

Lecture Notes in Civil Engineering

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Francesco Zullo
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Lucia Saganeiti *Editors*

Innovation in Urban and Regional Planning

Proceedings of INPUT 2023 - Volume 1

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Lorena Fiorini · Lucia Saganeiti
Editors


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Dedication

These volumes are the result of the collection of papers from the 12th International Conference on Innovation in Urban and Regional Planning (INPUT 2023): “Working for sustainable soil management and the role of land planning” and they are a tribute to the memory of Professor Bernardino Romano, who passed away prematurely on 1st September 2023, just before the conference took place. INPUT 2023 was possible due to his foresight and recognition in the academic world.

Prof. Bernardino Romano has been a full professor of Urban Planning at the University of L’Aquila. He had considerable influence on the development of his subject over a period of more than 30 years and provided much support to a generation of researchers and colleagues.

Since the beginning of his academic career, Prof. Romano has dedicated himself to the study of the relationship between the natural and built environment. He has been passionate about the issue of protected areas and ecological networks, expanding the existing meaning of concepts such as biopermeability and environmental continuity. In the eighties, he has been one of the first promoters of the institution of the main parks in Central Italy. His commitment in this direction was both academic and personal, through an intense activity at top level with the World Wide Fund for Nature (WWF) and the Italian Alpine Club (CAI). During these years, he has developed studies on land planning tools aimed at the establishment of both protected areas in Abruzzo region and the system of European Apennine Parks (APE). He has been a strong supporter of biodiversity conservation, and he made the knowledge of ecosystem dynamics a key point of his courses at university.

Prof. Romano has been a national reference for land take dynamics inspiring research and studies by many research groups. He always has been strongly convinced that land and urban planning plays a key role in sustainability of transformations. In fact, the dynamics of land transformation have always been a focus of his research and he has worked for years for drawing a precise and analytic description of the Italian settlement evolution. In the last period, he was active in the national discussion about drafting a law for stopping land consumption.

He has approached urban planning, ecology, and landscape both inside and outside the academic context, enriching the research with humanity. He has always been fascinated by the computational aspects of urban planning and by the possibility to explore new scientific approaches based on data analysis and indicator engineering. He has been a courageous explorer into this field, always looking for innovating the panorama of techniques and tools for spatial diagnosis.

Thanks to his creative vision, integrity, rigorous research, scientific excellence, and exceptionally broad intellectual horizons, he has left his imprint on the lives of students, PhD students, young researchers as well as many colleagues and collaborators from various institutions. He has also taught the value of autonomy of thought and collaboration.

He did so with passion, dedication, and desire to spread his great knowledge of Land Sciences.

He has left us with a significant legacy that we are going to preserve and share.

November 2023

CENTROPLANECO

Preface

The 12th International Conference on Innovation in Urban and Regional Planning (INPUT 2023) has been organized by CENTROPLANECO group of DICEAA—Department of Civil, Construction-Architectural and Environmental Engineering of the University of L’Aquila.

It took place in L’Aquila (Italy) on 6–8 September 2023 and has been titled “Working for sustainable soil management and the role of land planning”. Global challenges related to the sustainability of land transformations require the measurement of land transformations through specific indicators. Spatial planning and land management systems then play a crucial role in addressing issues of policy reform and investment, ecological transition, and sustainability in its three dimensions: environmental, economic, and social aspect. Integrating sustainability into our policies, strategies, and practices is fundamental to making a relevant impact with respect to current issues related to climate change, ecosystem services’ provision and the energy supply.

INPUT 2023 has given the opportunity to discuss such central issues and try to find and assess innovative and advanced methodologies to provide decision support systems through land science and indicator engineering.

Those proceedings represent the state of the art of modelling and computational approaches to innovations in urban and regional planning, with a transdisciplinary and borderless character to address the complexity of contemporary socio-ecological systems and following a practice-oriented and problem-solving approach.

In particular, this book presents the collection of 62 papers submitted at the INPUT 2023 Conference. The accepted papers, after a blind-review process, are here organized according to the thematic sessions of the conference:

- Geospatial earth data to support the restoration of soil ecosystems and implications for spatial planning (geo4sp).
- Geodesign for informed collaborative spatial planning and design.
- The urban digital twin: a new dimension for the land planning.
- Spreading porosity: the contribution of planning tools in increasing soil permeability.
- Research and standards for sustainable spatial planning (R&S4SP).
- Coastal planning: diagnostic tools to address physical, social, and environmental concerns.
- Territorial strategies in place-based and community-led energy transitions.
- Innovative simulations for urban planning: decoding configuration, morphology, and space.
- The energy transition of the built environment.
- Innovations in the 15 minute-city approaches: conceptual, data-driven, and practical developments towards a sustainable urban planning.

INPUT is a scientific community of Italian university and academic researchers who meet every two years and discuss issues from different fields related to urban and regional planning topics.

The latest editions have been hosted in Viterbo (2018), Turin (2016), Cagliari (2014), Potenza (2012), Catania (2021), and L'Aquila (2023).

During INPUT 2023 (L'Aquila), the conference recorded the following numbers:

- 20 parallel sessions have been organized from experts in different fields of research related to urban and land planning.
- 171 submitted abstracts.
- 124 accepted papers.
- 130 among online and in presence participants.

Keynote Speakers of the INPUT 2023 Conference

Three keynote speakers enrich the programme during three plenary sessions. Speeches have been held by:

Sara Meerow, School of Geographical Sciences and Urban Planning, Arizona State University

She is an associate professor in the School of Geographical Sciences and Urban Planning at Arizona State University where she leads the Planning for Urban Resilience Lab. She is an interdisciplinary scholar working at the intersection of urban geography and planning to tackle the challenge of making cities more resilient in the face of climate change and other social and environmental hazards, while at the same time more sustainable and just. Her current projects focus on conceptualizations of urban resilience, planning for urban resilience in a changing climate, and green infrastructure planning in a range of cities in the USA and internationally. She has published over 30 articles in academic journals, in addition to book chapters, reports, and popular press articles on these topics. She has a PhD in Natural Resources and Environment from the University of Michigan and an MS in International Development Studies from the University of Amsterdam.

Title of keynote speech: *Urban climate change resilience planning in theory and practice*

Jacques Teller, Local Environment Management and Analysis, University of Liège, Belgium

He is a professor of urban planning at the University of Liège, where he is leading the Local Environment Management and Analysis (LEMA) research group. He is a member of the Scientific Council of the Lab Research Environment (Vinci, ParisTech) and of the Efficacy Research Institute in France. His research typically combines urban governance issues with the modelling of urbanization and densification dynamics. It addresses the impacts of urbanization on energy consumption, heritage management, housing provision, and transport demand. He is presently working on the interactions between urbanization and exposure to floods, combining quantitative modelling and qualitative approaches.

Title of keynote speech: *Urban growth models for regulating urban densification in response to zero net land take policies*

Claudia (van der Laag) Yamu, Department of Built Environment, Oslo Metropolitan University, Oslo, Norway

She is an architect and urban planner. She is a professor of urban analytics at Oslo Metropolitan University. She is an expert on transport land use planning including people's behaviour in cities applying a wide range of analytical techniques including method and tool development at the forefront of virtual modelling. As a former project consultant, she excels in combining the theoretical innovations with practice-oriented solutions and has been involved in numerous international projects in industry and research. Claudia was awarded the prestigious Michael Breheny Prize in 2015 for her work on multiscale, multifractal urban planning models. She is an editorial board member for Springer's the Urban Book Series. She holds a PhD in Architecture from TU Wien connecting architecture, urban planning, and computer science and a PhD in Geography and Regional Planning in complexity-based modelling from Université de Franche-Comté. She dedicates her work to the development of sustainable cities and regions.

Title of keynote speech: *Accessibility and multiscale: fractal urban planning models*

Best Paper Award

Among the contributions, four papers have been selected for the Best Paper awards:

1. **Giovanni Cialone Best Paper Award** addressed to studies on inner areas, protected areas, and sustainable development. The award is dedicated to the memory of Giovanni Cialone: architect, passed away in 2020. He has been a CNR researcher (National Research Council) and served in the 1990s as an environmental councillor for the municipality of L'Aquila. He was highly committed to issues related to environmental protection and education, sustainability, and cultural enhancement of inner areas. He held the position of vice-president of the Gran Sasso–Monti della Laga National Park and was a member of the "Italia Nostra" association and a delegate of Slow Food. He enriched the debate about knowledge and defence of the territory defence, with a strong presence in the media and interventions in the political sphere, consistently displaying a well-regarded balance in his positions and numerous contributions of critique.

The award goes to the paper titled: *"The shapes of the adaptive ground design: formulation of a new taxonomy between spatial quality and ecological performance"* authored by: Simone Porfiri, University of Camerino (Italy).

2. **Giorgio Pipponzi Best Paper Award** addressed to studies on advanced GIS techniques. The award is dedicated to the memory of Giorgio Pipponzi: After his studies in geology and a PhD in geodynamics, he carried out highly professional positions in the Abruzzo Region, with the Basin Authority and the Civil Protection Service. He collaborated in the drafting of the Guidelines for the Seismic Microzoning Plans, in the development and management of computer databases as well as in the Level 3 Microzoning Pilot Project in the municipality of Sulmona. Since 2013 in the USRC, he has carried out his activity as Technical Geologist Directive Instructor, dealing with the geological problems inherent in the Reconstruction Plans and Private Reconstruction projects as well as being responsible for the GIS systems of the USRC. In 2019, he was appointed Head of the Procedure for the technical-economic investigation of the private reconstruction projects after the 2009 earthquake.

The award goes to the paper titled: *“The applicability of the urban digital twin in the detailed choices of the urban plan”* authored by: Federica Cicalese, University of Salerno (Italy).

3. **LAND Best Paper Award** addressed to studies on urbanization phenomena, densification, and land consumption. The award intends to enhance the merit of young researchers who will present scientifically relevant papers on topics related to urbanization phenomena, densifications, and contrasting land consumption. Work should focus on the role of urban and regional planning in urban growth management with the goal to meet specific needs while increasing the resilience of urban settlements. This award refers to the special issue *“Towards Sustainable Urban Development: New Approaches and Tools for Regeneration Strategies”*.

The award goes to the papers:

- *“Space Syntax vs Agent-Based Modelling in the maze of urban complexity: a critical comparison between top-down and bottom-up approaches and applications”* authored by: Federico Mara, University of Pisa (Italy).
- *“Urban energy resilience and strategic urban planning in Emilia-Romagna: evidence from three cities”* authored by: Giovanni Tedeschi, University of Parma (Italy).
- *“Digital Twin for urban development”* authored by: Angela Martone and Monica Buonocore, University of Sannio (Italy).

November 2023

Alessandro Marucci
 Francesco Zullo
 Lorena Fiorini
 Lucia Saganeiti

Organization

The 12th International Conference on Innovation in Urban and Regional Planning (INPUT 2023) was organized by the CENTROPLANECO group of the DICEAA-Department of Civil, Building, Architectural, and Environmental Engineering of the University of L'Aquila. The composition of the organizing groups is shown in detail below.

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Geospatial Earth Data to Support the Restoration of Soil Ecosystems and Implications for Spatial Planning

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Geodesign for Informed Collaborative Spatial Planning and Design

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Integrating Ecosystem Services into Spatial Planning Processes: Sustainable Solutions for Healthier and Safer Urban and Rural Environments

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The Urban Digital Twin: A New Dimension for the Land Planning

Fistola Romano	University of Naples Federico II
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**Supporting the Transition Towards Ecologically-Oriented Urban Planning:
What's the Role of Early-Career Researchers? Innovative Findings, Experiences,
and Ways Forward**

De Luca Claudia	University of Bologna
Ronchi Silvia	Polytechnic University of Milan
Cortinovis Chiara	University of Trento

**Towards Denser and Greener Cities? Methods and Indicators to Monitor Trends
And Impacts in Support of Urban Planning and Policies**

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**Innovative Approaches and Methodologies for Driving Sustainable and Inclusive
Urban Regeneration**

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The Innovation of Urban Planning Tools for Energy-Resilient Cities

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**Spreading Porosity: the Contribution of Planning Tools in Increasing Soil
Permeability**

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Research and Standards for Sustainable Spatial Planning

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Coastal Planning: Diagnostic Tools to Address Physical, Social, and Environmental Concerns

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Innovative Simulations for Urban Planning: Decoding Configuration, Morphology, and Space

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The Energy Transition of the Built Environment

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Smart Happy Region. Relationship Between Planning and Subjective Well-Being

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Innovations in the 15 Minute-City Approaches: Conceptual, Data-Driven, and Practical Developments Towards a Sustainable Urban Planning

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Climate Sensitive Planning: Re-defining Urban Environments for Sustainable Cities

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Urban and Peri-Urban Areas: Building Knowledge and Mapping to Better Plan the Sustainable Green City

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Densification and Urban Regeneration for Climate Adaptation in Sustainable Settlements

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Contents

Geospatial Earth Data to Support the Restoration of Soil Ecosystems and Implications for Spatial Planning (GEO4SP)

A Customized JAVA OpenStreetMap Preset to Extract Solar Panel Installations for Humanitarian Purposes	3
<i>Claudio Ladisa, Alessandra Capolupo, and Eufemia Tarantino</i>	
Copernicus Geodatabase for Investigating Land Cover Changes at the European Scale	12
<i>Carlo Barletta, Alessandra Capolupo, and Eufemia Tarantino</i>	
Earth Observation Data for Sustainable Management of Water Resources to Inform Spatial Planning Strategies	24
<i>Alessandra Capolupo, Carlo Barletta, Dario Esposito, and Eufemia Tarantino</i>	
Future Urban Setting and Effects on the Hydrographic System. The Case Study of Bologna, Italy	36
<i>Emilio Marziali, Gianni Di Pietro, and Cristina Montaldi</i>	
Using SAR Observation Data to Support the Spatial Planning in Areas Affected by Landslide Phenomena	47
<i>Alberico Sonnessa</i>	

Geodesign for Informed Collaborative Spatial Planning and Design

Geodesign as a Supplementary Tool to Strategic Environmental Assessment ...	59
<i>Luanita Snyman-van der Walt</i>	
Geovisualization and Geodesign in a Framework for the Evaluation of Landscape Units as a Basis for the Sustainable Planning of the Quadrilátero Ferrífero, Brazil	68
<i>Ana Clara Mourão Moura, Christian Rezende Freitas, Alfio Conti, Ítalo Sousa De Sena, Nicole Andrade Rocha, Danilo M. Magalhães, and Gustavo A. T. Martinez</i>	
Participatory Mapping to Improve Urban Resilience Starting from the Experiences in the Scientific Literature and Virtuous Cases	80
<i>Ilenia Spadaro, Fabrizio Bruno, Maria Cristina Lobascio, and Francesca Pirlone</i>	

Geodesign in the Shared Decision to Create Full Protection Conservation Units, as a Mitigating and Compensatory Action for the Transformations of Iron Mining in the Landscape 90
Flávia Las-Cazas de Brito and Ana Clara Mourão Moura

Geoprocessing, Geodesign and Urban Parameters: Geoinformation and Co-Creation of Ideas in Urban Planning Teaching 102
Ashiley Adelaide Rosa and Ana Clara Mourão Moura

Geodesign: (a Personal) Retrospective, and Perspectives 114
Michele Campagna

Geodesign in the Teaching Process of Global Agreements: Sustainable Development Goals and Smart Cities 122
Fabiana Carmo De Vargas Vieira, Tiago Mello, and Ana Clara Mourão Moura

Geodesign for Open Spaces Management in Mining-Dependent Urban Settlements 134
Luiz Glück Lima, Camila Marques Zyngier, Christian Freitas, and Ana Clara Mourão Moura

Strategies for Democratizing Development. Application of Geodesign in a Low-Context Culture 144
Simone Corrado, Luigi Santopietro, Alfonso Annunziata, Rosanna Piro, Rachele Vanessa Gatto, Rossella Scorzelli, Shiva Rahmani, Francesco Scorza, and Beniamino Murgante

The Urban Digital Twin: A New Dimension for the Land Planning

Applying 4.0 Technologies to Public Spaces. Exploring New Functions and Interactions in Savona University Campus 157
Daniele Soraggi and Federico Campanini

Urban Built Environment Visual Features Modeling for 3D GeoSimulation Using USD Standard Specifications 169
Igor Agbossou

Digital Twin for Urban Development 183
Angela Martone and Monica Buonocore

Digital Twins of Cities vs. Digital Twins for Cities 192
Maria Rosaria Stufano Melone, Stefano Borgo, and Domenico Camarda

Beyond the Smart City. The Urban Digital Twin for the Augmented City: The <i>Vox Hortus</i> Project	204
<i>Romano Fistola and Ida Zingariello</i>	
The Applicability of the Urban Digital Twin in the Detailed Choices of the Urban Plan	211
<i>Federica Cicalese, Michele Grimaldi, and Isidoro Fasolino</i>	
Urban and Spatial Planning Through the Support Tool of the Regional Digital Twin	221
<i>Sara Sacco, Federico Eugeni, and Donato Di Ludovico</i>	
Towards Sustainable Urban Development: Matera's Urban Digital Twin and Challenges in Data Integration	230
<i>Simone Corrado and Francesco Scorza</i>	
City Burning: New Approaches to Measure the UHI and Its Effect on Urban Energy Balance	237
<i>Federica Gaglione, Carmela Gargiulo, and Floriana Zucaro</i>	
Spreading Porosity: The Contribution of Planning Tools in Increasing Soil Permeability	
A Multidimensional Assessment Model of Settlement Efficiency at the Urban Scale	251
<i>Federica Cicalese and Isidoro Fasolino</i>	
The Shapes of Adaptive Ground Design: A New Taxonomy Between Spatial Quality and Ecological Performance	263
<i>Simone Porfiri</i>	
Urban Planning and Water Resources: Integrated Regeneration Strategies for Contemporary Territories	275
<i>Laura Ricci and Sofía Gabriela Fernández Balmaceda</i>	
Towards the Integration of Soil Desealing in the Urban Areas' Transformation Processes	286
<i>Barbara Caselli, Marianna Ceci, Ilaria De Noia, Emanuele Garda, and Michele Zazzi</i>	

Research and Standards for Sustainable Spatial Planning (R&S4SP)

Holistic Approach for Sustainable Cities and Communities: Best Practices
in Living Labs 301
*Antonella Tundo, Pasquale Capezzuto, Laura Blaso, Paolo Marinucci,
and Guglielmina Mutani*

Need of New Standards for New Definition of Cities 313
Pierluigi Potenza

The Issue of Standards Development for Sustainable Cities
and Communities: ISO 37101 Case Study 325
Angela Ruggiero, Bruno Barroca, Margot Pellegrino, and Vincent Becue

Establishing a Knowledge Value Chain for Sustainable Spatial Planning
and Urban Governance: Meeting the SDGs Through Technical Standards 337
*Dario Esposito, Raffaella Francesca Gueze, Francesca Bretzel,
Antonella Tundo, and Pasquale Capezzuto*

Towards a Definition of “Tourism Ecosystem” for Sustainable
Development of Inland Areas 350
*Rachele Vanessa Gatto, Simone Corrado, Beniamino Murgante,
and Francesco Scorza*

The Planning Tool Mosaic as a Tool for Sustainable Land Management.
Keys Point for a National Regulatory Framework 359
Cristina Montaldi, Chiara Cattani, and Francesco Zullo

Mapping Civic Uses in Abruzzo Region: Opportunities for Sustainable
Resource Management 373
Chiara Cattani and Francesco Zullo

Spatial Decision Making for Improvement of the Resilience of the Historic
Areas: SHELTER DSS 384
*Asel Villanueva-Merino, Amaia López-de-Aguileta-Benito,
Jose Luis Izkara, and Aitziber Egusquiza*

Achieving SDGs through Public Participation in Spatial Planning
and Urban Governance: International Standards for Effective
Implementation 396
Dario Esposito, Giulia Motta Zanin, Pasquale Balena, and Valeria Monno

Embedding Resilience to Climate Change and Natural Hazards in Smart Services	408
<i>Sonia Giovinazzi, Maria Luisa Villani, Roberta Pezzetti, Nicoletta Gozo, Laura Blaso, Antonio Costanzo, and Quintilio Piattoni</i>	
Coastal Planning: Diagnostic Tools to Address Physical, Social and Environmental Concerns	
Port Cities. Models of Governance, Port and Local Planning and Sub-areas of City-Port Interaction. The Case of Livorno and Valencia	423
<i>Carmela Mariano and Maria Racioppi</i>	
Analysis of the Influence of Coastal Urban Regeneration Strategies on Water Quality	435
<i>Annamaria Felli, Francesco Zullo, and Marcello Di Risio</i>	
Extreme Sea Level Variation in Future Climate Change Scenarios: The Case of Abruzzo Region Coastal Area	446
<i>Davide Pasquali, Daniele Celli, Carmine Di Nucci, Piera Fischione, and Marcello Di Risio</i>	
Physics and Coastal Planning Strategies: Two Sides of the Same Coin	457
<i>Marcello Di Risio and Luca Iagnemma</i>	
Long-Term Evolution of the Shoreline of the South Lazio Region (Italy) Littoral Cell by Combining Historical Aerial Photography and Satellite Imagery	466
<i>Francesca Scipione, José Antonio Palenzuela Baena, Marcello Di Risio, Maria Antonietta Marsella, Myrta Castellino, and Paolo De Girolamo</i>	
Distribution of Polycyclic Aromatic Hydrocarbons and Organochlorine Pesticides in Two Coastal Sediment Cores in the Mong Cai Area, Vietnam	478
<i>Bui Thi Thanh Loan, Nguyen Thi Hue, Hoang Nam, Vu Van Tu, Pham Thi Kha, Pham Tien Dung, Nguyen Thi Mai Luu, Paolo Roccaro, Daniele La Rosa, and Dang Hoai Nhon</i>	
Coastal Urbanization and Ecosystem Services Depletion: An Italian Case Study	490
<i>Giampiero Lombardini, Angela Pilogallo, and Giorgia Tucci</i>	

Territorial Strategies in Place-Based and Community-Led Energy Transitions

Modeling Structural Equations to Balance the Positive Energy Area in Cities ... 503
Nastaran Esmaeilpour Zanjani, Ghazaleh Goodarzi, Caterina Pietra, and Roberto De Lotto

Urban Polycentric Structures: Scenarios of Energy Communities of Small and Medium-Sized Cities 512
Pasquale Balena, Michele Vomero, and Antonio Leone

Place-Based Strategies for Energy Transitions in Apulia: Pilot Experiences, Limitations and Prospects 523
Alessandro Bonifazi and Laura Grassini

Innovative Simulations for Urban Planning: Decoding Configuration, Morphology and Space

Percolation Model to Capture Urban Coalescence («Natural Cities»). The Case of Italy 539
Giampiero Lombardini

Preprocessing Open Data for Optimizing Estimation Times in Urban Network Analysis: Extracting, Filtering, Geoprocessing, and Simplifying the Road-Center Lines 551
Müslüm Hacı, Federico Mara, Diego Altafini, and Valerio Cutini

Urban Safety and Resilience: Agent-Based Modelling Simulations for Pre-disaster Planning 563
Federico Eugeni, Sara Sacco, and Donato Di Ludovico

Territorial Analysis of Regional Disparities in Brazil: Impacts on Sustainable Urban Mobility and Accessibility 573
Franciele Marques

Space Syntax vs Agent-Based Modelling in the Maze of Urban Complexity: A Critical Comparison Between Top-Down and Bottom-Up Approaches and Applications 585
Federico Mara and Valerio Cutini

The Energy Transition of the Built Environment

The Energy Efficiency of Building Components. The Case of Historical Masonry Through a Multidisciplinary Approach	599
<i>Marianna Rotilio, Chiara Marchionni, Pierluigi De Berardinis, and Federica Cucchiella</i>	

Urban Energy Analysis and Building Performance Evaluation: The Case of Segrate Municipality	609
<i>Elisabetta Venco, Luca Alessio, Tancredi Marco De Francesco, and Nastaran Esmaeilpour Zanjani</i>	

Establishing a Renewable Energy Community in a Residential District: Advantages and Implementation Challenges	621
<i>Cristina Montaldi and Luca Giannobile</i>	

Innovative and Sustainable Solutions for the Organization of Energy and Service Networks in Historical Centres	632
<i>Marianna Rotilio, Chiara Marchionni, and Alessia Massari</i>	

Innovations in the 15 Minute-City Approaches: Conceptual, Data-Driven, and Practical Developments Towards a Sustainable Urban Planning

Tackling Un-sustainable Mobility. Smart City Tools to Limit Car Access to the City Center Through MaaS Solutions, the Genoese Experience	645
<i>Ilaria Delponte and Valentina Costa</i>	

Travel-Time in a Grid: Modelling Movement Dynamics in the “Minute City”	657
<i>Camilla Pezzica, Diego Altafini, Federico Mara, and Chiara Chioni</i>	

Building a 15-Minute City: A Methodological Approach for Assessing the Socio-economic and Environmental Effects of Locating Amenities in Low-Density Settlement Contexts	669
<i>Gennaro Pace, Lucia Saganeiti, Valentina Santarsiero, and Beniamino Murgante</i>	

Spatial and Configurational Analysis for the Implementation of the 15-Minute City Model. The Case Study of Perugia, Italy	681
<i>Lucia Patimisco, Alfonso Annunziata, and Beniamino Murgante</i>	

Assessing the Relationship Between Spatial Configuration and Proximity to Basic Services. The Case Studies of Matera and Terni, Italy	693
<i>Raffaella Valluzzi, Alfonso Annunziata, and Beniamino Murgante</i>	

Possibility, Opportunity, Capability. A Critical Reinterpretation
for Accessibility Planning in the 15-Min City 705
 Alessia Gualiani

Author Index 717



Geodesign for Open Spaces Management in Mining-Dependent Urban Settlements

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Abstract. Mining-dependent urban settlements include villages, cities, and regions that are economically dependent on mining activities. In these areas, mineral extraction is the main source of income, employment, and municipal revenues. In the Iron Quadrangle a territory in the state of Minas Gerais in Brazil, considered in this study, 19 out of 34 municipalities are mining-dependent urban settlements. Although mining activity is an important source of revenue for these municipalities, the collected funds often do not translate into social and environmental improvements for their population. As a result, these settlements face territorial conflicts generated by the need to reconcile environmental quality preservation with the economic activities of mining carried out by large enterprises. In this study, the potential application of geodesign as a methodological, advisory, and decision-making process is empirically addressed. The objective of applying geodesign is to encourage the effective appropriation of open spaces by communities in mining-dependent urban settlements, considering the environmental control of these spaces for sediment retention and aquifer recharge. The study presented here is composed of two fronts of development. The first is the development of a WebGIS (Web Geographical Information System) for recording and presenting data on environmental control performance indicators of open spaces for the community. The second is the adaptation of the GISColab platform, a tool built for the application of the geodesign method, allowing different users to access a set of territorial data and information, enabling the collective and consensual construction of proposals for the use and function of urban spaces.

Keywords: Geodesign · Mining-dependent urban settlements · Open space management · Environmental control

1 Introduction

The mineral-dependent urban settlements comprise villages, cities, and regions that economically rely on mining activities. In other words, in these settlements, mineral extraction is the main source of income, employment for the local population, municipal

revenues from the Financial Compensation for Mineral Resources Exploration (FCMR), and taxes.

The Iron Quadrangle (IQ), a region in the state of Minas Gerais located in south-eastern Brazil, is considered one of the world's largest mineral provinces, covering 12,785 km² and encompassing 34 municipalities (Fig. 1), of which 19 are specialized in the mineral extraction sector [1]. According to IBRAM [2], 10 out of the 15 Brazilian municipalities that collected the most FCMR were in the IQ, totaling R\$ 2.08 trillion in revenue in 2022.

Despite mining activities being an important source of revenue for municipalities in the IQ, often the collected funds are not translated into social and environmental improvements for the population.

Mineral-dependent urban settlements are characterized by territorial conflicts generated by the need to reconcile environmental preservation with mining activities conducted by large enterprises. The operations and facilities of these enterprises, such as open-pit mines, beneficiation plants, and tailings dams, are associated with significant negative environmental impacts, such as air and water pollution, noise and vibration emissions, soil erosion, and the destruction of wildlife habitats and landscapes.

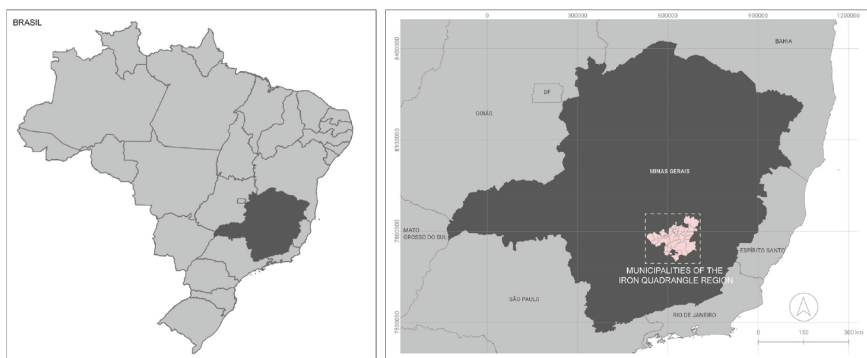


Fig. 1. Location map of the Iron Quadrangle region. Fonts: Map created by author using the map from IBGE (Brazilian Institute of Geography and Statistics).

The influence of mining activities on the quality of water resources in the IQ is significant. Gomes [3] found high concentrations of heavy metals in both abiotic and biotic compartments up to 20 km from the nearest mining site. The study indicates that the highest retention of pollutants occurs in the biotic compartment (seston and zooplankton), which is considered a primary food source in the trophic chain of aquatic ecosystems, contributing to the transfer of metals and semimetals to higher trophic levels.

Landscape improvement programs for mineral-dependent urban settlements are urgent and should be oriented towards the establishment of a system of open spaces. This system should be capable of minimizing pollution, protecting natural resources, and enhancing community engagement to expand understanding of the functions of open spaces as public facilities that provide ecosystem services.

Studies carried out in the IQ indicate a rich hydrography in this territory (specific to its geophysical characteristics), with many springs and watercourses, some even without a nominal reference. This fact strengthened the idea of working with water as an aggregating element to increase perception and, consequently, awareness.

Based on this context, the evaluation of the performance of the interventions proposed to contain the peak flow of surface runoff and associated sediments is centered on the geodesign as a pedagogical communication strategy. Through geodesign, communities in mining-dependent centers will be skilled to act as monitoring agents for environmental quality indicators.

Thus, this study addresses the potential of geodesign as a consultative and decision-making methodology to encourage effective community engagement in open spaces within mining-dependent urban settlements. This application considers the environmental control function of open spaces for sediment retention and aquifer recharge.

2 Sustainability is Perceived in Open Spaces

Open spaces are areas not occupied by built structures [4], inherent to urban form [5], as they shape the characteristics of the built environment [6]. Streets, sidewalks, squares, uncovered parking lots, vacant lots, beaches, and forests are examples of open spaces. We can also cite other examples such as: neighborhood/community gardens, playgrounds, parks, pocket parks, etc. They encompass environments that allow for the movement of people, the flow of fauna and flora, water, wind, and light. In other words, open spaces are a fundamental infrastructure for the permeability of the urban fabric. They are means through which basic city services are established, such as solid waste collection, transportation of people and goods, stormwater drainage systems, and community events. Open spaces are considered one of the key urban infrastructures, where a significant part of daily life takes place [5], and where the community can experience and truly perceive sustainable development.

The maintenance of public open spaces contributes to the conservation of environmental, historical, and scenic resources, as well as the restoration of hydrological balance and improvement of air quality [6]. Therefore, the quality of mineral-dependent urban settlements and, on a larger scale, the integrity of ecosystems, are directly affected by the absence or the inadequacy of open spaces, which can provide effective environmental services to protect and enhance ecological functions and processes, such as the filtration and infiltration of surface runoff, as well as carbon and nitrogen sequestration and cycling.

When open spaces are designed as green infrastructure complementary to gray infrastructure, the environmental function can be preserved or optimized in areas that are not yet urbanized or in the process of urbanization [7].

3 Nature-Based Solutions for Mineral-Dependent Urban Settlements

Natural wetlands (e.g., swamps, marshes, mangroves, fens, and bogs) are ecosystems that play a crucial role in protecting adjacent ecosystems. Among their functions, the following stand out: (i) protecting terrestrial and aquatic ecosystems against floods;

(ii) removing nitrogen from the ecosystem through denitrification; and (iii) retaining nutrients in sediments through the processing of organic matter. In this case, particular emphasis is placed on aquatic macrophytes and, especially, their associated microbial communities, which play a significant role in organic matter decomposition and nutrient cycling [8–10].

Vegetated detention basins and bioswales are compensatory devices inspired by or mimicking natural wetlands. Vegetated detention basins are shallow depressions that temporarily store the volume of intense rainfall and release it slowly, reducing downstream peak discharge and, consequently, the risk of flooding. In the root zone of their vegetation cover, physical and biological treatment of water contaminated by diffuse pollution occurs, favoring aquifer recharge with clean water. On the other hand, bioswales consist of open, shallow channels with a cover of herbaceous species designed to intercept, convey, treat, infiltrate, and attenuate the surface runoff from impermeable areas such as roads, small accesses, sidewalks, yards, and parking lots.

The combination of these two compensatory techniques, detention basins and bioswales (Fig. 2), becomes a suitable strategy for areas with high sedimentation rates in surface runoff contributing areas. This is the specific case for urban settlements located in areas influenced by iron ore mines in the IQ region.

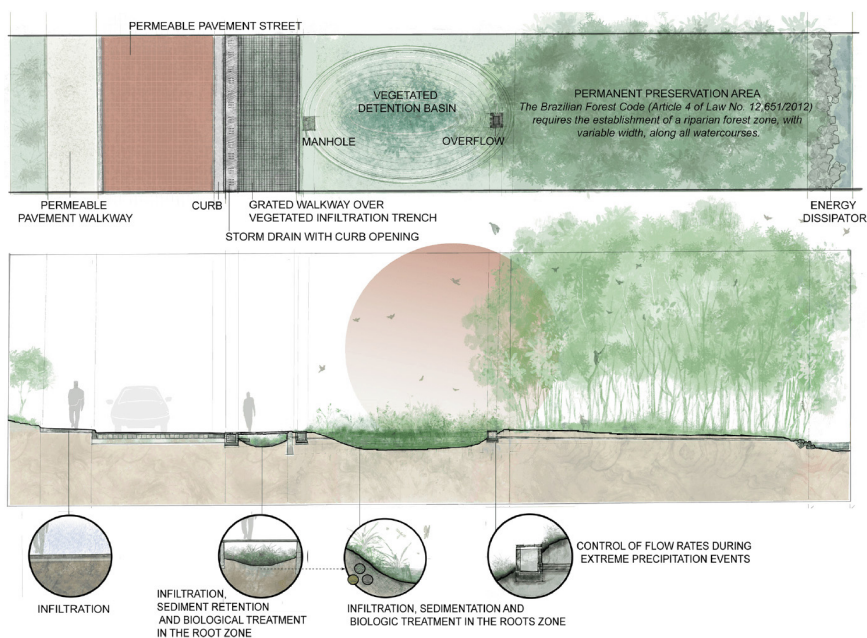


Fig. 2. Surface runoff treatment system in mining-dependent urban areas. Font: Developed by the author.

When positioned along the streets and upstream of the detention basins, bioswales function as sediment forebays. This complementary device provides essential pre-treatment by slowing down the flow velocity of stormwater and facilitating the sedimentation of suspended solids before entering the detention basin. This configuration helps minimize sediment loads and, consequently, improves the overall effectiveness of the system.

In narrow streets, a common situation observed in unplanned settlements associated with mining operations, the bioswale can be covered with a grate to enhance pedestrian mobility and facilitate regular maintenance of the device, including sediment removal and replanting.

Therefore, bioswales and detention basins are compensatory techniques aimed at reducing surface runoff on access roads and minimizing the significant amount of sediment that is transported daily by surface runoff to adjacent water bodies. It is important to note that, in addition to rainfall, contributions to surface runoff in urban areas near iron ore mines are caused by the ineffective practice of moistening the roads to control the resuspension of particulate matter. Such aspect intensifies the damage caused to water bodies.

Public open spaces in mining-dependent settlements play a crucial role in enhancing environmental quality. However, according to Macedo [11], the longevity of an open space is directly related to the preservation of its morphological identity, which is achieved through the appropriation capacity offered to users. The author also emphasizes that proper maintenance facilitates acceptance and, consequently, the appropriation of these open spaces.

Therefore, it is crucial for public management and the population to monitor quality indicators of open spaces in order to promote participatory management and user-oriented appropriation of these spaces. This will ensure that the benefits of applied environmental services are truly perceived by the users.

4 Geodesign for Monitoring and Communicating the Quality of Open Spaces in Mining-Dependent Urban Areas

Environmental quality indicators in urban environments have the main objectives of grouping and measuring information in a way that relevant characteristics become visible, understandable, and accessible to improve the communication process of data for a specific location and period for the public and public officials [12]. Therefore, performance indicators for actions promoting environmental quality in mining-dependent urban areas can be established and monitored in open spaces, as these spaces encompass a system where environmental services (sediment retention, aquifer recharge, wildlife habitats, etc.) and social activities are developed.

In this scenario, geodesign emerges as a relevant methodology for participatory management of public open spaces, enabling typological evaluation (analysis of functional and morphological categories and criteria of spaces) and communication of this data and information on the qualification of open spaces with and for the population. The methodological proposal comprises four steps that will be incorporated into an online management platform (Fig. 3).

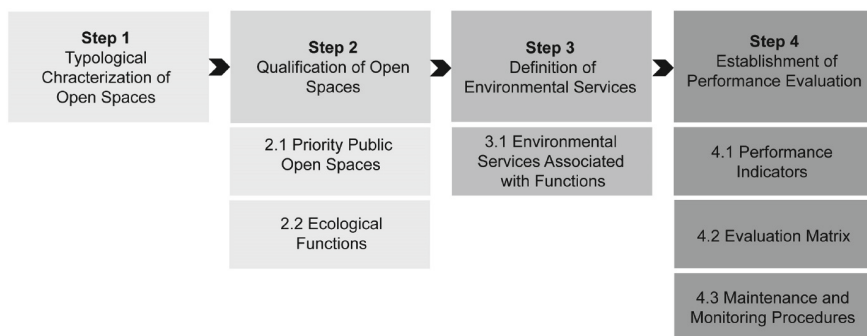


Fig. 3. Model of Open Space Management System.

The first step involves obtaining information about the typological characteristics of the available public open spaces, using functional and morphological categories and criteria. Then, the open spaces will be evaluated based on fundamental criteria to establish environmental control functions, such as:

- Permeability rate of the contributing basin of the open space;
- Susceptibility to erosion;
- Susceptibility to flooding;
- Percentage of native vegetation cover; and
- Potential for connectivity with legally protected green areas.

The definition of priority open spaces and the recognition of existing or potential ecological functions are expected outcomes of the qualification stage. These results will be used to expand or define and implement suitable environmental services for each ecological function. In step 4 of the open space management process, the definition of indicators to assess the performance of environmental services will be carried out, as well as the establishment of maintenance and monitoring procedures. These measures will allow for tracking and improving the performance of these spaces, transforming them into a green infrastructure system that produces ecosystem services.

The legitimate contribution of green infrastructure to urban sustainability essentially depends on multidisciplinary planning, addressing the needs of stakeholders, with the support of decision-makers, and furthermore, undergoing systematic short and long-term monitoring and evaluations [13].

Monitoring and management methodologies based on environmental quality indicators are more effective when they involve the participation of the local community, as they expedite decision-making processes to address current negative environmental trends at operational management levels and generate changes in attitude towards sustainable natural resource management [14].

In this scenario, the use of geodesign to monitor environmental quality indicators of open public spaces in mining-dependent urban centers becomes a strategy of great importance. In this strategic context, geodesign can promote access to the local community's knowledge about the environmental control functions assigned to open spaces and

allow the interaction of multiple local actors and other stakeholders in the construction of a systemic landscape planning.

4.1 Quality Indicators

The environmental quality indicators of open spaces were established considering basic parameters that influence the environmental quality of services proposed to contain high sediment loads and facilitate aquifer recharge. Therefore, they will serve to monitor the performance of compensatory devices of Sustainable drainage systems - vegetated detention basins and bio-swales, as follows (Fig. 4):

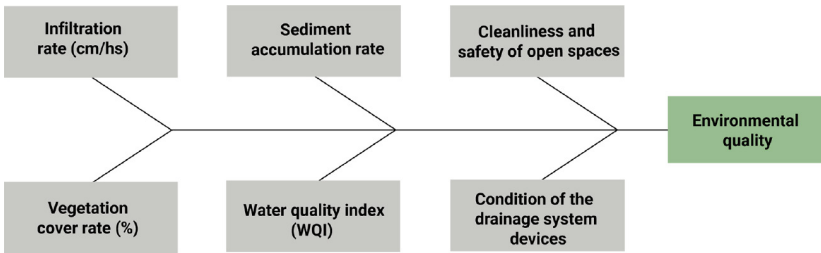


Fig. 4. Indicators of quality of open spaces.

The monitoring plan for these indicators should be carried out with the participation of a field team made up of residents (users of open spaces) and a technician in charge. This technician must be qualified to guide the activities and fill out the data collection forms for each open space that includes compensatory devices.

4.2 Geodesign Platform for Co-Creation

Geodesign combines proposal creation with impact simulation in a geographical context [15]. Eventually, it involves planning with and for geography to achieve consensus in a diverse environment with multiple stakeholders interested in the final outcomes [16]. Geodesign tools are applications that allow manipulation and processing of spatial information providing access to a variety of real-time geographic information, that can be used in various methods of territorial planning.

The geodesign framework deals with “the potential of geoinformation technologies on shared platforms to create collective agreements”. These agreements are based on processes of co-creation of ideas for the territory. In the context presented in this paper, GISColab is suggested as a reference platform, that favors the understanding of “citizens’ ability to read about their reality, reducing external interference in the process” [20].

In Brazil, a methodology for geodesign application has been proposed, aiming not only to obtain results but also to raise awareness and identify the spatial interpretations made by stakeholders in the geographic territory. This aspect contributes to community inclusion and expands the discussions for the participatory construction of a management plan for public open spaces. This methodology consists of well-defined stages

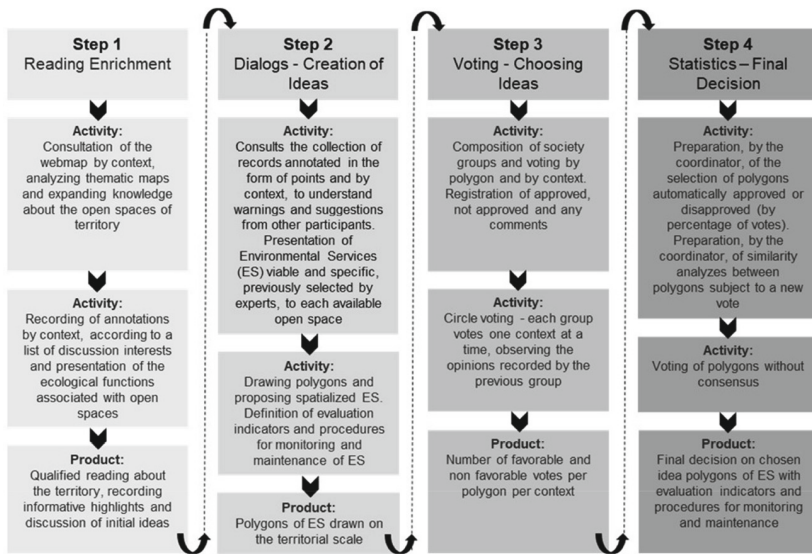


Fig. 5. Working framework in geodesign through Co-Creation.

that facilitate the identification of potential conflicts and agreements among participants (Fig. 5).

The methodological process is highly optimized when using a web-based platform, such as GISColab, which was initially developed by the GE21 Geotechnologies group [20] and adapted for geodesign by Moura [20] and Freitas [19].

GISColab facilitates the application of a framework for shared co-creation planning. It has broad adaptability potential based on the Open Geospatial Consortium standards and can accommodate scripts to support the work stages. Different users can access the same set of data and information, and the collective construction of proposals is shared. The methodology allows for the rapid spatialization of proposals through integration and dialogue among participants and their proposals [20].

5 Final Considerations

Given the economic dependency on mining activities in dozens of urban centers in the Iron Quadrangle the requalification of the drastically transformed landscapes becomes an urgent and compensatory program to achieve minimum environmental control conditions in these localities. The open spaces in these settlements constitute important public amenities and a starting point for implementing nature-based solutions aimed at minimizing impacts on water resources and enhancing the environmental comfort of the community.

The proposed model represents a methodological approach designed based on the morphological and functional characterization of public open spaces, enabling their qualification, and gathering a set of data to support the definition of specific treatment

requirements. These actions are focused on the implementation, monitoring, and protection of environmental control functions, with an emphasis on sediment retention and aquifer recharge.

However, it is crucial that this planning process is outlined and executed using participatory methodologies involving the local community. It requires the development of capacities for reflection, discussion, and determination of their own priorities for sustainable development.

In this regard, geodesign applied through the GISColab platform emerges as a powerful methodology capable of processing, spatially organizing information, and facilitating the construction of participatory management plans. The community can monitor environmental quality indicators to track performance, protect the functionalities of public open spaces, and consequently ensure the provision of associated ecosystem services.

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