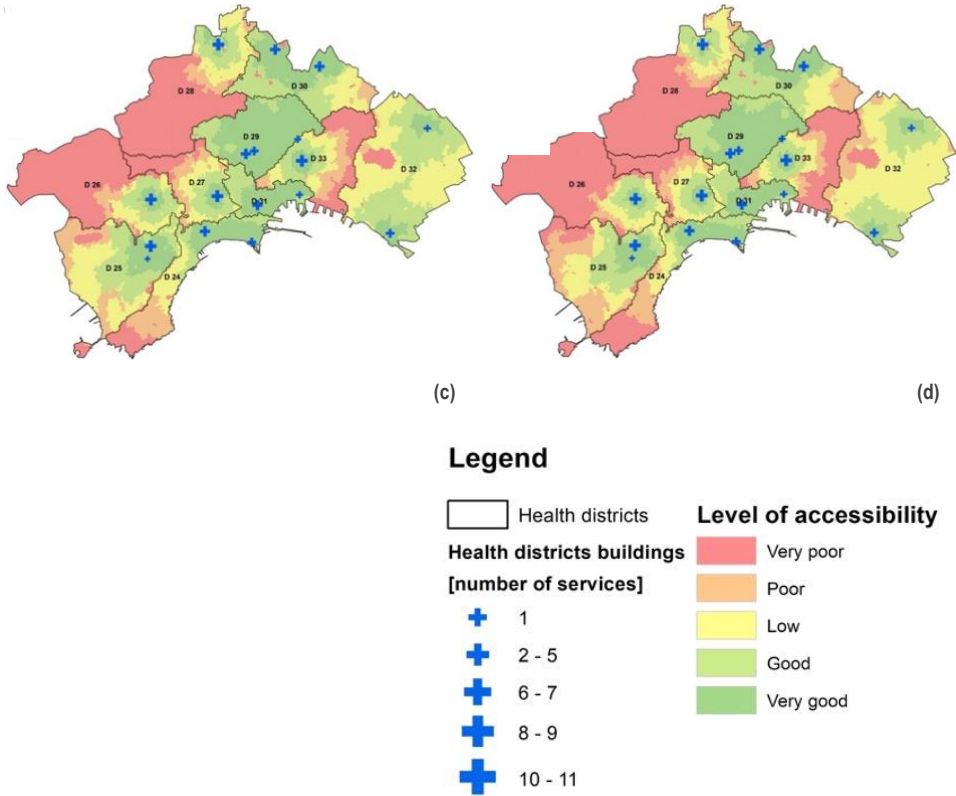


Fig. 6 Level of accessibility for an average person (a) and for the three elderly classes (b, c and d)

#### 4 FINDINGS

For what concerns the first age range (65-69), Districts 26 (Pianura and Soccavo) and 28 (Chiaiano, Piscinola, Marianella and Scampia) need an in-depth evaluation. In District 26 about 2,000 elderly people suffer from a very poor accessibility to primary health services and this percentage increases to nearly 60% if we also consider a low, poor and a very poor level of accessibility; this means that more than half of this District dwellers access to primary health services in more than 30 minutes.

Accessibility level for District 28 is even worst since just the 8% of elderly access to primary health services within 15 minutes, while over 70% have a low, poor and very poor level of accessibility.

Indeed, 98.9% of District 29 (Colli Aminei, San Carlo all'Arena and Stella) dwellers access to primary health services within 15 minutes. This highlights the deep social and spatial inequity even for bordering neighbourhoods.

DISTRICT	VERY GOOD	GOOD	LOW	POOR	VERY POOR
24	3,441	759	902	268	0
25	3,559	2,130	874	49	0
26	1,149	1,178	685	526	2,235
27	1,578	3,300	2,134	1,174	118
28	338	962	1,446	556	997
29	5,948	61	0	0	0
30	2,994	787	176	1	0
31	3,830	1,792	0	0	0
32	1,065	3,716	730	0	0
33	1,745	1,761	969	611	293
TOTAL	25,645	16,446	7,916	3,184	3,643

Tab. 4 65-69 aged population per district per level of accessibility

For the second age range (70-74), in District 26 and 28 more elderly people suffer from a very low accessibility level: respectively, 39.5% and 28.4% 70-74-aged people access to primary health services in more than 60 minutes. For District 27 (Arenella and Vomero), about 2.500 (more than 40%) people have a low level of accessibility, due to an access travel-time above 30 minutes. District 33 (Vicaria, San Lorenzo, Poggioreale) is not the worst in this context but it could be further investigated since nearly 40% of its 70-74-aged dwellers suffer from a low level of accessibility.

DISTRICT	VERY GOOD	GOOD	LOW	POOR	VERY POOR
24	2,286	723	692	438	23
25	2,365	1,580	882	52	0
26	641	754	622	221	1,425
27	1,205	2,571	1,667	1,024	107
28	176	574	1,049	390	778
29	4,363	143	0	0	0
30	2,009	764	69	22	0
31	2,439	1,461	42	0	0
32	758	1,924	1,100	7	0
33	986	1,273	604	436	357
TOTAL	17,228	11,767	6,726	2,589	2,690

Tab. 5 70-74 aged population per district per level of accessibility

Previous considerations are confirmed even for this last age range (over 75): districts 26 and 28 still have the highest rate of dwellers with the poorest accessibility level (respectively 37%

and 32%). Due to the slowest walking speed considered for this elderly age range (0.6 m/s), in every District the number of people with a low, poor and very poor levels of accessibility clearly increase.

DISTRICT	VERY GOOD	GOOD	LOW	POOR	VERY POOR
24	4,061	2,135	1,418	975	556
25	4,309	3,471	2,251	397	24
26	845	1,320	1,613	493	2,460
27	2,298	5,613	4,095	2,527	848
28	141	817	1,486	1,283	1,745
29	7,678	1,414	0	0	0
30	2,298	2,875	54	157	0
31	4,485	2,565	1,134	0	0
32	1,301	2,890	3,064	43	1
33	1,512	2,726	1,235	890	1,424
TOTAL	28,928	25,827	16,349	6,765	7,058

Tab. 6 Over 75 aged population per district per level of accessibility

## 5 CONCLUSION AND FUTURE DEVELOPMENTS

The growth of the elderly population in the last decades has generated a serious accessibility exclusion phenomenon. Some aspects influence the accessibility for the elderly population. The study of scientific literature on the relationship between service area extension, transport service frequency and age of users revealed the importance of considering these aspects in the evaluation of accessibility to urban services. This paper presented a quantitative method to assess accessibility to primary health services, considering a multimodal transport network and the local health system supply to elderly. In order to validate the methodology, it was applied to the city of Naples. The outputs show that entire neighbourhoods' elderly population suffers from a very poor accessibility to primary health services, especially in the city suburbs (Pianura, Soccavo, Chiaiano). In order to provide a higher accessibility level, more accurate and holistic land use planning policies are needed, also considering elderly needs and preferences. Based on the results, the methodology and the operational procedure proposed can be used as a decision support tool, in order to design new infrastructures or to optimize existing resources, in a G2B (Government to Business) point of view. In order to gain this aim, it would be useful to consider the whole primary health supply system, also considering its administrative rules and, since the main objective of our research is elderly population, a distance-decay function could be introduced to better compute their mobility availability.

Such decision support systems are efficient tools for policy makers and urban planners, however, their contribution to knowledge production concerning the interactions of urban planning with several other social issues are usually neglected. The future work can be clarifying the knowledge-based contributions of this tool to the European and Italian knowledge of interactions of land use and urban mobility of the elderly.

## ACKNOWLEDGEMENTS

This paper is a part of the research project 'MOBILAGE'. Mobility and ageing: daily life and welfare supportive networks at the neighbourhood level, that involves the University of Naples, the University of Groningen and the Politecnico of Milan. This work has been supported by Fondazione Cariplo (Grant n° 2017-0942). The authors acknowledge the financial support from the Fondazione Cariplo.

## AUTHOR CONTRIBUTIONS

Paragraph 1 and 3, Gerardo Carpentieri.; Paragraph 2 and 4 Carmen Guida; Paragraph 5 Houshmand Masoumi.

## REFERENCES

- Aceves-González, C., Cook, S., & May, A. (2015). Bus use in a developing world city: implications for the health and well-being of older passengers. *Journal of Transport & Health*, 2(2), 308-316. doi: <https://doi.org/10.1016/j.jth.2015.04.001>
- Alshalalfah, B. W., & Shalaby, A. S. (2007). Relationship of walk access distance to transit with service, travel, and personal characteristics. *Journal of urban planning and development*, 133, 114. doi: [https://doi.org/10.1061/\(ASCE\)0733-9488\(2007\)133:2\(114\)](https://doi.org/10.1061/(ASCE)0733-9488(2007)133:2(114))
- ARUP, Help Age International, Intel, Systematica (2015). Shaping Ageing Cities: 10 case studies from Europe.
- Bauer, J., & Groneberg, D. A. (2016). Measuring spatial accessibility of health care providers—introduction of a variable distance decay function within the floating catchment area (FCA) method. *PLoS one*, 11(7). doi: <https://doi.org/10.1371/journal.pone.0159148>
- Bohannon, R. W., & Andrews, A. W. (2011). Normal walking speed: a descriptive meta-analysis. *Physiotherapy*, 97(3), 182-189. doi: <https://doi.org/10.1016/j.physio.2010.12.004>
- Buehler, R., & Nobis, C. (2010). Travel behavior in aging societies: Comparison of Germany and the United States. *Transportation Research Record: Journal of the Transportation Research Board*, (2182), 62-70. doi: <https://doi.org/10.3141/2182-09>

Carpentieri, G., & Favo, F. (2017). The End-use Electric Energy Consumption in Urban Areas: A GIS-based methodology. An application in the city of Naples. *Tema. Journal of Land Use, Mobility and Environment*, 10(2), 139-156. doi: <http://dx.doi.org/10.6092/1970-9870/5173>

City of Naples (2016). *Piano Urbano della Mobilità Sostenibile (PUMS) della città di Napoli*. Retrieved from <http://www.comune.napoli.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/28525>

Currie, G., & Delbosc, A. (2010). Exploring public transport usage trends in an ageing population. *Transportation*, 37(1), 151-164. doi: <https://doi.org/10.1007/s11116-009-9224-x>

Delbosc, A., & Currie, G. (2011). Exploring the relative influences of transport disadvantage and social exclusion on well-being. *Transport Policy*, 18(4), 555-562. doi: <https://doi.org/10.1016/j.tranpol.2011.01.011>

Domencich, T. A., McFadden, D (1975). Urban Travel Demand: a behavioural analysis. (No. Monograph).

E. Masoumi, H., & Shaygan, M. (2016). A Longitudinal Analysis of Densities within the Pedestrian Sheds around Metro Stations. The Case of Tehran. *Tema. Journal of Land Use, Mobility and Environment*, 0, 5-20. doi:<http://dx.doi.org/10.6092/1970-9870/3908>

El-Geneidy, A., Grimsrud, M., Wasfi, R., Tétreault, P., & Surprenant-Legault, J. (2013). New evidence on walking distances to transit stops: identifying redundancies and gaps using variable service areas. *Transportation*, 41(1), 193-210. doi: <https://doi.org/10.1007/s11116-013-9508-z>

Eurostat (2018). Population structure and ageing. Retrieved from [https://ec.europa.eu/eurostat/statistics-explained/index.php/Population\\_structure\\_and\\_ageing#The\\_share\\_of\\_elderly\\_people\\_continues\\_to\\_increase](https://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing#The_share_of_elderly_people_continues_to_increase)

Fobker, S., & Grotz, R. (2006). Everyday mobility of elderly people in different urban settings: the example of the city of Bonn, Germany. *Urban Studies*, 43(1), 99-118. doi: <https://doi.org/10.1080/00420980500409292>

Geurs, K. T., & Van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport geography*, 12(2), 127-140. doi: <https://doi.org/10.1016/j.jtrangeo.2003.10.005>

Gutiérrez, J., & García-Palomares, J. C. (2008). Distance-measure impacts on the calculation of transport service areas using GIS. *Environment and Planning B: Planning and Design*, 35(3), 480-503. doi: <https://doi.org/10.1068/b33043>

Luo, W. & Wang, F., 2003. Measures of spatial accessibility to healthcare in a GIS environment: synthesis and a cas study in the Chicago region. *Environment and Planning B: Planning and Design*, 30, 865-884. doi: 10.1068/b29120.

O'Neill, D. (2016). Towards an understanding of the full spectrum of travel-related injuries among older people. *Journal of Transport & Health*, 3(1), 21-25. doi: <https://doi.org/10.1016/j.jth.2015.11.001>

- Kibambe Lubamba, J. P., Radoux, J., & Defourny, P. (2013). Multimodal accessibility modeling from coarse transportation networks in Africa. *International Journal of Geographical Information Science*, 27(5), 1005-1022. doi: <https://doi.org/10.1080/13658816.2012.735673>
- Kim, Y., Byon, Y. J., & Yeo, H. (2018). Enhancing healthcare accessibility measurements using GIS: A case study in Seoul, Korea. *PLoS one*, 13(2). doi: <https://doi.org/10.1371/journal.pone.0193013>
- Morency, C., Paez, A., Roorda, M. J., Mercado, R., & Farber, S. (2011). Distance traveled in three Canadian cities: Spatial analysis from the perspective of vulnerable population segments. *Journal of Transport Geography*, 19(1), 39-50. doi: <https://doi.org/10.1016/j.jtrangeo.2009.09.013>
- Papa, E., Carpentieri, G., & Angiello, G. (2018a). A TOD Classification of Metro Stations: An Application in Naples. In *Smart Planning: Sustainability and Mobility in the Age of Change* (pp. 285-300). Springer, Cham. doi: [https://doi.org/10.1007/978-3-319-77682-8\\_17](https://doi.org/10.1007/978-3-319-77682-8_17)
- Papa, E., Carpentieri, G., & Guida, C. (2018b). Measuring walking accessibility to public transport for the elderly: the case of Naples. *Tema. Journal of Land Use, Mobility and Environment*, 0, 105-116. doi:<http://dx.doi.org/10.6092/1970-9870/5766>
- Papa, E., Coppola, P., Angiello, G., & Carpentieri, G. (2017). The learning process of accessibility instrument developers: Testing the tools in planning practice. *Transportation Research Part A: Policy and Practice*, 104, 108-120. doi: <https://doi.org/10.1016/j.tra.2017.03.010>
- Páez, A., Scott, D., Potoglou, D., Kanaroglou, P., & Newbold, K. B. (2007). Elderly mobility: demographic and spatial analysis of trip making in the Hamilton CMA, Canada. *Urban Studies*, 44(1), 123-146. doi: <https://doi.org/10.1080/00420980601023885>
- Pharoah, T. (2018). Buses in Urban Developments. Chartered Institution of Highways & Transportation. Retrieved from [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=2ahUKEwiT3P\\_dgr\\_cAhXDBZ0KHdzWCz4QFjACegQIAxAC&url=http%3A%2F%2Fwww.ciht.org.uk%2Fdownload.cfm%2Fdocid%2FEF1127A5-0A84-47DB-B73487CC2913D627&usq=AOvVaw3ms3DOGNcoAVWVDNtegZcd](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=2ahUKEwiT3P_dgr_cAhXDBZ0KHdzWCz4QFjACegQIAxAC&url=http%3A%2F%2Fwww.ciht.org.uk%2Fdownload.cfm%2Fdocid%2FEF1127A5-0A84-47DB-B73487CC2913D627&usq=AOvVaw3ms3DOGNcoAVWVDNtegZcd)
- Poelman, H., & Dijkstra, L. (2015). *Measuring access to public transport in European cities. European Commission, Regional and Urban Policy*. Retrieved from [http://ec.europa.eu/regional\\_policy/sources/docgener/work/2015\\_01\\_publ\\_transp.pdf](http://ec.europa.eu/regional_policy/sources/docgener/work/2015_01_publ_transp.pdf)
- Radke, J. & Mu, L., 200. Spatial Decompositions, Modeling and Mapping Service Regions to Predict Access to Social Programs. *Geographic Information Sciences*, vol. 6, issue 2. doi: <https://doi.org/10.1080/10824000009480538>
- Ryan, J., Wretstrand, A., & Schmidt, S. M. (2015). Exploring public transport as an element of older persons' mobility: A Capability Approach perspective. *Journal of transport geography*, 48, 105-114. doi: <https://doi.org/10.1016/j.jtrangeo.2015.08.016>
- Saghapour, T., Moridpour, S., & Thompson, R. G. (2016). Public transport accessibility in metropolitan areas: A new approach incorporating population density. *Journal of Transport Geography*, 54, 273-285. doi: <https://doi.org/10.1016/j.jtrangeo.2016.06.019>
- Scheurer, J., & Curtis C. (2007). Accessibility Measures: Overview and Practical Applications. *Urbanet, Working Paper No 4*.

Voss, C., Sims-Gould, J., Ashe, M. C., McKay, H. A., Pugh, C., & Winters, M. (2016). Public transit use and physical activity in community-dwelling older adults: Combining GPS and accelerometry to assess transportation-related physical activity. *Journal of Transport & Health*, 3(2), 191-199. doi: <https://doi.org/10.1016/j.jth.2016.02.011>

Wang, J., & Cao, X. (2017). Exploring built environment correlates of walking distance of transit egress in the Twin Cities. *Journal of Transport Geography*, 64, 132-138. doi: <https://doi.org/10.1016/j.jtrangeo.2017.08.013>

Weber, D. (2016). Differences in physical aging measured by walking speed: evidence from the English Longitudinal Study of Ageing. *BMC geriatrics*, 16(1), 31. doi: <https://doi.org/10.1186/s12877-016-0201-x>

Weinstein Agrawal, A., Schlossberg, M., & Irvin, K. (2008). How far, by which route and why? A spatial analysis of pedestrian preference. *Journal of urban design*, 13(1), 81-98. doi: <https://doi.org/10.1080/13574800701804074>

Zhao, F., Chow, L. F., Li, M. T., Ubaka, I., & Gan, A. (2003). Forecasting transit walk accessibility: Regression model alternative to buffer method. *Transportation Research Record: Journal of the Transportation Research Board*, (1835), 34-41. doi: <https://doi.org/10.3141/1835-05>

## WEB SITES

<http://www.pcn.minambiente.it/>

<https://www.istat.it/>

<https://ec.europa.eu/eurostat/home>

<http://www.comune.napoli.it/opendata>

<http://www.aslnapoli1centro.it/>

## AUTHOR'S PROFILE

**Gerardo Carpentieri** is an Engineer, Ph.D. in Civil Systems Engineering at University of Naples Federico II and Research Fellow of Land Use Planning at the Department of Civil, Architectural and Environmental Engineering at University of Naples Federico II.

**Carmen Guida** is a Ph.D Student in Civil Systems Engineering Hydraulic and Transportation Systems Engineering at Department of Civil, Architectural and Environmental Engineering at University of Naples Federico II.

**Houshmand Masoumi** is senior researcher at Zentrum Technik und Gesellschaft (ZTG) at the Technische Universität Berlin. He holds PhD in urban planning and several years of work experience in civil engineering in industry and management section. His research interests are urban travel behaviour modelling, land use-transportation interactions, and active transportation.



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 1 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.

ISBN:978-88-6887-054-6

DOI:10.6093/978-88-6887-054-6