

Lecture Notes in Civil Engineering

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Francesco Zullo
Lorena Fiorini
Lucia Saganeiti *Editors*

Innovation in Urban and Regional Planning

Proceedings of INPUT 2023 - Volume 2

 Springer

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Lorena Fiorini · Lucia Saganeiti
Editors


Innovation in Urban and Regional Planning


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ISSN 2366-2557

ISSN 2366-2565 (electronic)

Lecture Notes in Civil Engineering

ISBN 978-3-031-54095-0

ISBN 978-3-031-54096-7 (eBook)

<https://doi.org/10.1007/978-3-031-54096-7>

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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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 (INPUT2023): “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 (INPUT2023) 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 September 6–8, 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.

INPUT2023 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:

- Resilient, Circular, and Sustainable Cities
- Integrating Ecosystem Services into Spatial Planning Processes: Sustainable Solutions for Healthier and Safer Urban and Rural Environments
- Supporting the Transition Towards Ecologically-Oriented Urban Planning: What’s the Role of Early-Career Researchers? Innovative Findings, Experiences, and Ways Forward
- Towards Denser and Greener Cities? Methods and Indicators to Monitor Trends and Impacts in Support of Urban Planning and Policies
- Innovative Approaches and Methodologies for Driving Sustainable and Inclusive Urban Regeneration
- The Innovation of Urban Planning Tools for Energy-Resilient Cities
- Smart Happy Region. Relationship between Planning and Subjective Well-Being
- Climate Sensitive Planning: Re-defining Urban Environments for Sustainable Cities
- Urban and Peri-Urban Areas: Building Knowledge and Mapping to Better Plan the Sustainable Green City
- Densification and Urban Regeneration for Climate Adaptation in Sustainable Settlements.

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 INPUT2023 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, Paritech) and of the Efficacity 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 (INPUT2023) 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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Borruso Giuseppe	University of Trieste
Fancello Gianfranco	University of Cagliari
Balázs Kulcsár	University of Debrecen

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

Tarantino Eufemia	Polytechnic University of Bari
Esposito Dario	Polytechnic University of Bari
Capolupo Alessandra	Polytechnic University of Bari

Geodesign for Informed Collaborative Spatial Planning and Design

Campagna Michele	University of Cagliari
Mourao Moura Ana Clara	Universidade Federal de Minas Gerais
Scorza Francesco	University of Basilicata

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

Privitera Riccardo	University of Catania
Lai Sabrina	University of Cagliari
Zoppi Corrado	University of Cagliari

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

Fistola Romano	University of Naples Federico II
Fasolino Isidoro	University of Salerno

**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**

Cortinovis Chiara	University of Trento
Ronchi Silvia	Polytechnic University of Milan
Geneletti Davide	University of Trento

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

Saganeiti Lucia	University of L'Aquila
Fiorini Lorena	University of L'Aquila
Pilogallo Angela	University of L'Aquila

The Innovation of Urban Planning Tools for Energy-Resilient Cities

Guida Carmen	University of Naples Federico II
Gargiulo Carmela	University of Naples Federico II
Cutini Valerio	University of Pisa
Zazzi Michele	University of Parma
Zucaro Floriana	University of Naples Federico II
Carpentieri Gerardo	University of Naples Federico II

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

Garda Emanuele	University of Bergamo
Caselli Barbara	University of Parma

Research and Standards for Sustainable Spatial Planning

Esposito Dario	Polytechnic University of Bari
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Bretzel Francesca	National Research Council, Pisa

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Capezzuto Pasquale

National Agency for New Technology
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Coastal Planning: Diagnostic Tools to Address Physical, Social, and Environmental Concerns

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Celli Daniele	University of L'Aquila
Castellino Myrta	Sapienza University of Rome
Scipione Francesca	Sapienza University of Rome
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Territorial Strategies in Place-Based and Community-Led Energy Transitions

Grassini Laura	Polytechnic University of Bari
Bonifazi Alessandro	Polytechnic University of Bari

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

Cutini Valerio	University of Pisa
Altafini Diego	University of Pisa

The energy Transition of the Built Environment

Rotilio Marianna	University of L'Aquila
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Smart Happy Region. Relationship Between Planning and Subjective Well-Being

Garau Chiara	University of Cagliari
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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

La Rosa Daniele	University of Catania
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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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- Slow Food L’Aquila
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- Italian standardization body-UNI (Ente Italiano di Normazione)

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Urban Coastal Landscape. The Fragile Buffer Areas of Bacoli, Palermo and Termoli to Switch the Decay into Development

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Abstract. The urban coastal landscape is now at the center of new attention, as a result of cultural, social, economic, and real estate evolution. A new approach is actually clearly expressed by the National Recovery and Resilience Plan (PNRR) missions, which identify as priorities those actions for mitigating hydrogeological risks, safeguarding green areas and biodiversity, ensuring the health of citizens, and attracting investments. Starting from the interference between anthropic pressure and the need to preserve the biotic and abiotic environment, this work is aimed at highlighting the impact of the built environment on natural ecosystems in the urban coastal landscape. This study will be conducted on three sample areas in southern Italy, representative of Mediterranean biodiversity. Referring to these cases, a study will be carried out, considering both factors of anthropic pressure and those relating to ecosystems and their degree of naturalness.

Keywords: Waterfront · ecosystem · regeneration

1 Introduction - Objectives for the Moderation of Human Pressure on Fragile Peri-Urban Areas

The themes of fragile landscapes and climate change require a review of the contents and meanings of urban public space as a frontier terrain between users and the environment. The impact of human presence and activities on the components of the natural system has modified 75% of terrestrial ecosystems and 66% of oceanic ones, causing the transformation of numerous ecosystems and the extinction of many living species [1].

The urban coastal landscape is now at the center of new attention as a result of the cultural, social, but also economic, and real estate evolution of the first urban redevelopments of port areas. The Waterfront cannot be considered a simple demarcation between water and land but is a portion of territory—the mainland—that has a strong connection with the sea, and that man, over the centuries, has shaped with urban settlements and infrastructure [2].

Starting from the interference between anthropic pressure and the need to preserve the biotic and abiotic environment, we aim to highlight the impact of the built environment on natural ecosystems, choosing the fragile landscape of the waterfronts as a study sample. In this ecosystem, the ecological landscape and the environmental substrate merge into the material and social components, giving life to complex processes that are often the cause of degradation, degeneration, abandonment, and neglect.

The study proposes a methodology to identify the indicators useful for the evaluation of sustainability processes in transformation; it is calibrated in reference to the specificities of three study areas, representative of different environmental conditions on Mediterranean coasts and meaningful for the region to which they belong. Termoli is a settlement on a very short coastal segment on the Adriatic Sea, the only outlet to the sea in Molise, for this reason it has undergone a strong pressure from the industrial and inhabiting growth; the area “Bandita-Acqua dei Corsari” on the east side of the Palermo’s waterfront was, up to ‘70s, characterised by high interest because here biodiversity is merged with man’s settlement from the Neolithic, while, in last 50 years, the urban growth has turned this area in a landfill of building materials; the Bacoli’s waterfront is part of the “Parco dei Campi Flegrei” area where highest natural, archaeological, and cultural values are recognized but they are seriously at risk because of the touristic exploitation and illegal building. All these areas are covered by Integrated Management policies for Coastal Zones.

2 Elements for an Intervention Methodology

The role of Cities is considered crucial in developing and testing effective strategies capable of increasing the resilience of territories meant as Anthropic Resilience, Climatic Resilience, and Biodiversity Resilience. With reference to the Sustainable Development Goals defined by the 2030 Agenda, the following priority aspects are considered: protection of natural capital and biodiversity, restoring ecosystems with nature-based solutions, defense and restoration of degraded soil, protection of water resources, oceans, and seas, efficient use of resources and circular economy.

Starting from the specifics of the studied areas, a methodology is defined for determining the relationship between sustainability indicators and resilience impact zones.

The study presents the methodological apparatus defined to structure a monitoring and control tool for urban waterfronts to direct regeneration actions towards compatible and effective solutions, selecting those most able to mitigate impacts.

The following criteria for the discretization of the study areas have been obtained, referring to:

- degree of urbanization (with different densities: natural rural, natural anthropized);
- evolution of anthropization;
- climatic and microclimatic bands;
- destabilizing tendencies and behaviours;
- state of degradation and degeneration, man-made and natural;
- identification of risks.

The sample areas have the following common characteristics: being located in a border area between water and land, integrating both natural and anthropic processes, both urbanization and rurality; at the same time, they present characteristics of diversity in terms of bioregion (climate, flora and fauna, urban layout).

The analysis methodology, elaborated starting from the characteristics of the sample areas, considers distinctly two categories of elements:

- agents of anthropic pressure (built environment, mobility, accessibility, infrastructure, etc.)
- areas of impact of the natural ecosystem (flora, fauna, CC, abiotic systems, waters, etc.).

The analyses on anthropic and natural factors are oriented towards identifying those human actions that trigger degradation processes and are independent of other natural factors such as climate change, the migrations of fauna and vegetative species, the natural hydrogeological regime, in order to thus be able to isolate the direct and indirect drivers of degradation, i.e., those factors responsible for the effects of decay and impoverishment of the ecosystem.

Based on the degradation drivers, a system of indicators is identified that allows the measurement, evaluation and monitoring of pathological or risk conditions that can arise in these borderline contexts between different ecosystems, both in terms of pollution and changes in the characteristics of the habitats.

From the susceptibility of the indicators, we could deduce the range of stable and unstable areas on which to base the evaluation matrices in relation to the single contexts. Monitoring soil properties and interactions between surface and groundwater allows for the selection of indicators that are informative of the effects of environmental impact and land use on the natural setting and soil quality. Soil and water quality indicators are useful tools for management programs aimed at the conservation and recovery of terrestrial ecosystems and environmental quality.

Based on the measurement of the indicators, an evaluation matrices can be developed in relation to the individual contexts based on an innovative range procedure oriented towards the Ecological Footprint.

In order to guarantee the overall health level of a coastal site both in terms of anthropic and natural life and habitat it requires the definition of criteria that guide the survey on the overall level of impact on the natural and man-made environment, so as to predict future risks, and instruct in the definition of guidelines for future urban regeneration works [3].

Referring to the studied areas, the indicators are considered in the following groups:

Urbanized Systems Indicators (USI), Soil Indicators (SI), Biotic System Indicators (BSI), Cultural Indicators (CI). In Table 1, the assumed indicators are listed, for each of them, in the application for this study, the value 1 is assumed if relevant to the impact on the considered Resilience Areas, and the value 0, if not. For implementing results, a detailed evaluation could be developed to define threshold levels of the indicators in order to detail risk conditions in anthropic pressure on waterfront areas; based on the results returned by the matrices, the corrective actions necessary to contain the indicators within the tolerance ranges can be identified.

Table 1. Indicators of impact on the ecosystem

<i>Urbanized Systems Indicators</i>	<i>Soil Indicators</i>	<i>Biotic System Indicators</i>	<i>Cultural Indicators</i>
usi1 settlement dynamics	si1 resistance to erosion of outcropping lithologies	bsi1 genetic diversity of tree species	ci1 distance from the original pre-anthropoc landscape
usi2 industrial settlements	si2 soil stability	bsi2 agricultural crops	ci2 historical - archaeological pre-existence
usi3 illegal building	si3 presence of streams/lakes	bsi3 biodiversity	ci3 practicability of non-urbanized areas (paths and farm roads)
usi4 road connections	si4 clinometry	bsi4 riparian vegetation and low scrub	ci4 recognition of pre-existing settlements
usi5 railway connections	si5 surface runoff		
usi6 presence of landfills	si6 soil pollution		
usi7 demographic trend	si7 water pollution		
	si8 sewerage collection		

3 Termoli Case Study

The challenge dictated by the transformation process of the built environment of such a particular area, to identify issues that link environment, society and economy, makes it necessary to field new strategies of interpretation and governance, able to combine the cognitive and decision-making tools deriving from different disciplines and to promote a more conscious territorial planning. The implementation of such strategies can be fostered by the creative and targeted use of Information and Communication Technology (ICT), as emphasized by the EuropIA Conferences, with particular reference to the Cross-Platform of EuropIA 13: Connecting brain - Shaping the World - Collaborative Design Space applications of ICT to architecture, building engineering, civil engineering, urban design, and policy analysis interaction of different disciplines.

3.1 Environmental Characteristics

The regeneration of Termoli's waterfront cannot disregard an analysis of the settlement dynamics typical of Molise's areas and correlated with its status as a 'diffuse city', which developed by incorporating the surrounding minor centers. For a long time, the city of

Termoli consisted only of the Borgo Vecchio, the so-called 'old town'; the urban area, however, extended as far as the railway, which constituted the first major obstacle to the expansion of the coastal centre. Starting in the 1970s, various events contributed to changing this layout. The completion of the A14 motorway and the consequent opening of the Termoli motorway tollgate led to a demographic boom in the Molise coastal area. On the other hand, the establishment in 1972 of the industrial development nucleus in the Rivolta del Re area and the arrival of the FIAT group governed the process of industrialisation of lower Molise, tying its fate to the extraordinary intervention in southern Italy. In this period, the spread of illegal building profoundly transformed the Termoli coastline. The Molise coast was, in fact, completely invested by residential building with the birth of a continuous urban fabric from north to south, extending uninterruptedly from Petacciato (in the north) to Campomarino (in the south).

3.2 Geological and Landscape Features

The heterogeneity of the Molise territory, which is represented in its entirety by soils of a sedimentary nature, amply describes the geological characteristics of the entire Apennine chain [4]. In particular, the eastern and periadriatic sectors of the regional territory, in which the Termoli waterfront falls, are characterised by sandy deposits of Plio-Pleistocene transgressive-regressive cycles [5]. The great variability in the erosion resistance of the outcropping lithologies gives the region an articulated morphology. With reference to the central-eastern sectors, closest to the Adriatic Sea, where the less conservative successions prevail, such as the flyschoid clayey and sandy-clayey terms and the marine and continental Plio-Pleistocene clayey and arenaceous-conglomeratic successions, the territory is characterised by an often-undulating morphological profile. These soils are generally characterised by dense vegetation and are often the site of agricultural crops. The morphological evolution, especially of the flyschoid terms, is in places due to gravitational movements of considerable extension and, in some cases, modeled by runoff water that has determined gully-type forms of erosion. The coastal strip is characterised by deposition processes, even though there are areas where coastal erosion, due to sea currents and their interaction with river currents, is prevalent. For example, the high erosion of the coastal strip north of Termoli, at the height of the municipality of Montenero di Bisaccia, and the erosion of the stretch of coastline between Termoli and Campomarino [6] are noted. This sector of the regional territory, although heavily impacted, still has patches of naturalness such as the fossil dune systems in the municipalities of Petacciato and Campomarino, colonised by *Juniperus oxycedrus* subsp. *Macrocarpa* and *Juniperus phoenicea* and by sclerophyll species typical of the Mediterranean maquis [7].

In the Termoli Municipality, on the other hand, the peculiarities of these areas have made it possible to identify two Sites of Community Importance (SCI) within the Natura 2000 Network Project: the Foce del Trigno - Marina di Petacciato SCI (IT7228221) and the Foce del Biferno - Litorale di Campomarino SCI (IT7222216). The recent ISPRA report, however, notes precisely in these areas the presence of biotopes that are still lacking forms of protection or management of a conservationist type, making evident the

great vulnerability of an area characterised by a high ecological value and a great environmental fragility, deriving mainly from the structures and articulations of urban settlements that interfere with erosion and sedimentation processes and favour phenomena of contamination of surface and underground waters.

	Urbanized Systems Indicators USI							Soil Indicators SI								Biotic System Indicators BSI				Cultural Indicators CI			
	us i1	us i2	us i3	us i4	us i5	us i6	us i7	si 1	si 2	si 3	si 4	si 5	si 6	si 7	si 8	bs i1	bs i2	bs i3	bs i4	ci 1	ci 2	ci 3	ci 4
AR	1	1	1	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	1	0	1	0	1
CR	1	0	1	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0
BR	1	0	1	0	0	0	1	1	1	0	0	0	0	1	1	1	0	0	0	1	1	1	1

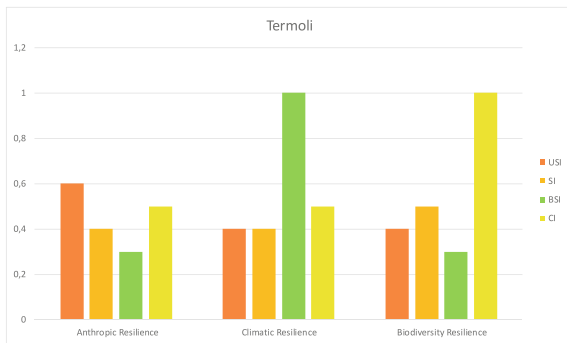


Fig. 1. Resilience Indicators/Areas Report for the Termoli study area.

4 The Case Study of Palermo

4.1 Environmental Factor and Eco-Sustainable Use

The landscape of the urban waterfront in the municipality of Palermo, between Monte Gallo and Monte Aspra, appears to have been profoundly modified and remodelled over time by man, since the Neolithic period (Fig. 2).

In this coastal stretch, there is a succession of beaches and cliffs, the latter usually with outcrops of compact limestone typical of the Panormide platform, in some places with banks of calcarenite of recent Quaternary deposition. The area falls within a stretch of sandy shoreline to the east of the Oreto River, which feeds it, and which, until the 1970s, was used for bathing activities. The loads of pollutants transported by the river and the use of the area as a dump for ‘waste materials’, resulting from the demolition of old houses, led to the abandonment of all forms of use and the establishment of bathing bans,

which are still in force. The applicative potential of the research for the Palermo area concerns the regeneration of the urban coastal landscape aimed at environmental/social wellbeing with a view to a substantial change in intervention scenarios based on the possible re-balancing of natural and artificial systems.

In terms of socio-economic impact, recognising economic development as a factor that sometimes exerts strong environmental pressures (on human health and ecosystems), the research intends to propose new status and incidence indicators (amount of pollution, over-exploitation of resources - soil water and genetic diversity of tree species) that will make it possible to identify undesirable changes to be combated (concentrations of nitrates, pesticides in the water environment, etc.), but also contexts to be preserved (habitats valuable for biodiversity, diversified agricultural landscapes, etc.), i.e. the elements that have a negative and positive impact on the environment [8]. Once the status and incidence of pressures have been established, they must be linked to the determining driving forces, since it is these driving forces that are the means of responding to environmental pressures that can generate a new and more balanced development of the coastal area.

In terms of scientific/strategic impact, the research is elaborating and testing the use of new 'specific' sustainability and response indicators, elaborated as possible models that contain to varying degrees all the peculiarities of the Mediterranean coastal landscape and its regeneration potential. From the integrated representation of several indicators, we will derive the ecological index, which is capable of assessing multiple and combined impact agents and effects, including the chemical-physical characteristics of the environment and, in particular, both the biological components living in it and the ecological processes taking place, and the pressures and impacts acting in the system, in order to assess the intensity of the degradation of all these components [9]. Such a multimetric index, i.e., based on different indicators and parameters, will make it possible to assess different and competing elements: territory, natural resources, landscape, also in its aesthetic and cultural value, healthiness as a living condition.

In terms of project technology impact, the various elements of the development matrix will form the nodes of a pathway that includes monitoring of the environment and assessment of the effectiveness of the measures to be planned with regard to - climate resilience: degree of adaptation to future climate change uncertainties, including sea level rise, warming and drought;

- anthropogenic resilience: degree of adaptation and/or counteracting the negative impacts of human processes, including pressure from tourism and urban development on the coast;
- productive capacity: assessment of the economic aspirations of the coastal community to provide a competitive asset for the local economy with a high content of natural and economic values;
- attractiveness capacity: creation of a distinctive marketing image on which to attract investment, to promote a cycle of self-support and sustainable growth;
- healthy capacity: development of design solutions that provide a healthy environment for people, natural resources, and wildlife.



Fig. 2. The waterfront landscape of Palermo, from Monte Gallo to Monte Aspra. (*Author archive*).

4.2 Naturalistic Factor and Local Biological Heritage

From the point of view of the degree of naturalness, the area of intervention is the furthest removed from the original pre-anthropogenic landscape. In the absolute lack of elements that can be recognised as belonging to an original landscape, it is considered that compromise solutions must be found, as the only constraint or limitation in the area is the wind and the presence of the sea.

In order to give functionality to the environmental recomposition project, it is deemed necessary to proceed in stages: initially, all the species that make up the “real vegetation” must be surveyed, the only ones that will be able to provide useful indications relative to the “potential vegetation”, after checking for “invasive” species, considered today one of the major causes of biodiversity loss.

Once the contingent of species to be used for the redevelopment of the area has been identified, it will be necessary to plan a planting scheme that is functional with the planning and use requirements (paths, rest areas, recreation areas, services, etc.) and that at the same time can harmoniously and with continuity, with the existing ornamental species in the green spaces already created or with the tree species of the street trees in the neighbourhoods involved in the coastal redevelopment plan.

On the basis of these segments of analysis, a line of research of a technological and ecological nature aimed at the defence of the built environment has therefore taken shape, which has its epistemological foundations in the analysis of heritage and its distinctive features in a bio-constructive relationship with nature.

	Urbanized Systems Ind. USI							Soil Indicators SI								Biotic Sys. Ind. BSI				Cult. Ind. CI				
	usi 1	usi 2	usi 3	usi 4	usi 5	usi 6	usi 7	si 1	si 2	si 3	si 4	si 5	si 6	si 7	si 8	bsi 1	bsi 2	bsi 3	bsi 4	ci 1	ci 2	ci 3	ci 4	
AR	1	1	1	1	0	1	1	0	0	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1
CR	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	1	0	1	1
BR	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1

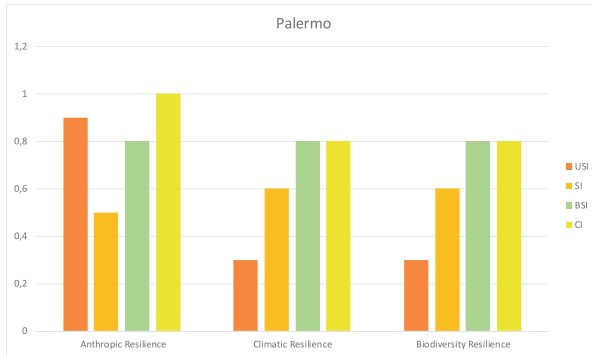


Fig. 3. Resilience Indicators/Areas Report for the Palermo study area.



Fig. 4. The Flegrean Area

5 The Case Study of Bacoli

5.1 Environmental Factor and Eco-Sustainable Use

The area of interest is included in the territory of the Municipality of Bacoli, of the metropolitan city of Naples, the territory, of volcanic origin, belongs to the Campi Flegrei system and, the area where the town stands, is characterized by an alignment of seven volcanoes, which determines a particular orographic configuration (Fig. 4). The geology

of Campi Flegrei and Bacoli is extremely complex and fascinating, with volcanic and sedimentary features that reflect the geological evolution of the region over the millennia. The Campi Flegrei are the result of a prolonged volcanic activity that began more than 39,000 years ago which led to the formation of a vast volcanic field characterized by calderas, craters, scoria cones and pyroclastic deposits. One of the main geological elements of Campi Flegrei is the Pozzuoli caldera, a vast crater depression that extends over an area of about 13 square kilometers.

Along the very articulated coasts, and on the slopes of eroded volcanic cones, dating back to the Greco-Roman era, over the centuries settlements have superimposed themselves which form a fabric rich in historical, archaeological, and naturalistic interests. A particular richness and concentration of sites of great interest in an area of only 13 km² which are in conditions of abandonment and exposure to indiscriminate and unaware uses of the impoverishment they cause to the ecosystem and cultural heritage. Since 2016, the Municipality of Bacoli has been involved in the Program for the Archaeological Park of the Municipalities of the Phlegrean Area (Development and Cohesion Fund 2014–2020). Among the significant aspects that motivated the choice of the case study, the following are underlined: - close link between urban space and archaeological heritage; - close link between urban space and natural heritage; - presence of paths, albeit fragmented, linking archaeological and naturalistic resources. Archaeological and naturalistic aspects intersect in a network which constitutes the greatest wealth of the territory. The risk factors that affect this patrimony are linked both to the consistency of the assets and to the use of the assets. Among the development activities, one of the most reckless and self-injurious is the tourism exploitation of the waterfront that, with the integration of infrastructure and services aimed at satisfying the demand for tourism, it compromises the very source of attraction and the territorial value [10].

The evolution of urbanization in the Phlegrean area in the last part of the nineteenth century and the first decades of the twentieth century was strongly influenced by the strengthening of the capitalist enterprise. This process has led to important changes in the organization of the territory, with the appearance of large industrial plants and specialized infrastructure. Industrial development has not been without negative consequences for the environment in the Phlegrean area. The urban growth that occurred in that period took place without adequate territorial control and planning, leading to a distortion of the landscape and the morpho-structural characteristics of the Phlegrean cities.

Cities such as Bacoli, Monte di Procida, Quarto and Pozzuoli have gone beyond their natural borders, ignoring the characteristics of the surrounding area. Furthermore, the increase in building construction has led to the progressive disappearance of the Mediterranean scrub vegetation and terraced cultivations, which were once typical of the local landscape. An important factor that contributed to this transformation was the establishment of the Baia shipyards, which led to a discontinuity in the development of the coastal area, once the site of Roman imperial villas and grand thermal baths that exploited the proximity to the sea. Another consequence of uncontrolled urbanization has been the increase in population; in the course of sixty years, from 1951 to 2011, the total permanent population of *Campi Flegrei* more than doubled; in the municipality of Bacoli the number of inhabitants increased from 1500 to 26648 [11].

5.2 Naturalistic Factor and Local Biological Heritage

The transition environments that extend from the coastline, delimiting the marine ecosystem, towards the more internal terrestrial ecosystems are very peculiar. In fact, in them, there are interconnections not only between abiotic and biotic factors of the ecosystem but also with anthropic factors.

In the study area, the coastal landscape is made up of a large spatial heterogeneity of ecosystems deriving from the different uses of the territory by human activities and expressing the human impact on the level of naturalness of the territory. In particular, the coastal landscape is made up of natural ecosystems (riparian vegetation and low scrub) interspersed with ecosystems with different degrees of anthropization (agricultural areas, grazing areas, small urban centres). The heterogeneous coastal landscape is dynamic because, being the result of the interaction between the environment and man, it is affected by the continuous changes in land use and the extent of the various human activities [12].

Human well-being strictly depends on the quality of ecosystems that provide a series of services. The continuous transformation of areas with a high level of naturalness into anthropized areas (agriculture, pasture, urban) and the fragmentation of the habitat reduce the functionality of ecosystems and therefore the benefits for humans deriving from ecosystem services. Population explosion and land use change are among the main causes of habitat fragmentation.

	Urbanized Systems Indicators <i>USI</i>							Soil Indicators <i>SI</i>								Biotic System Indicators <i>BI</i>				Cultural Indicators <i>CI</i>			
	us i1	us i2	us i3	us i4	us i5	us i6	usi 7	si 1	si 2	si 3	si 4	si 5	si 6	si 7	si 8	bs i1	bs i2	bs i3	bs i4	ci 1	ci 2	ci 3	ci 4
<i>AR</i>	1	0	1	0	0	0	1	0	0	1	0	0	0	1	1	0	1	1	1	1	1	1	1
<i>CR</i>	1	0	1	0	0	0	1	1	0	1	0	0	0	1	1	0	1	1	1	0	0	0	0
<i>BR</i>	1	0	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	0	0	1

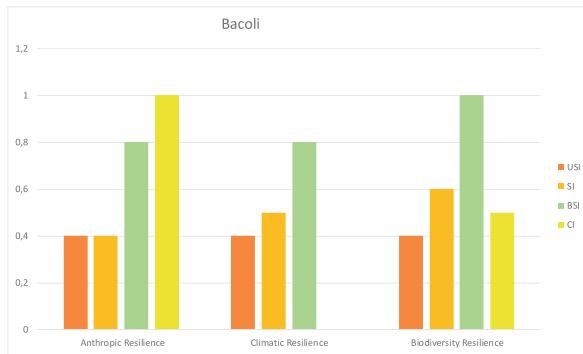


Fig. 5. Resilience Indicators/Areas Report for the Bacoli study area.

For management purposes, it is necessary to restore the connection of isolated habitats through the design of ecological corridors in order to favour the continuity of animal and plant flows, conserve or recover biodiversity, and give the territory a great landscape, cultural, social value and cheapness.

6 Conclusions

The analysis of the transformation processes of the coastal landscape, a place of friction between the urban element and the natural system, is aimed at refining knowledge on the sustainability indicators of urban and territorial regeneration.

The described methodology is based on the peculiarities of the sample areas; the main use of the obtained results from the evaluation system of the incidence of human pressure on coastal landscapes is to establish any considerations on the connection between the pre-existing buildings and the natural habitats, in order to direct regeneration actions towards compatible and effective solutions in terms of impact mitigation.

Referring to the graphics in Figs. 1,3, and 5, indicators are shown for each study area; the main impactful systems are recognizable in relation to the resilience field.

The application of the proposed methodology returns data on the sudden or gradual changes that act in the habitats of the coastal and river systems, to guide the interventions to be adopted to maintain the resilience capacity of the ecological systems and to guarantee the prospects for the future well-being and development of the local community. Through this representation it is possible to control how much new future scenarios of transformation can affect the actual conditions by increasing or decreasing the resilience performance of anthropic, climatic and biodiversity.

Acknowledgment. The contribution is the result of a common reflection by the authors. Despite this, the paragraph §3 is to be attributed to Catalano A. and Fabbrocino S., the §4.1 to Vitrano R., the §4.2 to Ilardi V., the §5.1 to De Joanna P. and Francese D., the §5.2 to Maisto G., while the introductory paragraph §1, §2 and §6 are to be attributed to all the authors.

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