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Libera Amenta
Michelangelo Russo
Arjan van Timmeren *Editors*

Regenerative Territories

Dimensions of Circularity for Healthy Metabolisms

REPAiR

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Springer

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Volume 128

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Editors
Libera Amenta
Department of Architecture
University of Naples Federico II
Napoli, Italy

Michelangelo Russo
Department of Architecture
University of Naples Federico II
Napoli, Italy

Arjan van Timmeren
Department of Urbanism
Delft University of Technology
Delft, The Netherlands

ISSN 0924-5499 ISSN 2215-0072 (electronic)
GeoJournal Library
ISBN 978-3-030-78535-2 ISBN 978-3-030-78536-9 (eBook)
https://doi.org/10.1007/978-3-030-78536-9

This research is done within the framework of the European Horizon 2020 funded research 'REPAiR: REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism'. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688920. This work reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Introduction to the Volume

> *Eliminating the concept of waste means designing everything - products, packaging, systems - from the beginning based on the principle that waste does not exist*
>
> —Braugart and Mcdonough, *Cradle to cradle. Remaking the way we make things*, 2002.

This book is a multi-faceted reflection on the links between territory and circular economy, a theme that revolutionizes our way of understanding the logic of production and consumption, of organizing social and urban structures, and of thinking about the principles and objectives of planning.

The circular economy changes the forms of urban life: this volume intends to explore how the concept, starting from its origin and in relation to its possibilities of directing individual and collective choices and behaviors, reorients planning and territorial management models.

"The circular economy is a resource-rich economic system and a device for innovation, bringing ongoing benefits to society, now and in the future. It is planned cradle to cradle, for an endless recirculation of clean technical and biological materials, energy, water, and human ingenuity". Innovation is the focus of our attention because it allows us to rethink the territory in terms of sustainability and relationships between city and environmental components, between society and ecology, as references to innovate objectives and methods of observation and description, models of prediction and design, forms of participation and evaluation, of contemporary urban planning.

Our reflection starts from a Horizon 2020 research entitled REPAiR (Grant Agreement No. 688920), which worked on the concept of urban and territorial metabolism aimed at the regeneration of territories in crisis, problematic and malleable of the contemporary: those of the peri-urban, crossed by phenomena of incipient mutation, where more at risk is the integrity and continuity of the ecological and environmental system in relation to settlements, functions, and people who live there.

To implement circular and healthier urban and territorial metabolisms, and to ensure a better quality of life for all, towards a more Circular Economy (CE) (EC, 2014; Ellen MacArthur Foundation, 2017) requires a true paradigm shift. Although studies show that over the past decade there is a growing amount of existing research and practical implementation of best practices in this direction, still in many cases, it is more limited to that of a reuse economy instead of a Circular Economy: circular principles are only applied in a sectorial way and/or at a very small scale (e.g. at the building scale), focusing mostly on reuse and up-cycling of materials and components. Very seldom, if at all, a more holistic approach towards the urban sphere is realized. This shortcoming is quite clear if existing plans, strategies, and policies, at the urban, regional national and even European level, are analysed.

Nevertheless, it is well known that the transition towards circular cities has been gaining momentum in the last decade, and more recently the search for a sustainable territorial metabolism is upfront as a new paradigm for change.

Several challenges should be tackled to move towards a circular Urban Metabolism as a new design approach, while including quantitative approaches typical of the accounting of the metabolic material flows as well as the qualitative aspects related to socio-ecological values. In literature, the importance of considering the four ecologies which compose a territorial urban metabolism has been recognized (Grulois, Tosi, & Crosas, 2018): (i) human ecology, which deepens the adaptability to humans to the environment; (ii) industrial ecology, which studies the impacts of the anthropic activities on the environment, the related availability of natural resources and the capability of the environment to metabolize waste; (iii) urban political ecology, which is related to the achievement of more just and sustainable decision-making processes; and the (iv) landscape ecology, which is focusing on ecosystems and it studies the effects of urbanization on contemporary territories, including a specific focus on city and countryside. The first three mentioned are not sufficient if considered separately from landscape ecology, since they do not include the reflections on the complex interrelations among city and countryside. This book takes all four ecologies together and thus emphasizes the importance of a regenerative approach, and its interdisciplinary nature.

At the same time new questions and further challenges—arising during this actual critical moment and exacerbated gravely by the pandemic due to the spread of the COVID-19—are asking for different kinds of answers for urban and territorial planning and the use of space in particular. *What kind of new questions can be identified? How to fill the gap between research and practice to imagine new possible ways of living in cities? How to implement a circular management of (land) resources in the contemporary territories, considering waste and wastescapes as new materials for sustainable urban transformation? How to implement regenerative approaches to the regeneration of neglected urban and peri-urban resources?*

Therefore, the aim of this book is also to clarify some of the definitions and new terms one could encounter nowadays when applying CE principles in daily research and work.

In this edited volume, in particular, the spatial dimension of circularity is explored, as it aims to address the application of the principles of CE in the wider territorial context, contributing to bring to light the spatial impacts (both positive and negative) of the implementation of circularity principles. It can be read as an underpinned manifesto for circularity and regenerative territories, as a new logic and design approach for a new urban planning *modus operandi*.

The European H2020 REPAiR project (Grant Agreement No. 688920) is the starting point of this edited volume, which presents some of the explorations carried out within the framework of the aforementioned European Horizon 2020 project “REPAiR. Resource Management in Peri-Urban Areas. Going Beyond Urban Metabolism”. In this project, among other aspects of a more circular economy for better urban metabolisms, the need to understand the impacts of circularity principles on the spatial structures of our territories has been studied (EC, 2016). However, for the sake of completeness, it also brings together further studies, beyond the framework of REPAiR (e.g. including Cities of Making, and P.U.R.E. projects).

Outstanding scholars have been thus invited to contribute to this edited volume, to bring their, and their projects’ specific perspective on circularity. All the included contributions have been deepening different kinds of outlooks, which according to the editors, show to be fundamental to delineate the different aspects that all together can give form and draw the philosophy of “Regenerative Territories” towards an updated concept of circularity.

As stated, a specific focus on land, an aspect that has been overlooked for a long time in the academic and practical discourse about CE (Williams, 2019), has been put forward, with the aim to improve the understanding of the functionality of territorial metabolism (Grulois et al., 2018). In fact, the spatial debris of metabolic processes namely wastescapes (Amenta, 2019; Amenta & van Timmeren, 2018; Cerreta, Mazzarella, Spiezia, & Tramontano, 2020) have been included as resources in the metabolic chains, opening up on the reflection on life cycles of territories and on closing the loops of their possible use and reuse in a sustainable manner. Besides the urban, particularly peri-urban areas become important contexts for rethinking urban transition in the light of a Circular Economy. Peri-urban areas are fragile territories since they are characterized by low-density urbanization and contain often a infrastructure-based fragmented spatial structure, while being affected by a huge presence of wastescapes, including both drosscape (Berger, 2006) and operational infrastructure of waste (Brenner, 2014). Wastescapes ask for fixing the attention beyond the reduction and the reuse/recycle of material waste, as it requires the understanding of how to apply circularity principles to the regeneration of abandoned, underused, or polluted spaces that need to be regenerated.

Multidisciplinary and participative approaches are also key in the application of circularity principles, combining top-down (institutional) decisions, with bottom-up and spontaneous practices from the local communities. This can be done in (Peri) Urban Living Labs (PULL) environments, which support inclusive tackling of complex problems. Experimenting in Peri-Urban Living Labs means to realize a procedural approach that derives from the geodesign framework (Steinitz, 2012) in which processes of social interaction, decision-making processes, and innovative project aims of the territory are interwoven. Actors representing the quadruple helix in co-creation sessions address the specificity of the challenges. In addition, Living Labs can be considered a transferable methodology for learning, and for producing innovation, through the identification of specific guidelines. Living Labs allow going beyond institutional lock-in situations, ensuring a dialog among stakeholders.

A territorial vision for regenerative territories is composed of a set of images for the city, and it deals with both the physical space and the local practices that take place in it, systematizing, through eco-innovative solutions (REPAiR, 2018a), the bottom-up reflections widely shared with all local stakeholders, with a top-down and properly institutional approach. In this way, a vision can hold together integrated and systemic images, which are able to re-interpret the existing city and to build feasible and sustainable projections towards a desirable and circular future (Secchi & Viganò, 2009).

A multiscale approach is crucial for a strategic regenerative vision. In order to really function, such a vision is strongly connected with the urban and territorial environment, and to their socio-economic structures. A vision is not just a simple sum of actions, but should have a strategic value, with an innovative approach capable to rebuild territorial connections at different scales, as well as through a systemic and multidisciplinary approach. To build overarching regenerative and site-specific visions for the palimpsest of contemporary territories (Corboz, 1998), a multi scale approach is configured as a central principle to analyse and plan the increasing complexity of contemporary cities. It is an important aspect to achieve healthier metabolisms: through a multiscale approach, ecology and landscape are the essential values embedded in the contemporary urban project (Russo, 2015).

Dimensions of Circularity for Healthy Metabolisms and Spaces (Chapter 1)

In the first chapter, Michelangelo Russo and Arjan van Timmeren introduce the main topic of the book in a reflection on Circularity and Spatial Planning within the wider context of global processes and their consequences for the field. The focus is on the development of spatial planning in relation to circularity over time, and in particular, the way how spatial planning and strategies respond to new urgencies and opportunities related to territorial metabolisms. In relation to space and time, five grand rules are explored extensively.

New Definitions: Amplifying the Perspective of Circular Economy (Part I)

In the first part, this book aims to outline a wider approach for circularity that could amplify the very concept of Circular Economy (CE), by better defining its scope and the related disciplines involved in its interpretation.

When CE is applied to cities and territories, its environmental, economic, and design features are often disregarded, thus presenting the need for a broader theoretical discourse on the CE's territoriality. In Chapter 2 “Territorialising Circularity”, by Cecilia Furlan, Alexander Wandl, Chiara Cavalieri, Pablo Muñoz Unceta, the role of territory in the CE conceptualization in the urbanism literature is explored, to develop insights on which tools and methods are requested to interpret territories through the lens of circularity.

In Chapter 3 "Shifting Risk into Productivity: Inclusive and Regenerative Approaches Within Compromised Contexts in Peri-Urban Areas", Francesca Garzilli, Federica Vingelli, Valentina Vittiglio, present peri-urban areas as challenging territories to enact regenerative design and practices, stressing how new policies in sustainable agriculture are considered as potential solutions for the rapid soil consumption in Europe.

Next, in Chapter 4 "The Circular Metabolic Urban Landscape: A Systematic Review of Literature", by Chiara Mazzarella and Libera Amenta, it is shown that during the past ten years, the scientific literature on Urban Metabolism (UM) and Circular Economy (CE) is constantly evolving and requires to be systematized also in order to underline the importance of collaboration between the different disciplines and the useful aspects to be deepened for designers, planners, and policy-makers to move towards circularity.

Finally, in Chapter 5 "Urban Manufacturing for Circularity: Three Pathways to Move from Linear to Circular Cities", by Birgit Hausleitner, Adrian Vickery Hill, Teresa Domenech, Víctor Muñoz Sanz, the need for merging both expert knowledge and transdisciplinary collaboration is highlighted. The argument is that urban manufacturing and its manufacturers are of great importance in delivering CE ambitions through processing materials, providing skills and technology for repair or reconditioning goods and the capacity to deliver innovative technology.

The Spatial Scope of Circularity (Part II)

Moving towards the definition and understanding of the relationships between urban form, spatial characteristics, and structure of urban areas, Part II focuses on argumentations to understand the ecological, spatial, socio-cultural, and site-specific impacts of the implementation of Eco-Innovative and Circular Solutions to contemporary territories. This chapter focuses on case studies across Europe and beyond, including an example from Vietnam.

In Chapter 6 "Evolving Relations of Landscape, Infrastructure and Urbanization Toward Circularity", Bruno De Meulder, Julie Marin, Kelly Shannon argue that contemporary spatial circularity practices are often decoupled from their site-specific socio-cultural and landscape ecologies. This is symptomatic of the role that performative aspects have, and of how a series of normative tools generate solutions, which do not take into consideration locational, spatial, and socio-cultural specificities.

In Chapter 7 "Circular City: Urban and Territorial Perspectives", Giulia Lucertini and Francesco Musco elaborate on the possibility to optimize the space used by flows and how to improve their interactions in urban and peri-urban areas, to construct another step towards circularity. It requires to rethink and redesign urban spaces, urban practices, and infrastructures, for facilitating a shift from linear to circular city.

In Chapter 8 “New Urbanization Phenomena and Potential Landscapes: Rhizomatic Grids and Asymmetrical Clusters” Enrico Formato explores the closing of short supply chains for the use and recycling of materials—also with reference to the CDW streams—as urban reconfiguration processes, which are structurally open to uncertainty, through a condition of “unfinished”, open to the assembly and accumulation over time of functions, forms, aggregations, and densifications.

In Chapter 9 “From Wastescapes Towards Regenerative Territories. A Structural Approach for Achieving Circularity”, Libera Amenta and Arjan van Timmeren investigate the spatial dimension of circularity, going beyond material resource management, by deepening the importance of revalorizing territorial waste and thus the spatial implications of a more circular management and reuse of wastescapes, investigated at the urban and metropolitan scale.

In Chapter 10 “Towards Circular Port-City Territories” by Paolo De Martino, ports are shown to play a crucial role in the transition towards circularity, by transforming the challenges of the port into opportunities and new forms of integration. It shows however also how limitations and path dependencies could obstruct the transition to new forms of circular economy in the future.

Methodology and Representation (Part III)

Part III unpacks the characteristic of complex tools and methodologies which have been set up for representing and interpreting waste streams, including the wastefulness of land and of parts of the territory. To support the significant transition towards circularity, metropolitan areas need planning, co-designing, and implementing solutions, which are shared with a wide range of stakeholders, who thus have to deal with data on material and territorial resources.

A geodesign framework helps model information and present consequences to inform the planning process and decision-making.

In Chapter 11 “Eliciting Information for Developing a Circular Economy in the Amsterdam Metropolitan Area”, by Gustavo Arciniegas, Alexander Wandl, Marcin Mazur, and Damian Mazurek, a novel Geodesign Decision Support Environment (GDSE) developed in the REPAiR project as an interactive web application for facilitating the collaborative process of developing spatial strategies for advancing circularity is shown.

This concept elaborated as a ‘Collaborative Urban Living Lab’, presented in Chapter 12 “Collaborative Decision-Making Processes for Local Innovation: The CoULL Methodology in Living Labs Approach” by Maria Cerreta and Simona Panaro, is able to support the Collaborative Decision-Making Processes to activate local innovation processes at the neighbourhood, city, or landscape scale and has been tested in four different research projects (including REPAiR), supporting the co-design, co-production, and co-decision cycles of urban innovative and sustainable solutions.

Finally, in Chapter 13, "Urban Metabolism Evaluation Methods: Life Cycle Assessment and Territorial Regeneration" by Pasquale De Toro and Silvia Iodice, the use of Life Cycle Assessment (LCA) is elaborated as a crucial evaluation of circular solutions, to support and assess the environmental impacts of the life cycles of industrial products and services. Here, it is extended to the field of urban planning, thus assessing sustainability of a territorial approach to circularity.

Sustainable Strategies and Solutions for Circular and Healthy Metabolisms (Part IV)

Finally, in Part IV, several practical examples and case studies are analysed, showing that the implementation of circular principles requires a focus on the involvement of experts and professionals from different fields through collaborative processes.

The chapter 14 "Planning Wastescapes Through Collaborative Processes", by Anna Attademo and Gilda Berruti shows that places originally designed for public use, but abandoned over time or never actually completed, are actually available for new uses and services. Their redesign could be based on criteria of flexibility, activating a dialogue between public institutions, private enterprises, local associations, and citizens' groups. Issues on spatial inequalities in access to spaces and services could be part of a wider redefinition of welfare and welfare spaces concept, as an effect of global economic and financial crisis.

Next, in Chapter 15 "Manufactured in the Peri-Urban: Regenerative Strategies for Critical Lands" by Giuseppe Guida", peri-urban areas are defined as intermediate land, characterized by a hybrid nature which makes them specifically vulnerable to speculation, indiscriminate use of soil resources, erosion of agricultural residues. Moreover, in some contexts, they lack control due to inadequate planning instruments and policies which require eco-innovative solutions and strategies.

In continuation, in Chapter 16 "Urban Regeneration: An "Incremental Circularity" Perspective" by Paolo Cottino, Dario Domante, Alice Franchina, Urban Regeneration (UR) practices take into consideration Circular Economy principles and their application. Contrasting soil consumption by catalyzing social energies to reuse territorial heritage, such as brownfields and disused buildings is presented as a method that reaches potentials and it requires an interdisciplinary perspective, combining in particular policy analysis and urban planning.

Chapter 17 "Reloading Landscapes: Democratic and Autotrophic Landscape of Taranto", by Francesca Rizzetto and Fransje Hooimeijer, introduces the concept of a Democratic Landscape beyond its natural environment, by recognizing the well-being of the inhabitants. This approach aims to overcome the conflicts between economy and environment. The analysis of a Democratic Landscape in relation to the concept of an 'autotrophic organism', merges together the transformation by regeneration of the ecosystem and the economic regime, by establishing new economic models in order to make a sustainable city.

In Chapter 18 "Hybridizing Artifice and Nature: Designing New Soils Through the Eco-Systemic Approach", Marina Rigillo elaborates on Ecological thinking as a design approach able to produce and implement eco-innovative strategies for achieving environmental and societal challenges of our global age. Today's major environmental challenges are not about single issues, such as waste reduction or soil loss, rather they involve systemic change and design processes, linking together economy, social habits, and technological responses.

Finally, in Chapter 19 "Towards Regenerative Wasted Landscapes: Index of Attractiveness to Evaluate the Wasted Landscapes of Road Infrastructure", Maria Somma analyses and assesses, through spatial indicators, the potential of wastescapes along with major road infrastructures, and how they can provide society with economic as well as environmental benefits.

In the Afterword to this edited volume, the editors look beyond the actual status quo of circularity in relation to spatial challenges, and in particular, how recent disruptions, like the Covid19 pandemic, on the one hand, re-value land and space, particularly near living areas, and on the other hand highlight the importance of finding strategic pathways towards securing safe ways to realize and include regenerated waste(d) territories into our living areas, and to do so in such way, that it can help make individuals, communities, and society as a whole, more resilient to such disruptions.

Libera Amenta
Michelangelo Russo
Arjan van Timmeren

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Editors and Contributors

About the Editors

Libera Amenta is a Post-doc Researcher in the Department of Architecture at the University of Naples Federico II, Italy where she teaches Urbanism at the Laboratory of Urbanism at the master level of the MAPA Course 'Laurea Magistrale in Architettura Progettazione Architettonica' (https://www.docenti.unina.it/libera.amenta). She has been, until recently, a Post-Doc Researcher at Delft University of Technology (TU Delft), Faculty of Architecture and the Built Environment, Department of Urbanism, chair 'Environmental Technology & Design'. Since 2016, she has been carrying out research on topics regarding the circular regeneration of wastescapes as a member of the EU-funded Horizon 2020 REPAiR project. Her latest book is 'beyond WASTESCAPES. Opportunities for sustainable urban and territorial regeneration' (please check https://doi.org/10.7480/beyond_WASTESCAPES).

Michelangelo Russo is the Dean of the Department of Architecture, University of Naples Federico II, where he is a Full Professor of Urbanism (https://www.docenti.unina.it/michelangelo.russo). He coordinated—from 2013 until recently—the Doctorate School in Architecture in the same Department. He has been carrying out so far several funded research of national and international interest. He was from 2014 until 2018 the head of the Italian Society of Urbanists (SIU). He has been the leader of the Neapolitan Team of the European project Horizon 2020 entitled: 'REPAiR—Resource Management in Peri-urban Areas: Going Beyond Urban Metabolism'.

Arjan van Timmeren is a Full Professor *Environmental Technology & Design at TU Delft (Faculty of Architecture and the Built Environment, Department Urbanism)*. Besides he is *Scientific Director of Resilient Delta Initiative* in Rotterdam (a joint Rotterdam based initiative by TU Delft, Erasmus University and Erasmus Medical Center), *Academical Portfolio Director 'Sustainable Cities' for the TUD Extension School for continuing education*, and was (co)founding Scientific Director, and now

Principal Investigator at AMS Institute (Institute for 'Advanced Metropolitan Solutions', a joint Amsterdam based initiative by TU Delft, Wageningen University and Research and MIT). His work focuses on sustainable development in the built environment, with emphasis on Urban Metabolism, Circular and Biobased Economy, Urban Climate and environmental behavior, and Nature-based technologies. He leads several (inter)national projects and has seats in (inter)national steering groups, quality teams and scientific boards.

Contributors

Gustavo Arciniegas is the lead consultant and director of Geo-Col GIS and collaborative planning, a Netherlands-based consultancy firm specialized in collaborative GIS, Geodesign, sustainable spatial planning, and Planning Support Systems that include collaborative instruments (hardware + processware). His background is Geoinformatics and he holds a Ph.D. degree in map-based decision support tools for collaborative planning. As consortium partner and guest researcher at the Chair of Environmental Technology and Design, Department of Urbanism, Faculty of Architecture and the Built Environment, Delft University of Technology, he collaborated within the Horizon 2020 REPAiR project, which focused on integrating Geodesign, Life Cycle Analysis, Sustainability Assessment, and Living Labs for improving waste management in European cities. Currently, he also works as geodesign and circular economy consultant for Susmetro (Sustainable Design for Metropolitan Landscapes), consortium partner of the H2020 project FoodSHIFT 2030, which focuses on the citizen-driven transition of the European food system toward a low carbon circular future, including a shift to less meat and more plant-based diets.

Anna Attademo is a Post-Doc Researcher in the Department of Architecture at the University of Naples Federico II (Italy) where she teaches 'Governing Urban Metabolism - Lab' in the course on Sustainable Development and Territorial Networks. She has been a member of the EU-funded Horizon 2020 'REPAiR' project. She participated in international conferences and she published scientific publications, working on the topics of circular economy and the urban regeneration of urban fringe. With Enrico Formato, she edited the volume 'Fringe Shifts. Transforming Planning for new suburban habitats' (2019, ListLAb, Barcelona-Trento), on the results of the URBACT Project 'Sub>urban. Reinventing the fringe'.

Gilda Berruti, architect and Ph.D. in Urban Planning, is an Assistant Professor at the Department of Architecture, Federico II University of Naples (Italy), where she teaches 'Territorial Surveys' and 'City Design'. She has been a member of the EU-funded Horizon 2020 'REPAiR' project. Her research interests include: public spaces between urban form and social dimension, inclusive urban policies and plans, the sustainable city as an aspect of the new urban question. Starting from the fieldwork, through surveys based on active observation and listening, she carries out research on the relationship between planning rules and urban informalities.

Chiara Cavalieri, architect and PhD Urbanism (IUAV, University of Venice), is Professor of Urbanism and Territorial Management and member of the scientific committee of Louvain4City at the Université Catholique de Louvain (UCLouvain). Over the last years, she has collaborated and taught in the field of architecture and urbanism at a number of different international schools, including IUAV Venice, GSD Harvard, EPFL Lausanne, ITMO St. Petersburg, and ENSAP Lille. She coordinated and directed several research activities and regional visions such as 'Extreme City' (Iuav Venice), 'The Horizontal Metropolis: a Radical Project' (Lab-U, EPFL Lausanne); 'The 'Blue Space', Eurometropolis Lille–Kortrijk–Tournai (StudioPaolaViganò, Lab-U, EPFL Lausanne), 'The Language of Water' (UCLouvain with Latitude—Platform for urban research and design). In 2016 she co-curated the exhibition 'The Horizontal Metropolis: A radical Project', exhibited first in 2016 at Venice Biennale. She is currently developing water and landscape urbanism research throughout transboundary city-territories, with a particular focus in mapping and representing the related territorial dynamics.

Maria Cerreta is a Full Professor of Appraisal and Evaluation, Department of Architecture (DiARC), University of Naples Federico II, Italy, Ph.D. in 'Evaluation methods for the integrated conservation of architectural, urban and environmental heritage', Coordinator of the Second Level Master in 'Sustainable Planning andDesign of the Port Areas', Director of the Advanced Course in 'Real Estate Market and Urban Regeneration (MIRU)' and Coordinator of the Master Degree Course in Architecture. She is CNN-IRISS Associate since 2019. She carries out research in the fields of appraisal and multidimensional evaluations in hybrid, collaborative and interactive decision-making contexts, typical of urban planning and territorial planning, developing adaptive Decision Support Systems for the enhancement of cultural heritage and landscape, for urban regeneration and spatial transformations, also with the aid of Geographic Information Systems (GIS), integrating methods and tools specific to economic, multi-criteria and multi-group evaluations. She has been a member of the EU-funded Horizon 2020 REPAiR project.

Paolo Cottino Urban planner and policy designer, committed to two complementary levels of academic activity and professional practice. Ph.D. in Town planning and public policies at IUAV in 2005, in 2014 he got the National Scientific Qualification as Associate Professor. From 2006 to 2016 he has been working as contract researcher and Adjunct Professor at Politecnico di Milano, School of Architecture and Society, Urban Planning Department. In a decade of research, held different positions and wrote many articles and scientific publications, being the author of 5 monographies. He has been also working since the beginning of his carrier as a practitioner in the field of urban governance: consultant at the Institute for Social Research (IRS) from 2001, in 2009 he was one of the founding members of KCity Ltd, one of the first multidisciplinary firms in Italy specialized in strategic design for urban regeneration, committed by public, private and NGOs to support their involvement in urban transformations by consultancy, design commissions and the drafting of feasibility studies. KCity's Scientific Director and CEO from 2018, he has recently been recognized as a national expert of city making by the Italian Ministry of Culture.

Paolo De Martino is a researcher at Delft University of Technology (TU Delft). He received his Ph.D. diploma in May 2021, with a thesis entitled '*Land in Limbo: Understanding path dependencies at the intersection of the port and city of Naples*', within a dual Ph.D. program between the Department of Architecture of Delft University of Technology and the Department of Urbanism of the University of Naples Federico II. His research interest—which touches upon the complex relationship between ports, cities and regions—deals with port cities from a spatial and institutional perspective. He has investigated the port city of Naples in comparison to port city territories along with the Hamburg-Le Havre range, with particular reference to the cities of Rotterdam, Antwerp and Le Havre. Since August 2021 he has had a temporary teaching position at the Department of Architecture in Delft and he is involved as teacher in the development of MOOCs on port cities and water works with Port city Futures research group.

Bruno De Meulder is a Professor and Chair of Department of Architecture, Research Group Urbanism and Architecture (OSA) Faculty of Engineering Science, KU Leuven. He studied civil engineering-architecture at the Department of Architecture, KU Leuven (Belgium), where he obtained his doctoral degree, and where today he teaches urbanism, its history and practice. He has been teaching also at AHO Oslo, UAH Ho Chi Minh City, TU Delft and TU Eindhoven. His work is anchored in a historical understanding and critical evaluation on current conditions and is mostly situated at the intersection of urban analysis and urban design projects. It is situated in contexts of dispersed urbanism with heterarchical characteristics that conventionally would be understood as weak urban planning traditions. As most work is dealing with postindustrial or postcolonial conditions, continuity and radical change are simultaneously on the agenda. His teaching mainly takes place in urban design studios and his mainly international practice RUA (together with Kelly Shannon) cherishes the cooperation and exchange with local partners. He publishes regularly on issues of urbanism in scholarly and professional media. Books include volumes on colonial urbanism of Congo, design research on the center of Brussels. Together with Kelly Shannon, he edited *Water Urbanisms* and *Water Urbanisms East* in the UFO series Explorations of Urbanism, that set the agenda for an urbanism that reorients the agenda of urbanism.

Pasquale De Toro is an Associate Professor of Appraisal and Evaluation at the Department of Architecture (DiARC) of the University of Naples 'Federico II' and director of the Interdepartmental Research Centre in Urban Planning 'Alberto Calza Bini'. He has a Ph.D. in 'Evaluation Methods for the Integrated Conservation of Architectural, Urban and Environmental Heritage' and is involved in different national and international research activities in decision support systems in the architectural, urban and environmental fields, and in particular on the integration between economic and multi-criteria evaluation methods and tools. He also deals with the elaboration of integrated multidimensional evaluation approaches using Geographic Information Systems (GIS) to support the decisions on an urban and territorial scale (urban metabolism, real estate market, interaction between city and port areas, ecosystem services, etc.). He is involved in several research projects and acted as scientific coordinator of research agreements at the national and international level. Dr. De Toro has been invited speaker at national and international conferences and lecturer at Italian and foreign universities.

Dario Domante Urban planner graduated at Politecnico di Milano in 2003 with a specialization in Environmental Planning. He has more than 15 years of experience in the field of local development. From 2003 to 2014 he has been working as a project manager in the Territorial Planning area of the Agency for the promotion and sustainable development of the metropolitan area of Milan. In 2013 he took part in the Executive Programme in Real Estate Finance at SDA Bocconi. KCity Senior Project Manager from 2016, he is specialized in the management and development of participatory programs applied to strategic town planning projects. He conceived together with Paolo Cottino a methodological framework for stakeholder involvement which won the 'URBANISTICA' prize in 2017.

Teresa Domenech is an Associate Professor at University College London Institute for Sustainable Resources (UCL ISR). She is the founder director of the UCL Circular Economy Lab and the UCL Plastic Innovation Hub. She has contributed to leading international research in the areas of sustainable industrial development, decarbonisation pathways and the circular economy. Her expertise covers analysis of resource flows and their environmental impacts across different scales (local, regional and global) and across sectors (plastics, textiles, Construction and Demolition, steel, cement and others). Her work has also studied resource implications (e.g. critical materials reliance) of green mobility (e.g. EV batteries) and renewable technologies. Her research activity also covers sustainable urban and industrial transitions. Her work has been published in leading academic journals, including Nature Sustainability, and she has contributed to influential reports for the European Commission and UN in the area of the Circular Economy. She delivers talks and lectures internationally in the areas of the circular economy and industrial decarbonisation. She regularly engages with the media (BBC, Channel4, TVR, NTVS, Times and Metro). She currently is part of the ISO Editorial Teams drafting the new family of standards in the Circular Economy.

Enrico Formato is a Researcher and Professor in charge of spatial planning and design at the University of Naples Federico II. He coordinates the 'spatial analysis' task of the 'Repair' project funded under the Horizon2020 program. He worked in the cooperation network between European cities 'Sub> Urban. Reinventing the fringe', coordinated by the city of Antwerp, funded under the UrbactIII project. His researches concern open public space, contemporary city (with particular reference to informal city), innovations of urban planning. His works have been exhibited at the Biennale di Venezia ('Fundamentals', by Rem Koolhas, 2014) and at the Triennale di Milano ('Exporting the historic center', by Benno Albrect, 2015). He is the author of scientific articles, essays and books, the latest of which is: 'Fringe Shifts. Transforming planning for new suburban habitats' (with Anna Attademo, ListLab, 2018).

Alice Franchina Architect specialized in Landscape design. Ph.D. in Urban and Regional Planning at the University of Palermo and Birmingham City University in 2018 with a thesis on ecosystem services in urban planning and policies. Between 2015 and 2018 she has been involved both as an activist and a researcher for the University of Memphis (TN, USA), in the activities of the Simeto River Agreement (Sicily), a regional development plan based on a shared and participatory governance. She also got a diploma as EU Project Manager, obtained at IlSole24Ore Business School (Rome). KCity Senior Project Manager from 2019, she is specialized in EU project management, social impact assessment, and is involved in different urban regeneration projects.

Cecilia Furlan is an Urbanist, Senior Research Fellow at the Faculty of Design of the University of Antwerp and Guest Researcher at the Department of Urbanism, Delft University of Technology. Cecilia's interest focuses on urban design and urban planning strategies for sustainability and circularity, with particular focus on sustainable urban development under conditions of resource scarcity. She believes that cities can do more with less, working toward sustainable growth. Over the past years, she has worked and taught in different architecture and urbanism schools across Europe.

Francesca Garzilli is an Architect and Ph.D. She received her Ph.D. on the topics of urban planning and landscape architecture at the Department of Architecture (DiARC) of the University of Naples Federico II (2021), with a thesis entitled 'Unfolding the Peri-urban Landscape Design: Towards the definition of a Peri-Urban Lexicon for Open and Catalytic Scenarios', developed in part at the University of Pennsylvania, Department of Landscape Architecture of the Stuart Weitzman School of Design, where she spent a period as a visiting scholar, during which she participated in seminars, was an assistant tutor (LARP 701-402), and participated in final and intermediate review juries (2019–20). She has been a member of the EU-funded Horizon 2020 REPAiR project. She is active as a tutor at National and International bachelor, master and workshop courses in the field of Landscape and Urban Planning at DiARC and at Politecnico di Milano. Before the Ph.D. she worked in Paris at Michel Desvigne Paysagiste office (2017).

Giuseppe Guida has a Ph.D. in Territorial and Urban Planning and currently Researcher in Urban Planning at Department of Architecture and Industrial Design of the University of Campania "Luigi Vanvitelli", where he leads the Planning Laboratory. His research activities are mostly focused on metropolitan areas, periurban and landscape urbanism. On these issues he is author of numerous books, scientific articles and chapters in books, such as: 'The Other Side of Illegal Housing. The Case of Southern Italy', in *NMP-New Metropolitan Perspectives*, Springer International Publishing AG and 'Territory in the Middle of the Ford' in *Sustainability*. He is a consultant to public bodies and he is a columnist for the newspaper *La Repubblica* on urban planning and landscape urbanism.

Birgit Hausleitner is an architect and urbanist, lecturer of Urban Design at the Faculty of Architecture and the Built Environment, TU Delft. She studied architecture at TU Vienna and the Politecnico di Milano and urbanism with distinction at

TU Delft and IUAV Venice. Birgit's research comprises work on urban diversity and mixed-use cities. Her research focuses on the multi-scalar and configurational aspects of urban morphological and socio-spatial conditions that facilitate, introduce or improve, combinations of living and working and their adaptation. Birgit has expertise in spatial design for micro-economic activities and for urban manufacturing, and in the development of multi-scalar analytic methods and multi-scalar and multi-actor design instruments. Her most recent projects include Cities of Making (2017–2019, research coordination TU Delft team), a research project exploring the future of urban manufacturing in Europe with the focus on Brussels, London and Rotterdam and Liveable Manufacturing (2020–2121, PI), a research project concerned with manufacturing as part of mixed-use areas with main case study city Amsterdam.

Adrian Vickery Hill is a researcher, designer and planner working at the intersection between cities, resource management and cooperation. He launched and coordinated the European project, Cities of Making (https://www.citiesofmaking.com), editing a book on urban manufacturing in Brussels, London and Rotterdam called *Foundries of the Future: a manual for cities of making* (TU Delft Open). He has consulted on projects concerning manufacturing and production in cities across Europe such as the ESPON Metropolitan Industrial Strategies & Economic Sprawl (MISTA), The French Le Plan Urbanisme Construction Architecture (PUCA) project *La Ville Productive* and regional industrial planning for the region of Brussels. Adrian co-founded the Belgo-Dutch Osmos Network (https://www.osmosnetwork.com), a non-profit organization offering design and development for sustainable transition projects. Adrian is a visiting researcher at the Université Libre de Bruxelles developing projects around industrial symbiosis.

Fransje Hooimeijer is specialized in system integration of technical conditions in urban design. In her research and teaching, she takes the perspective on the city as technical construction and investigates how these conditions can be utilized better in urban design and how the systems can adapt to new technologies. The focus lies on design and planning processes and how by representation of the subsurface as engine room of the city they can be made climate proof, energy neutral, more biodiverse and of better spatial quality. She is involved in practice and research networks in and outside the Netherlands, is editor of the Journal of Water and Climate Change, edited several books and published in urbanism and engineering journals.

Silvia Iodice is Contract Agent at the Joint Research Centre (European Commission), working in the Territorial Development Unit to support European policies with quantitative territorial analyses. She has a Ph.D. in Architecture (Doctor Europaeus; thematic area: Urban Planning and Evaluation), at the Department of Architecture of the University of Naples 'Federico II', with a thesis entitled: 'Urban Metabolism and Construction & Demolition Waste. Life Cycle Assessment As a Tool to Support the Territorial Regeneration'. Between 2018 and 2020 she was a research fellow at CNR-IRISS within the Horizon 2020 project 'CLIC—Circular models Leveraging Investments in Cultural heritage adaptive reuse'. As part of the Ph.D., she conducted an internship abroad at the Joint Research Centre (JRC) of the European Commission

(Seville, Spain), contributing to the Work Package 4 of the Horizon 2020 Project ‘REPAiR’. She carries out research in relation to Life Cycle Assessment, Urban Metabolism evaluation methods and Ecosystem Services. She is also interested in Multi-Criteria Decision Analysis integrated with Geographic Information Systems for the development of Spatial Decision Support Systems, using ecological, economic and social indicators for the enhancement of cultural and natural heritage. Finally, she has spoken at national and international conferences and has authored several articles in international journals.

Giulia Lucertini PhD., is a planner and researcher at the Iuav University of Venice, and associated researcher at FEEM. Since 2013 she has worked at the Climate Change Lab as an expert in resilient spatial planning, evaluation, and analysis of public policies. In the last year her main research interests are about the circular economy and urban metabolism linked to land use planning for more sustainable and regenerative exploitation and consumption of natural resources. She is mainly focused on the assessment and construction of projects and strategies for urban and rural development (in their interaction and dependence) with particular attention to local food policies and more generally local agriculture. She has been involved in many research projects, national and international, that explored different aspects of resilience, planning and use of resources.

Julie Marin is a postdoctoral researcher (FWO), Department of Architecture, Research Group Urbanism and Architecture (OSA) Faculty of Engineering Science, KU Leuven. She is engineer-architect (UGent, 2007). She obtained a Master of Science in Architecture and Urban Design at the Graduate School of Architecture Planning and Preservation, Columbia University New York in 2012. Her Ph.D. ‘Circular Economy Transition in Flanders. An Urban Landscape Design Contribution’ (KULeuven, 2019) received the VDK prize for sustainable development. Julie was architect and urban designer at the City of Antwerp (2007–2009), Artesis Hogeschool Antwerp (2009–2011) and Scape Landscape Architecture (2013) in New York City and Associate in Architecture at Columbia University’s Urban Design Program (2012). Julie’s main area of expertise is the integration of circular economy in urban development. Developing process-oriented urban design approaches of space as a metabolism, her research reinterprets the territory’s resourcefulness as the basis for contextualized circular economies. Co-producing imaginaries for circular territorial redevelopment, her research mediates ongoing conversations between different transition actors, while constructing knowledge on how circular economy can spatially restructure urbanized areas.

Chiara Mazzarella is Architect and Ph.D. in Architecture, with a thesis in the field of Urbanism and Evaluation at the Department of Architecture (DiARC) of Federico II University of Naples. During the Ph.D. she spent a year as a guest at TU Delft and has been part of the UNINA research group in the h2020 REPAiR project. Her Ph.D. research investigated the wastescapes, focusing on the urban metabolism of waste, the wasted architectures and the role of urban communities, identifying values, approaches and multidimensional evaluation tools for collaborative regeneration processes. Graduated in Architecture at the University of Roma Tre and Master in Architecture|History|Project, she worked in the field of architecture, design and exhibition set-up in offices in Europe and in Chili. Her research interests concern the circular city and the reuse of the built environment in relation with other cultural fields, with particular attention to artistic and creative processes.

Marcin Mazur is an Assistant Professor at the Institute of Geography and Spatial Organization of Polish Academy of Science, a member of Department of Rural Geography and Local Development. His research activities are mostly focused on cartographic quantitative methods of presentation and applying of quantitative methods in human geography. His master's degree thesis title is: *Perception of maps presented by means of cartodiagram* and Ph.D. thesis title is: *Cartographic method and perception of statistical map content*. He is an cartographic editor of the *Atlas of Polish Agriculture*, and two scientific journals: *Rural Studies and Geographic Review*. In the period of 2009–2020 a member of the Main Board of Polish Geographical Society, has participated in numerous international (ESPON, FP7, H2020), national and regional, scientific and applicable projects. An author of over 60 scientific publications.

Damian Mazurek has a master's degree in socio-economic geography and cartography and geoinformatics. He graduated from Maria Curie-Skłodowska University in Lublin in 2015. Then he started his scientific career at the Department of Rural Geography and Local Development in the Institute of Geography and Spatial Development of Polish Academy of Sciences in Warsaw. His main research interests are focused on spatial modeling, regional and local development and rural geography. He is the author of 19 scientific publications (8 in English) and co-author of 3 atlases. He participated in 9 research projects (National Science Center' projects, Horizon 2020) and expertise for regional governments, ministries and local authorities. He has two ESRI certificates in the field of advanced spatial analysis.

Víctor Muñoz Sanz is an Assistant Professor of urban design at the Faculty of Architecture and the Built Environment of TU Delft. His work examines architecture and urbanism at the intersection of technology and ecology. He holds a degree in Architecture and a Ph.D. cum laude from ETSA Madrid, and a Master of Architecture in Urban Design, with Distinction, from Harvard University. His Ph.D. received the 2018 Anthony Sutcliffe Dissertation Award of the International Planning History Society. Muñoz Sanz has been: Harvard's Druker Traveling Fellow; Emerging Curator at the Canadian Centre for Architecture, Montreal; coordinator of the Jaap Bakema Study Centre, Het Nieuwe Instituut, Rotterdam; co-principal researcher of 'Automated Landscapes' at Het Nieuwe Instituut; postdoctoral researcher at TU Delft, in the project 'Cities of Making'; and fellow in Architecture at the Akademie Schloss Solitude, Stuttgart. He is the co-editor of *Habitat: Ecology Thinking in Architecture* (NAI010, 2020), *Footprint: Delft Architecture Theory Journal* (2019), and *Robocar and Urban Space Evolution* (TU Delft Open, 2018). He has published essays in books and periodicals such as: *Foundries of the Future: a Guide for 21st Century*

Cities of Making (TU Delft Open, 2020), *Steel Cities: The Architecture of Logistics in Central and Eastern Europe* (Park Books, 2020), *Harvard Design Magazine, Work Body Leisure* (Hatje Cantz, 2018), e-flux Architecture, Volume, and Domus. His research on automation with Het Nieuwe Instituut was exhibited at the 2017 Vienna Biennale, and 2018 Venice Architecture Biennale.

Francesco Musco, Ph.D., architect and planner. He is a Full professor in Urban Planning and Design at the Iuav University of Venice, Director of Iuav University Research and coordinator of the Ms in Urban Planning for Transition. He is a member of the board of directors of CORILA Consortium for Coordination of research activities concerning the Venice Lagoon System. His research interests are mainly focused on urban planning and sustainability, urban regeneration, policy design, urban resilience, climate change and strategies of mitigations and adaptations, energy and environmental planning, circular economy and urban metabolism, maritime spatial planning and coastal zones management.

Simona Panaro is a Senior Research Associate at the Faculty of Business and Law of the University of Portsmouth. She is Ph.D. in 'Evaluation methods for the integrated conservation of architectural, urban and environmental heritage' and deals with decision-making processes for urban sustainability. Her background includes decision analysis and the design, monitoring, and assessments of urban policies/programs/projects oriented to sustainability. She has participated in several research projects on the enhancement of cultural sites, UNESCO sites, regional and national parks, urban and rural areas. She has been a member of the EU-funded Horizon 2020 project called CLIC—Circular models Leveraging Investments in Cultural heritage adaptive reuse.

She has worked in multi-stakeholder environments, supporting participatory and collaborative decision-making processes.

Marina Rigillo is an Associate Professor, Ph.D. in Technology at the Department of Architecture, University of Naples Federico II, Italy. She teaches at the Degree Course 'Sustainable Development and Territorial Networks' and 'Design for the Built Environment'. The specific of her scientific field of study is ecological design, focusing on the topics of climate adaptation and of technologies and processes for improving circularity within the construction sector. A special focus in her studies is the regeneration of urban soils, both polluted and impervious. Since 2016, she has been part of the EU-funded Horizon 2020 REPAiR research team. At the present she is involved in several research projects such as the selected Demolition and short supply chain of former industrial areas in East Naples. More information about Mrs. Rigillo's publications are available at: https://www.docenti.unina.it/marina.rigillo and https://www.researchgate.net/profile/Marina_Rigillo.

Francesca Rizzetto is an urban designer and planner, living and working in Rotterdam. In 2011, she moved to Netherlands to study urbanism at Faculty of Architecture at TU Delft, where she graduated in 2013, her graduation project has been awarded with the 2nd prize on Archiprix NL. Over the years, she has developed experience in different scale from the masterplan of Tirana (AL) with UNLAB and SBA approved in 2016, till a small square in Ferrara (IT), completed in 2019. Francesca is involved as external researcher and guest teacher at TU Delft. In her research, she focuses on the imbalance of politics, economics, polluted landscape and built environment.

Kelly Shannon is a Professor of Urbanism at the Department of Architecture, Research Group Urbanism and Architecture (OSA) Faculty of Engineering Science, KU Leuven. She studied architecture at Carnegie-Mellon University, Berlage Institute and completed her doctoral degree at KU Leuven. Before entering academia, she worked in a number of internationally known architecture firms. She has taught at Harvard's GSD, Peking University, AHO Oslo School of Architecture, UAH Ho Chi Minh City, University of Southern California, Aarhus School of Architecture, University of Catalunya and University of Colorado. Her teaching, research and practice engages numerous contexts in the public sector and focuses on the development of robust landscape structures as a form of resilience—particularly the consequences of climate change—to deal with contemporary design challenges at the territorial and urban design scales. She has been working in the Belgian and Vietnamese context for several decades through the international practice RUA (with Bruno De Meulder) together with local partners.

Maria Somma completed her studies in Territorial Urban Planning and Environmental Landscape with honours at Federico II of Naples. Her passion for data science led her to implement her knowledge in the use of geographic information systems (GIS) for spatial planning. She then participates in an intensive course on urban policies and territorial information systems at the Autonomous University of Barcelona. She won a research grant with the interdepartmental center of Urban Research and Territorial Planning 'Raffaele D'Ambrosio' for the implementation and functional study of the road network of the metropolitan city of Naples with network analysis tools in the GIS environment. At the same time the Master's Degree in Forensic Urbanism ends with honours. She is currently doing an industrial Ph.D. in planning and assessment at the Federico II University, TUDelft University and RINA (Italian Naval Register). She is working on issues related to the development of spatial analysis methods and processes for the analytical integration of waste landscapes related to road infrastructure into decision-making and planning processes in a sustainable and circular perspective. She has been part of the UNINA research group in the h2020 REPAiR project.

Pablo Muñoz Unceta is a researcher at the Institute for Advanced Architecture of Catalonia in Barcelona, where he works in research projects on urban regeneration of industrial areas (CENTRINNO), and collaborative governance and circular economy (Reflow). He holds an Architecture degree from the ETSA Madrid and a M.Sc. degree from the European Post-Master of Urbanism at TU Delft. He has professional experience in participatory planning, housing policies or urban mobility projects, among other fields. He has worked for the Barcelona Housing Observatory, the Municipality of Lima, Peru's Ministry of Housing and Construction, the World Bank, CESAL and other organizations, and he has developed consultancy work for different private companies. He collaborates in research projects, publications and initiatives with TU Delft, Wageningen University & Research, TU Wien, or PUC Peru, focusing on the intersection between spatial analysis, design, geographic information systems (GIS) and decision-making processes.

Federica Vingelli Ph.D. candidate at the Department of Architecture (DiARC), University of Naples Federico II in Italy. She has achieved a Master Degree in Urban and Landscape-Environmental Planning with honours with a research on cruise tourism and the impacts on contemporary port cities, focusing on the Hamburg case study in Germany. In Hamburg, she has also carried out an internship as landscape architect approaching the design of open and public spaces. Back in Naples, she completed her advanced formation in geographic information systems and participated in the Horizon 2020 "REPAiR" research project in the fields of circular economy, waste flows and waste landscapes. She is deepening these topics within her Ph.D. research program on the metabolism of urban and peri-urban regenerations.

Valentina Vittiglio is an Architect and Research Fellow at University of Campania "Luigi Vanvitelli"—Department of Architecture and Industrial Design on a project entitled PURE—Productive and Urban metabolism Resources. Eco-solutions for new lands and she is also a member of the research team of the project RI.P.ROVA.RE—RIabitare i Paesi. StRategie Operative per la VAlorizzazione e la REsilienza delle aree interne. She has Ph.D. in Architecture, thematic area: Urban Planning and Evaluation, at the Department of Architecture of the University of Naples Federico II, with a thesis entitled: 'Wasted Landscape. Circular perspectives and innovative approaches on landscape remediation', with a focus on the design and evaluation techniques for the implementation of environmental remediation. As a part of the Ph.D., she conducted an internship at the ERM_Environmental Resource Management (ERM), in Milan, deepening her interest in the remediation of polluted soil and water, sustainability and innovative solutions to improve urban metabolism and circularity of the fragile urban contexts.

Alexander Wandl is an Urbanist and Associate Professor of Environmental Technology and Design, at the Faculty of Architecture and the Built Environment. His research focuses on developing sustainable urbanization, using an extended territorial metabolism approach and integrating (GIS-supported) methods and tools from different disciplines. As scientific coordinator of the Horizon 2020 Funded Research Project Repair—Resource Management in Peri-Urban Areas—he is at the forefront of developing spatial strategies which support the transition toward more circularity. He specifically focuses on the challenges related to the sustainable development of dispersed urban areas and periurbanization processes in Europe.

Chapter 1
Dimensions of Circularity for Healthy Metabolisms and Spaces

Michelangelo Russo and Arjan van Timmeren

1.1 Introduction

In the past three decades, one of the biggest transformations ever took place, viz., the fusion of the various geographical markets in the world into one dynamic, complex organism. In this, roughly forty to sixty "global cities" are taking up a key position within the global economy. They can be called the "hubs" of modern global economy, characterized by "denationalization" (Sassen, 2004). Consequently, the "global city" is much more complex and chaotic, and there is a growing number of connections extending across boundaries. It has resulted in a global rearrangement, which is still occurring and for instance accelerated by the recent pandemic, but also quite scattered and very localized decline of certain spaces, often a result of the disappearance of functions, or of negative consequences of ageing, including pollution.

Cities are not only dealing with the external challenges, like this, but also with their internal structure and how to deal with spaces "under pressure" as a consequence of forces that seem outside cities' control. Cities' internal structure is often based on traditional linear, top-down, and expert driven planning-oriented policies. In order to cope and shift from closed centralized systems to an open innovation model related to circularity, cities must address different forms and levels of communication and co-production with consumers, customers and citizens. Meanwhile, during these last decades of the twentieth century, in a large part of the publications on environmental issues, a rising awareness can be noticed that the (environmental) credo of "Think

M. Russo (✉)
Department of Architecture (DiARC), University of Naples Federico II, Naples, Italy
e-mail: russomic@unina.it

A. van Timmeren
Department of Urbanism, Chair of Environmental Technology and Design,
Delft University of Technology (TUDeflt), Delft, The Netherlands
e-mail: a.vantimmeren@tudelft.nl
Scopus ID: 6602379241

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_1

global, act local" should be the basis for any possible solutions. At the same time, many observers believe the post-industrial era is characterized primarily by the power of information rather than by either the importance of leisure or the change to a service economy.

Despite (or perhaps due to) global interconnection, inequality regarding access of resources, capital and other "drivers for opportunities", along with the common profit they offer, also have increased (Röling, 2000). At the same time, the process of globalization implies a further-reaching specialization, and accompanying risks resulting from larger national and international dependence and heteronomy (van Timmeren, 2006), something which has been experienced again recently with the (medical) equipment during the pandemic. The problem arises that globalization leads to further-reaching homogenization (and denationalization) because of the background of the so-called market, ecology, raw materials and information technology imperatives. And then, it is exactly the speeding up of the change that results in the biggest change in present-day society. Toffler calls this the future shock: "Future shock is what happens when change occurs faster than people's ability to adapt" (Toffler, 1984). Therefore, the relation between the various spatial scales cannot be regarded independently from the time scales, as well as paradigm shifts (Kuhn, 1962).

In this chapter, the relation between circularity and space is explored. The development over time, and in particular the way how spatial planning and strategies respond to new urgencies and opportunities related with territorial metabolisms is the focus of this chapter. In relation to space and time, five grand rules are explored as necessary to implement the transition to Circularity: (1) The Circular Economy paradigm shift requires a socio-ecological perspective and looking beyond boundaries; (2) Circular Economy is based on systems thinking and territorial metabolism; (3) a Circular Economy calls for a renewed approach to the public domain and stakeholder involvement; (4) amplifying the definition of Circular Economy with the inclusion of wastescapes; and (5) Planning the Circular Economy as an open collaborative system.

1.2 The Circular Economy Paradigm Shift Requires a Socio-Ecological Perspective, Looking Beyond Boundaries

Around the beginning of the twentieth century, based on his innovative documentation on the traditional, incremental approach to urbanism in Europe (Sitte, 1889), Sitte called, in his contribution to magazine Städtebau, parks the "lungs of the city". Subsequently, one of the first signs for a changing attitude towards health aspects in relation to planning and design of our built environment at scales larger than (a cluster of) buildings is Ebenezer Howard's (1902) publication "The garden cities of tomorrow", in which he designs "healthy urban living" with garden cities which should facilitate interaction between the city and the country. He intends to direct social processes with them. He hopes to secure the quality of the improved situation with the occupants having their own management and self-government of their housing and surroundings. After the First World War, movements arise in Britain and Germany as a reaction to industrialization going back to movements such as Arts and Crafts from the previous century, which also aimed for healthier living and housing. It is also in this period that Leberecht Migge and Ernst May link up "healthy" agriculture with "healthy" building and living. In collaboration with May, Migge translated this into designs for the new "Siedlungen" in Frankfurt, Germany. He made the suggestion to introduce green spaces and educational and recreational facilities, and to combine high-rise and low-rise buildings; Migge argued in favour of "Gartenkultur statt Gartenkunst" and zones of intensive horticulture around the cities, just like Daniel Paul Schreber did (Tjallingii & Reh, 1989; Winblad, 2000). Gradually, a movement of "building differently and a closer connection between nature and culture" comes into existence, e.g. like taken by Rudolf Steiner's anthroposophical movement. About a decade later Patrick Geddes (1915) publishes his study on the urban growth patterns. Geddes's antidote planning was planning at a regional scale, based on a solid analytical understanding of the natural features and processes of the landscape and its resources. It can be seen as one of the first expressions of a regenerative vision on urban development.

Now, about a century later, again regenerative strategies which address a need to connect urban regions to their landscapes and resources, largely based on similar grounds, however forced by new drivers, come into place. Different drivers, as urban regions around the world now more than ever are interconnected, through lots of tangible and intangible relationships, as for instance via technology, transportation, trade and a postmodern metaculture. This structural characteristic, on the one hand, gives them a comparative advantage in our continually globalizing economic system (van Timmeren, 2013). On the other hand, this also has a downside, mostly involving certain risks related to this particular interconnectedness. These risks are related to spatial and environmental features and to the so-called ***cascading effects*** (Forgaci & van Timmeren, 2014), making communities increasingly vulnerable.

Of course, in this century in between, a lot of things happened, a lot of new important insights came up. Like for instance, in 1962 Rachel Carson publishes *Silent Spring*, the first book that established the link between loss of biodiversity and the use of chemical agents. In her book, Carson argued that entire bird populations were rapidly disappearing due to the agricultural use of pesticides such as DDT. Although Carson's thesis was highly controversial, within a few years the book became one of the most relevant texts for the environmentalist movement and provided an argument for organizations such as Greenpeace to campaign against the loss of biodiversity. A year earlier in 1961, the writer and urban planner Jane Jacobs pointed out the loss of a different kind of diversity: that of social exchanges in inner-city neighbourhoods being replaced by urban renewal schemes in the post-war period.

Throughout the twentieth century, consumption, the throughput of the one-way flows, became increasingly concentrated in large cities, demanding ever-increasing volumes of material from the sources. More and more cities are determining what happens in the rest of the landscape, namely ***a pattern of degeneration***. By the

1960s the ecological dysfunctions were beginning to gain attention, and environmental activities began to make themselves heard. In April 1968, Italian industrialist Aurelio Peccei and Scottish scientist Alexander King convene the first meeting of the "Club of Rome". Concerned by prevailing short-term thinking in international affairs, their mission was to focus on the long-term consequences of growing global interdependence. The Club of Rome's project, the "Predicament of Mankind", was one of the pioneering works aimed at identifying the limits to growth in population and industrial capital. In 1980, the word "sustainability" is introduced in the book *Building a Sustainable Society* by Lester Brown. Subsequently, in 1987, the Brundtland Commission, which the United Nations General Assembly charged with formulating an "agenda for the future", introduces the concept of ***Sustainable Development*** in the report "Our common future" (WCED, 1987, p. 42):

> *Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.*

This report is more optimistic than the earlier report to the Club of Rome and links up poverty and environmental issues for the first time. Summarizing you might say the WCED definition means for humankind: living on the interest yielded by our natural systems rather than on the capital. One of the most significant consequences of *Our Common Future* has been the creation of the Intergovernmental Panel on Climate Change (IPCC) in 1988.

This is also the time in which first attempts on further going interconnections between several essential flows (energy, sanitation, nutrients) were made. An example of this time is the city of Kalundborg, located on the Danish coast about 110 km west of Copenhagen, which is regarded today as the oldest and well-known example of industrial symbiosis. This term refers to a specific type of material and energy exchanges that occur whenever industrial clusters take advantage of the geographic proximity between companies to eliminate industrial waste. The concept of ***carrying capacity***, which can be easily defined for other species, is inapplicable to human populations, as argued by Rees (1996), owing to the major differences that exist in terms of behaviour, technology and affluence. The maximum number of people that can be supported may not be the optimum, as both biological and industrial consumption relating to a population of people have, in turn, to be supported. Despite enormous efforts by activist groups and governmental agencies and despite an impressive volume of environmental legislation, overall environmental quality has not dramatically improved since 1970. Although there have been numerous and sometimes even considerable improvements, in other ways the situation has gotten worse. Our ***basic life support systems continue to decline***. At the same time, a handful of prominent environmentalists have acknowledged the mistakes of the earlier generation of environmental forecasters. This occurred most notably during the controversy over Bjorn Lomborg's "The Skeptical Environmentalist". Some environmentalists complained that Lomborg's "litany" of environmental doom amounted to a "straw man." Allen Hammond of the World Resources Institute, for example, argued at a public forum in October 2001 that Lomborg's litany "paints a caricature of the environmental agenda based on sometimes mistaken views widely held 30 years ago, but to which no serious environmental institution subscribes today" (Hammond, 2001). Michael Grubb of Cambridge University, wrote in a Science magazine review of Lomborg that "to any professional, it is no news at all that the 1972 Limits to Growth study was mostly wrong or that Paul Ehrlich and Lester Brown have perennially exaggerated the problems of food supply" (Grubb, 2001).

Meanwhile, in this time ***the planning model has based its theory and practice on the paradigm of growth***: an expansive idea of the built territory, aimed at adding settlements to the consolidated settlements to be built in the areas that are still free, agricultural and natural, to accommodate the urban functions required by the economies of growth. A model that has also developed in the form of reconstruction and expansion of the *existing*, after the Second World War and disastrous events of the twentieth century, in the stratified city and in the historical centres. An expansion that, in particular in the most economically and socially underdeveloped urban areas, has been very aggressive for the environmental values, dissipative of non-reproducible resources (territorial, environmental, landscape), as for example in Italy, where since the post-war period until the '60s and partly '70s, an indiscriminate growth, regimented with difficulty by institutional planning tools, has impoverished historical and environmental values. Since the early '80s, following the great global changes—the energy crisis, the post-Fordist transition, the ecological decadence—the approach to the planning of territories and cities has marked the gradual ***shift from expansion to transformation***, in the light of the emergence of new cultural and socio-economic values claimed by public opinion, and therefore able to affect the orientation of public policies. Environment, landscape, heritage and historical territory represent political as well as social and cultural values, more and more central in the management of the urban territory at the end of the twentieth century, and for this reason relevant in modifying the guidelines of urban planning. Values that see the centrality of the *existing city*, a territory characterized by the diffusion and stratification of practices and settlements, not always depicted by artistic or historic features: constitutive cores of the great European urban areas, milestone of the urbanization processes, inescapable content of the contemporary project.

Meanwhile, a sensitivity has been consolidating through which urban planning and territorial policies have been paying increasing attention to the changes in the shape of the city and the links with the society that inhabits it, as resources to be treated in a processual way both from an economic and institutional point of view, in ***an open field of competitiveness and plurality of actors***. There is a consolidated awareness that the "existing city" is a non-negotiable common heritage, the result of a "selective accumulation" of material and immaterial traces produced by the slow and progressive anthropic work in the territory. A cultural palimpsest that progressively becomes the object of a rationality of urban planning capable of acting incrementally, with a new sensitivity to fragility, imbalances and differences—social, economic and cultural—that characterize the conditions of the contemporary city.

Since the 1980s, the dismissal of manufacturing areas, buildings and specialized settlements that had been abandoned has been a theme of experimentation and research. At the same time, "building and urban redevelopment" was an opportunity for the reconstruction and densification of existing buildings, with the creation (more or less complex) of new settlements. In those years, ***decommissioning was treated with a productive approach, as an opportunity to regenerate the settlement capacity of abandoned built up areas***. Many European cases have highlighted this approach, which was strictly aimed at the reconfiguration and expansion of disused buildings, not focused primarily on the continuity of environmental values. The share of environmental redevelopment and the construction of new landscape, in the projects for the recovery of disused areas in the 1980s and 1990s, referred to the creation of urban parks and gardens, of accessory spaces to the large-scale redevelopment of buildings. Attention to the landscape as the sum of punctual and circumscribed interventions, the added value of large-scale real estate development operations in response to the crisis of urban growth, not always marked by a holistic and systemic approach.

The theme of brownfields and the redevelopment of functional retreat areas was the result—since the late 1970s—of the post-Fordist transition, which had generated a large supply of abandoned industries and other large civic structures (barracks, hospitals, infrastructures, shopping malls, etc.). However, the approach to that theme was a productivity one, as many cases from Brno's (CZ) and Manchester's (UK) textiles manufacturing, to Lingotto in Turin to Bicocca and Portello in Milan: opportunities for real estate development, with expansion of the original cores. In other words, the approach was not centred on a new ecological urban planning directed primarily to the enhancement of environmental and ecological values, but rather seemed to be the use of opportunities for the development of settlement capacity, in a conventional logic of the real estate market: ***parks were designed as accessory components of new settlement planning and were not the form of a process of ecological regeneration of the territory***.

The crisis of the concept of unlimited growth (economic and urban) has led to the transition to a way of planning capable of reviving and sustaining the intimate connection between territory, landscape and environment, based on ecology as a frame of reference. A transition perceived at the international level by scholars and institutions (see e.g. UN Agenda 2030, SDGs) but not yet rooted in the processes of multilevel governance at the local scale. This is particularly to be seen in vulnerable areas such as (peri-urban) green areas in or near towns, and, to a smaller extent, along frayed edges of towns, in areas dominated by industry and, for example, greenhouse farming. This is also to be seen in the urbanized areas in emerging countries, and in Europe in areas known as Territories-in-between, e.g. the Po Valley and the Napolitan metropolitan area (Italy), the urbanized zones Glasgow and Edinburgh (UK), the Flemish urban regions, and the so-called "green heart" of the Randstad region (the Netherlands).

Apart from a global awareness of the importance of sustainable development, there are some important megatrends in various present-day social processes:

- increasing ***emancipation, ageing, multiculturality and individualization*** of society;
- occurring ***scale differentiation, internationalization and globalization***;

- continuing ***transformation, economic-technological innovation, digitization*** and ***changing tasks in the public sector***.

Individualization and emancipation are often distinguished together with other social developments, including self-development, secularization and flattening of geographical differences in ideology. The intensification of these processes through demographic developments, including population growth, immigration, smaller families and ageing, plays a role here. The increasing emancipation of individual persons and groups of persons and the individualization influence people's needs, while expansion and internationalization are important trends changing their focus. The changing focus is based on the social and economic aspects, including lower costs through efficient production of goods and services, intensified use of scarce space and high attractiveness for users due to an increase in supply level.

The absence of a general theory of sustainability is a topical problem (Yaneske, 2003). Particularly, the role of spatial planning in this respect: the connection between local and global sustainability is characterized by uncertainty, ignorance and inexperience. Too often, developments follow paradigms, which often leads to a development with a fixed end, as an assumed "nec plus ultra" (van Timmeren, 2013). They can lead to an "a priori" brake on attempts to finding better alternatives. Within this context, there is growing consensus that a reductionist command and control approach is perhaps not the most appropriate way of interacting with what is in essence a dynamic complex adaptive living system, and that resilience and adaptation are factors of urban sustainability as important as (if not more than) conservation, efficiency and equity. This necessitates a quite dramatic mind shift in how cities are viewed. The notion of ***cities as part of an overall network of natural and artificial systems*** can be traced back at least to the fifties and sixties of the former century and the thinking of Howard T. Odum (1953). More recent thinking attempts to describe the interface space between humans and nature (of which cities are one example) as social-ecological systems. However, while there is general consensus that social-ecological systems refers to the human–nature relationship, exactly how this relationship is to be comprehended and structured as an integrated system is not clear.

Spatial planning must be able to conduct continuously the spatial consequences of developments. Therefore, ***it is necessary to look beyond boundaries***. This does not only concern physical boundaries (between areas or countries), but also ***boundaries of the various scale levels of solutions, of the interrelated networks, of the public space and, particularly, of their reciprocity***. And even as a closer form of reciprocity, the introspective: looking at the backsides, or downsides within territories. It induces the scrutinization of the underlying social needs and the finding of instruments that allow the spatial planning and renewed infrastructure to fit the changing social objectives (among which that of sustainability and liveability) and another way of dealing with "public affairs" better.

In a materialist sense, the process of urbanization is dependent on increasing the throughput of water, material and energy flows to satisfy the growing concentration of domestic and economic processes taking place within the urban fabric. Due to our skyrocketing population, this hastening of socio-economic activities has resulted in the degradation of ecosystems near and for vis-à-vis habitat loss, GHG emissions, climate change and environmental pollution. And it is factually correct to say that the increased circulation of water, energy and material resources concomitant with urban growth is predicated upon the expansion of capital-intensive infrastructures to appropriately mediate their transference. But viewing urbanization from a strictly materialist or economic perspective conveniently ignores how the control (or lack thereof) of key material flows by state and/or private actors further entrenches existing asymmetries in political power (Henriquez & van Timmeren, 2017). We can consider ***planning under the Circular Economy a natural development of the evolution of this model centred on the relationship between city and ecology***, which involves the need to observe the territory in its systemic components, environmental and ecological (soil, water, air, vegetation cover, etc.), as an organism, place of transit of metabolic flows that ensure the eco-systemic balance. The circular economy radically overturns the paradigm of unlimited growth and affirms itself as its antithesis: it brings closer the possibility of looking at the territory as a complex organism, consisting of "***dense interwoven socio-ecological networks***" (Swyngedouw, 2006), a landscape in constant evolution subject to different life cycles, which requires the use of the principles of care, regeneration and rebalancing of eco-systemic flows as reference principles of its project.

1.3 Circular Economy Is Based on Systems Thinking and Territorial Metabolism

Applying a regenerative logic to the urban landscape means treating the city in terms of metabolism applicable to the territory as an organism. Metabolism, in fact, allows us to consider the territory from an unconventional perspective, linked to its functioning in relation to the flows that are used and/or generated there, which pass through different life cycles, defining its spatial as well as systemic structure. It allows the dynamics of cities (beyond "traditional" mobility and the relationship between built/(un)cultivated environments) to be studied in relation to scarcity, carrying capacity and conservation of mass and energy (van Timmeren, 2013). It is tangential to concepts of regenerative design, cradle to cradle, the academic field of industrial ecology.

If we consider the metabolic balance of these streams as an equilibrium of inputs and outputs, we can understand how the reduction of the use of a linear economy, dissipative and extractive, can allow ***a regenerative perspective, the preservation and enhancement of ecological and eco-systemic values: a form of "dynamic equilibrium"***, aimed at minimizing waste and subvert the continuation of an economy and a system of consumption based on the dissipation of non-reproducible resources. Because it is a complex self-organizing system the city is always changing. Within this ongoing change, one can identify long periods of steady state during which the city is subject to small-scale disturbances and short chaotic periods where it is subject to strong fluctuations. Oftentimes the incremental accumulation of soft, hardly observed urban perturbations leads to dramatic unintended side effects (ibid.). When described in the language of complexity theory as found in Haken's *Synergetics* (1983), such an accumulating effect is called a "control parameter". Current and future cities must be (re)designed to account for these control parameters in order to find a suitable dynamic equilibrium between the reciprocitie***s*** (nature, urban areas, rural communities, technology and design) that define our way of life, the spectre of anthropogenic climate change and resource scarcity (van Timmeren, 2013). ***Urban metabolism*** is a notion that highlights the ecological crisis of the contemporary territory on the basis of the transformations of biological organisms in balance between growth and reproduction of life forms: a balance—in the urban analogy—between input and output flows, between energy and material flows that cross the city as an open system (Wolman, 1965). Understood as mutation, transformation of life-enabling materials, metabolism interacts with material and energy flows and the processes of their production, transformation, use and dissipation, and with conventional modes of consumption, which draws at the global scale contemporary urban societies (Russo, 2014). These mutations, while sustaining human systems, trigger a chain of negative by-products (Pincetl et al., 2012): consumption, production and waste, are the cornerstones of the growth processes of the urban, until the unbalanced relationships between these basic cycles produce significant impacts on natural and urban environments, on the continuity of their ecological structures, with strong repercussions on habitability also in view of the growing climate impacts in urbanized territories. The ecological aspects of metabolism require a holistic view of cities as "ecosystems" (Golubiewski, 2012; Pataki, 2010) consisting of the sum of multiple metabolisms and not simply as individual biological organisms. This emphasizes the process of exchange and the relationship between different parts of the system for a better understanding of the complex and dynamic functioning of the city. Urban metabolism, however, neglects the sociological fact that ***humans are malleable and conditioned by their social environment, not just by the natural environment***. Human behaviour is primarily influenced by societal norms rather than immutable natural laws. Though sociological studies of urban metabolism have shown the irrationality of societies in regard to essential streams (water, nutrients, etc.), there is one, thankfully positive observation: human settlements are able to adapt to environmental conditions. Unlike all other organisms' ***humans are self-aware of their actions and can adjust behaviors accordingly*** (van Timmeren, 2013).

An inadequate urban metabolism determines the overproduction of non-recyclable waste with a strong imprint on the territories, increasing the risks and effects of fragmentation and marginality on the living contexts of local societies and settled communities; see the example of the "terra dei fuochi"—*lands of fires*—in the Neapolitan hinterland as a symbol of environmental and social degradation (Palestino, 2017). Restoring environmental balance is an objective of planning that acts directly on metabolism through a project capable of managing waste flows, to minimize its production, support its reduction and recycling, regenerate the territory, resorting precisely to the paradigm of circular economy (Ellen MacArthur Foundation, 2013; Russo, 2017).

The circular approach therefore modifies the way of constructing maps of the contemporary territory, their thematization and the framework of knowledge that can be used by planning.

In fact, mapping the territory in transformation means ***rethinking the themes of transformation and monitoring the life cycles of the different parts of the territory***, foreseeing future development, observing in advance the times and forms of functional, technological and ecological decay, of abandonment and waste. A description of the territory that requires rethinking the sequence of transformations in a *timeline* in which the metabolism of the city is also represented. New forms of *mapping* could configure an innovative way of planning, able to identify reference materials to add other significant for the purpose of an ecological enhancement of settlements. Mapping the metabolism (cfr. Urban Metabolism Project, Geemente Rotterdam, IABR, FABRIC, JCFO, & TNO, 2014), next to, for example, settlement characteristics, or the ability to provide eco-systemic services, next to the specifications of mobility systems, or even the description of the forms of decay and waste next to the classic stratigraphic maps of the periods of transformation of the territory, are ways to represent new cartographies of the circular economy of the territory, aimed at guiding the strategies of the project, to build a geography of change, to indicate priorities and hierarchies of interventions and parts to be treated according to a timeline as a guide to the contemporary urban project.

Time, a powerful project material in the context of circularity: timeliness of use allows to govern the intermediate phases between decommissioning and re-functionalization of entire areas.

Circular economy does not only mean the ability to recycle areas or buildings that have completed their life cycle: it means combining a rationality in the management of waste flows with the aim of creating socio-economic development based on territorial regeneration. This means that it is necessary to rethink the overall management of waste cycles not only in terms of limiting the impact on the territory, but rather reversing the perspective, so as to assume the consolidation of an "added value" resulting from the application of circular economy to the territory, to be reinvested on its transformation: in an idea of ***value production applied to urban and environmental regeneration***.

So, for example, the treatment of organic waste in terms of innovation, rationalizing the forms of composting, decreases the impact and makes available locally land/soil resources for landscape regeneration of abandoned areas. Or, an innovative treatment of recycling flows of construction/demolition materials can significantly reduce costs, produce a surplus value to be reinvested on urban regeneration, not only in terms of construction materials but also and especially in terms of decreasing costs of intervention, in the demolition phase.

It is possible to start from the deepening of CDW flow treatment to understand this double value of flow treatment for regeneration.

In fact, the processes of construction and transformation of the city generate large flows of materials that have a negative impact on the peri-urban territory during the entire metabolic cycle, from the phase of extraction of raw materials, until the dismissal of buildings and infrastructures.

On the one hand, the intense exploitation of the subsoil for the extraction of aggregates for construction is an environmental and landscape emergency, especially in a country that is among the first countries in Europe for production and consumption of cement. Of the at least 4,700 active quarries in Italy, for example, more than half are used to extract non-value materials for construction such as sand and gravel while at least 13,500 abandoned quarries (half of which are sand and crushed stone) still await reclamation (Legambiente, 2017).

After the phase of dismantling of the built heritage, demolition waste (CDW) is another problematic aspect: in fact, it represents in Europe one of the most significant flows in quantitative terms. In Italy, they account for 43.5% of the total Special Waste with almost 53 million tons of non-hazardous waste produced in a year (ISPRA, 2018). In the Netherlands this accounts for nearly 23.5% (van Berkel et al., 2019), where at the same time 54% of all recycled materials also were on account of the construction sector (ibid.), however this concerned mostly low value, high volume/mass materials, such as minerals (often for road construction). The current regulatory framework and the technical and technological specialization, allow the activation of good practices in terms of reuse and recycling of CDW, able to “close the circle” and prevent on the one hand the extraction of new materials—and consequently the environmental impoverishment (extraction from quarries and their abandonment)—on the other hand, they allow obtaining very useful recycled aggregates for the realization of sports equipment, as in the case of the track of the Turin Olympics, or for the construction of road foundations or artificial orography for landscape use.

Therefore, the transition to a circular model of land transformation is not entrusted exclusively to individual innovations or technological materials, but must ***change the model of planning, as an integrated action of landscape regeneration***. A transition that has an eminently local character, linked to the identity characteristics of the contexts, territorial and social. This calls into question the spatial limits of the system-metabolism (Korhonen et al., 2018): matter and energy flows cross the administrative limits of territories and interact with local and global flows. Indeed, not all products of a cycle are sustainable, and it may be the case that, for example, biomass extraction from one site may produce renewable energy at the final destination but affect the biodiversity and balance of the extraction site. Similarly, it may happen that innovative and recycled materials are produced in physically distant systems, thus missing the opportunity to “consume” the waste produced on a local basis, aggravating the environmental load due to emissions associated with the transport of the elements.

These considerations call for a model of intervention focused on the specific characteristics of the territory, that is ***place-based***, localized, able to provide a local response to a global problem. An approach that is able to relate the resources present (both in terms of skills and actors and in terms of materials/waste) to build a ***short regenerative supply chain***. So, even the demolition project (Baiani & Altamura, 2018) cannot be thought of as an action limited simply to its implementation phase, but rather as the terminal of a much broader process that starts from the design phase of the artefacts, involves the transformation of the criteria and principles of reference of the entire process of programming, land use planning, and can address the architectural and technological design of settlements, in relation to the contexts.

Ultimately, then, the regenerative treatment of CDW is a project material deeply linked to the pre-existences, also because the waste of the previous life cycle of the land becomes material for the new cycle. It is necessary, as the study of CDW flows shows, to frame the sectorial treatment of the flow within a project that is much broader in time and space, capable, for example, of estimating the actual amount of CDW obtained from demolition, at the design stage, through the proper prediction of construction methods and materials of the existing heritage (today with the essential support of BIM methods). Ultimately, in order to foster the circular process of CDW treatment, it is necessary to plan and design innovation, changing the approach to demolition—which is only the last segment of its life—but above all rethinking the concept of the whole life cycle of a building or a construction, starting from a design that aims at the recyclability of products, "taking into account their next life" through an idea of "eco-efficacy".

Dealing with one of the fundamental waste flows, also means **dealing with the soil in terms of circularity**, in an attempt to recover where necessary its eco-systemic characteristics, through an appropriate and integrated use in the planning process, of reclamation. Urban expansion typically occurs in peri- and ex-urban landscapes. Therefore, ***global urbanization and food production are in direct competition for land*** (Bren d'Amour et al., 2017; van Vliet et al., 2017), while also putting claims on "valuable soils" (Barthel et al., 2019). Urban encroachment on landscapes of food production makes that there is an urgent need to define strategies to navigate and mitigate such land use shifts. While processes driving global social-ecological change are interconnected and highly complex, curbing urban encroachment on urban and peri-urban land with soils suitable for food cultivation is essential for maintaining and building food security, on both a local as well as a global level (ibid.). The theme and the practice of urban encroachment on landscapes and need for land reclamation represents a very constructive example of how to apply the principles of circular economy to the themes of planning: in fact, land reclamation is not a sectorial treatment of the soil, but part of a project, inscribed in a process of environmental transformation that sees the regeneration of the soil as the pivot of its future structure. Urban and peri-urban soils on average are approximately twice as productive as the global mean (Barthel et al., 2019). Therefore, it is important to address conservation (and recreation) of healthy soils. Also, from a more global perspective, as displacing crop production from urban and peri-urban land to other areas will demand a substantially larger proportion of the Earth's terrestrial land surface than the surface area lost to urban encroachment (ibid.). The reclamation process recognizes in the peri-urban areas a preferential and priority field of action. In fact, the peri-urban for the sensitivity of the transition between urban and rural, as a transition zone and tension between two contiguous ecosystems (Mininni, 2013), is configured as a context with significant ecological and productive potential, on which insist agents that contribute to delineate the condition of *waste*, exposure to anthropogenic and natural risk and therefore low resilience to pressure and vulnerability that arise from this interaction.

The necessary adaptive logic highlights the limits of conventional and sectoral approaches, in order to ensure the achievement of high parameters of safety, territorial value and ecological quality of the contexts. The concept of adaptive remediation, understood as a model of complex and integrated intervention, allows to combine objectives and actions of the urban design with the treatment of ecological issues (Vittiglio, 2020) for the identification of benefits from an environmental and socio-economic point of view according to an evolutionary approach, in time and space, aimed at the restitution of public spaces with ecological value (Robiglio et al., 2014).

In a circular and metabolic logic, reclamation is configured as a material of urban planning and as a mediation tool between technical, anthropic and natural aspects for the definition and future development of a circular and regenerative urban system, as much as it conforms to the laws of natural ecosystems (Girardet, 2015). In the peri-urban territory thus becomes malleable, modifiable, open space, the reclamation intervention can play the role of driver of change. The conceptual shift from a sectoral approach, understood as mere elimination or reduction of the source of contamination in environmental matrices, to an integrated vision, leads to remediation interventions, capable of producing environmental and socio-economic balance, minimizing impacts and optimizing the use of resources.

This finds accommodation in the concept of ***Eco-Innovation*** (EC, 2012), able to return a product, process or methodology that provides a win–win situation for the parties involved, in a long-term perspective (Horbach et al., 2012). Possible eco-innovations include those directly supported by natural processes, ***Nature-based Solutions, or NBS*** (EC, 2015), marked by ecosystem and site-specific approaches, favouring bio and phytoremediation actions over more impactful physical and chemical treatments, or integrated with other solutions inherent to economic, governance and social innovation aspects (Walters et al., 2016). Regenerative actions, NBS, i.e. “aimed at protecting, managing and restoring natural or artificial ecosystems in a sustainable way, addressing societal challenges in an effective and adaptive way while providing benefits for human well-being and biodiversity” (Walters et al., 2016). They are solutions that, integrated with other approaches, provide direct environmental, social, and economic benefits to the contexts in which they are applied (Walters et al., 2016). They are site-specific spatial development strategies aimed at ensuring the protection of natural capital, fostering conditions for mitigation and adaptation to climate change while meeting landscape reconfiguration needs.

From an ecological perspective, an NBS approach can be advantageous if, applied to compromised environmental matrices, it makes use of technologies such as phytoremediation for their decontamination through the use of local plant species that can trigger new regenerative processes of contexts and recycling of resources used, in a perspective of circularity. With regard to the social dimension, the NBS, provide important inputs for the implementation of the attractiveness and usability of urban contexts, help to increase the welfare of the community at a wider range and not only with respect to the local scale. Significant benefits are also found from the economic point of view, as the reversal of the condition of marginality of a site implies an increase in its public value by contributing to new economies and therefore, in a directly proportional way, the potential for development. Therefore, the

NBS approach is a pretext for the initiation of new forms of regeneration and remediation of ecologically compromised contexts, in which to test effective solutions in the long term and able to start proactive transitions towards sustainable and circular perspectives.

The spatial spillovers take the form of an improvement in the resilience of contexts in terms of usability and perceptual quality, safeguarding their original agricultural vocation and eco-systemic biodiversity. Their application also allows, in the remediation phase, the temporary reuse of the site undergoing remediation, as an innovative hub of experimentation in which to activate public–private participatory processes useful to imagine and activate new local economies. Waste flows and polluted soils solicit correctives and remedies that, in a circular logic, can represent ***new values and new practices of territorial design***: they transform the models of urbanism and planning, its tools, its forms of analysis, its evaluative rationality. In other words, they modify the project guidelines but also the forms of participation in the processes of public decision-making and the construction of a choice that is shared and collaborative, with respect to the multiplicity of subjects of governance. With particular reference to the weakest subjects, to the inhabitants, to the citizens, in a planning process firmly hinged on the activation of forms of social interaction.

1.4 A Circular Economy Calls for a Renewed Approach to the Public Domain and Stakeholder Involvement

Though no two cities are exactly alike, they are all highly dependent on the built and natural environment of their surrounding hinterlands. Urban growth is inexorably linked to the network of infrastructures and mobility that ensure the free flow of essential materials, energy, and waste. Growth in cities leads to a ***reciprocal increase in the complexity of these infrastructures, their role and integration in public space, and their dependence on the resources of surrounding territories*** (water, food, energy, waste management, etc.). Positive societal spillovers often remain implicit or secondary to environmental and economic gains (Padilla-Rivera et al., 2020). For the goals of restoring environmental balance, towards Circular Economy, spatial policy will be able to have a guiding function in a limited way only, since spatial planning is mainly guided by economic interests. The main consequences are considered to be ***waste of space, suburbanization and fragmentation***. Political choices can determine the market hierarchy of changes in the infrastructure, e.g. through the speed of the market opening, policy on competition, price regulation, tax constructions, environmental regulations and supervision. The original objectives and needs of the project, however, will keep slipping further and further to the background, particularly when new systems and ways of generation or treatment are introduced, through the investment of effort and time when running through the process and the many interests that come into being. On account of the continuous adjusting of objectives and starting points, and on account of the fragmentation of the moments of decision, decision-making becomes "stealthy" (the argumentation to carry out a project or not changes when criticism on the project—or arguments to not carry out the project—cannot be refuted sufficiently, or when time outruns the arguments). One of the negative effects of stealthy decision-making is a "shift of objectives".

The way in which planning addresses "public goods" or the "public interest", is relevant. Key aspects of importance for public goods are "essentiality" and "usefulness". Usefulness is described in relation to the various networks and spaces as a situation in which a fixed, "irreplaceable" organization, appointed by legislator or government, is entrusted with the performance of public tasks. One speaks of public tasks often in connection with various flows which form part of the (urban) metabolism and corresponding infrastructures and (inter)related public space. Public tasks are tasks that come into being for various reasons (including market failure, political advisability), but in general not by autonomous behaviour of participants on markets. Perhaps the Dutch district of Oosterwold in Almere, is an exception. Although Oosterwold is purposely developed as a development in which no public services were realized by the public authorities, they did however create a legal framework, including basic agreements that services should be taken care of, either by the citizens individually or in self-organized groups. In general, however, related to public space and infrastructures therein, there is a strong ***segregation between the various stakeholders, as there is between the various disciplines*** (energy, water, waste management, recreational areas, etc.).

On top of this, during the eighties and nineties of the former century policies also became more and more characterized by institutional fragmentation. Until now, in area (re)development, in most case, there are little to no attempts to rise above the compartmentalized policy domains. As a result, many well-meant initiatives got stuck in thematic and effect-oriented solutions without reaching a certain degree of integration or added value of environmental measures, e.g. through ecosystems services. The corresponding spaces and infrastructures are often restricted to transport infrastructure with its own status, dominant parties involved and path-dependent policy. At the same time, the scientific and policy compartmentalization is limited by speaking of specializations, with the various "specialists" keeping up the sectorial way of thinking. As a consequence, connection or interrelation of various scale levels is lacking. Moreover, in the last two decades the "old" sectorial compartmentalization appears to disappear, with a "new" sectorial compartmentalization arising with themes becoming more independent in separate circuits and institutions, each with its own network of experts and facilities (separate circuits along themes, such as sustainability, regenerations programs, protection of cultural historical heritage). This leads to a certain degree of fragmentation in the public domain. The interactions between the various specialisms and types of infrastructures and their future manifestations are relative virgin territories from a scientific point of view. The sciences that somewhat deal with this subject are spatial planning and economy, be it with somehow restricted perspectives. Spatial planning, for example, focuses on types of spatial aspects, including (the often non-technical) infrastructure with a clear material component. More specific subquestions, including the theme of dematerialization, are addressed less often. In economic science, the various types of infrastructures are also included in the analyses. This integration is accomplished however as a mere cost assessment. The problem still remains that it is not possible to express all "values" in money.

In most countries, the general basis for spatial policy nowadays is still too much of a certain pragmatism focused on specialism. The "public interest" is translated into its own scale, a narrow spatial coherence, that is insufficiently characterized by the creation of conditions for the diversity and changeability of society. Within this framework, it is of importance to carry out research into the spatial consequences of the shift of infrastructures and/or parts of the shared outside space from public to semi-public or even private property.

Private preferences are fundamentally contrary to public wishes. Infrastructure and a certain spatial development at a higher scale level, e.g. that of the region, is often a public wish, a collective good, that should be to the profit of the whole society. Decision-making where collective goods are concerned, should be accomplished in a collective way. "Cost–benefit analyses address people as consumers, rather than citizens. The private preferences should be investigated. Private preferences often differ from public preferences" (Sagoff, 1988). There is much left to be improved in this matter. First of all, it is the case that many public infrastructures are (still) paid out of the general means of the authorities, with often little incentives to earn back the costs made. Second, there are external costs that are often not charged or settled. Finally, costs are still not made to depend on the extent to which the infrastructure or space is used, the so-called variabilization of the costs. It is particularly important to consider management aspects of shared (public or not) spaces and infrastructures, and in some cases charge systems connected to them:

- More clarity is needed with respect to the practical and principal reasons for the preference of ***private or public management*** (or combinations thereof);
- The charges are independent of distance (so-called "postage charge", "Commodity Services System"), and ***the internalization of costs for environmental aspects*** (and reliability of supply) will have to be introduced;
- How to handle ***the (improper) derivation of legal rights from the infrastructure and public space***, or how to change this;
- The option of so-called ***delocalization*** as a proposed solution: a shift from responding to local circumstances and making use of them towards having control over the physical conditions. Delocalization is closely interrelated with the programme design or the setting of the agenda of the urban and regional development. It is of particular importance to make spatial interventions leading through the concrete formulation of the commissions and the strategic use of this; and
- How to handle the ***"first mover" problem*** in spatial development. The sheer risk of specialization in the various professional specialisms is that one loses sight of the entirety, while this is a prerequisite for being able to accept one's responsibility for one's own contribution. Each group, each individual member becomes more functionally dependent on others because of specialization of one's own

functions. The "chains of interdependence" branch off and become longer, and, consequently, become less transparent and less verifiable for each individual and each group.

1.5 Amplifying the Definition of Circular Economy with the Inclusion of Wastescapes

The territory of the Circular Economy is the city, as a complex and multidimensional organism. However, the most problematic field for experimenting with "circular planning" is ***the peri-urban territory***: a case consisting of urbanized areas beyond the dense and consolidated city, crossed by differentiated phenomena of settlement expansion beyond the limits of the countryside, which identifies rural and open space, traditionally coinciding with the limits of the city. Spaces that extend "within dense basins of populations and activities that simultaneously function as both local systems and complex ecosystems that connect through communication networks and high-speed clusters of dozens of cities" (Balducci, in Russo, Perrone, 2019, p. 26). Spaces to be interpreted within the phenomena of ***regionalization of the urban***, as the point of arrival of long-term urbanization processes (Soja, 2011). A type of territory that, due to the settlement and environmental specificities, is at high risk of environmental impoverishment, since it suffers the pressure of urban functions that act on the most fragile components of these territories: settlements, transport infrastructure, specialized areas, threaten the survival of permeable territories, agricultural areas and the mosaic of fragments of rurality, waterways, forests and biodiversity reserves attacked by the urbanization phenomena. A wide-meshed territory, where the countryside enters beyond a frayed perimeter, ***fragmented by phenomena that struggle to be controlled by planning tools***. As, for example, in the urban growth due to illegal building, in the south of Italy or in the proliferation of district areas, productive or logistics, in the context of large metropolitan areas. The risk of dissipation of non-reproducible ecological resources, of the mosaic of permeable areas, of residual agricultural soils in the mesh of urbanization processes, is accompanied by the potential of areas that, if removed from fragmentation, are networks of areas of high eco-systemic value, potential landscapes. Territories in transition, landscapes that change progressively with the changing state of the life cycles of settlements, infrastructures, productive and specialized areas, but also for the different impact of waste flows that cross these territories. Treating the obsolete, abandoned or neglected parts as wasted landscapes, turns on the interest of planning to work on ***transitional landscapes***, potential, regenerable through an orientation of circular metabolism able to regenerate eco-systemic characteristics, but also urban and social role of the project areas.

This is the sense of a ***circular planning for the regeneration of the peri-urban***: identifying the waste spaces and then treat them, regenerating the eco-systemic characteristics and at the same time the urban role of space or equipment of collective interest. An example, is the possibility of using the recycling of organic waste streams, produced locally with a rationalization of composting systems, through the reconfiguration of the morphologies of abandoned areas, such as disused landfills, which—also through a nature-based approach to soil remediation—can become an urban park at the service of a neighbourhood lacking public equipment and common space (REPAiR, 2018a).

Such a circular project approach is, however, very much linked to the geography of peri-urban territories, changing in different European (and beyond) contexts.

From a metabolic perspective, some emerging themes closely relate the circular economy to the territory and call for a constant reference in orienting theories and regulating the practices of spatial planning.

The first theme recalls the necessary reduction of the global phenomenon of ***land consumption***, particularly in urban and peri-urban areas, where expansive phenomena are growing. A model of territorial planning that does not necessarily pursue the reduction of new housing or equipment for the city, but rather their rationalization and the quality of residential housing, is aimed at the regeneration of existing settlements. Urban growth decoupled from expansion is possible and is supported by the generally widespread phenomena of reduced population pressure on European cities. The methodological perspective of "building in the built environment" saves land, especially if it is endowed with eco-systemic characteristics, and requires the recycling of the existing building stock: starting with settlements that have reached the end of their life cycle. ***Transforming disused areas, planning the recycling of abandoned and discarded territories***, be they infrastructures, settlements or landscapes, is not an innovative instance in itself, although in current practice it takes on a new and experimental character. The case of the Ruhr Basin was an ante litteram intervention of circular economy, with specific attention to the regeneration of landscape and environmental components, anticipating contemporary awareness. An approach capable of placing the theme of ecological enhancement at the centre of the multiple valorizations, including real estate, with a completely innovative consideration of the principle of urban metabolism as a structural component of urban systems, as shown by the mature experiments of a generation of "metabolic" landscape and urban designers, such as Alan Berger, Kate Orf, James Corner, etc.

The theme of the contraction of the ecological footprint of settlements is functional to the broader issue of risk due to ***climate change*** as a reference scenario of the contemporary territory, to which the cities react adaptively through less dissipative consumption in a perspective of energy-saving and waste of resources, an increasingly sustainable mobility, circular consumption models.

The decay of the territory, the obsolescence and end of life of buildings, functions and urban parts now inadequate, generates ***wasted landscapes*** (***wastescapes***) (Amenta & van Timmeren, 2018; REAPAiR, 2018b): this theme is both the result of metabolic transformations of the territory and generator of prospects and potential for rebalancing the material welfare of the city. Working on the system of open spaces and equipment, becomes a central question in the regeneration of the contemporary city in terms of deficit of public space, especially in the territories of marginality, in the neighbourhoods of social housing, suburbs and peri-urban areas. Regenerating and transforming on discarded landscapes, in interstitial areas and metropolitan urban belts, in public housing districts, means designing open space. On the one hand, as a landscape in transition that has the potential to be transformed into a "new landscape", revitalizing its ecological and environmental characters. On the other hand, as open space, to which topological, morphological and infrastructural continuity can be restored: a potential form of public space, as a large urban infrastructure, able to rebalance the lack of equipment, fragmentation and poor urban accessibility.

Even the issue of reducing ***pollution*** of urban and peri-urban soils can be considered as a form of application of circular economy to the territory: in fact, territories of pollution can be regenerated, revitalizing the continuity of eco-systemic flows. Water, soil, air, vegetation, in critical environments such as quarries, landfills, abandoned soils are critical elements to be transformed into opportunities for the territory. In this sense, the reclamation of compromised environments through naturalistic and ecological models, represent integrated actions of territorial regeneration that must necessarily be part of a multidimensional process of territorial planning. Finally, the theme of the ***management of the waste system***, in a logic of metabolism, as shown by the REPAiR research, represents an oriented management that allows you to apply to waste flows a regenerative treatment that can become strategic in the production of materials useful to the territorial project, such as in the treatment of organic waste flows or waste from demolition and construction.

These issues guide the ways in which the Circular Economy can be integrated into the statutes of planning models, and how such integration can solicit methodologies and experimental lines of work for the identification of best practices and eco-innovative solutions.

1.6 Planning the Circular Economy as an Open Collaborative System

Circular planning is not a top-down way to transform the territory, but rather a means to facilitate the change of behaviours aimed at indirectly modifying its multifaceted structure. Through a ***participatory mode*** capable of interpreting metabolism as a social and at the same time ecological action on the territorial system. This is a transformation that deeply modifies also the evaluation system, for the circular treatment of territorial resources. This is to say that it is about an evaluation that concerns the process of treatment and use of the territorial resources, such as that applied to consumer materials (e.g. Life Cycle Assessment).

Therefore, the recourse to Circular Economy could transform the planning model, which is necessarily dialogic and interactive, and therefore also the assessment models, especially where these are oriented towards taking into account the demands of the collective subject.

Traditionally, evaluation in urban planning allows the development of ***Decision Support Systems*** aimed not only at building cognitive frameworks to evaluate the status quo, but also to compare different planning solutions, facilitating the selection and distribution of territorial resources (Loconte et al., 2013). With the introduction of Circular Economy (CE) principles, it is necessary to adapt the traditional assessment approaches to an innovative vision of the territory, which starts to be interpreted as a dynamic system of interconnected flows. In this perspective, the use of traditional indicators may prove to be inadequate to assess circularity, especially when it comes to the complex dynamics that characterize urban ecosystems. There is an unclear correlation between CE indicators and the socio-economic metabolic systems (Gao et al., 2021) and too often this relies only on specific sectors, such as that of Waste Management. Also, Circular Economy includes a multitude of concepts and its complexity increases in relation to urban areas, determining the need to develop tailored indicators systems to support policymakers. Despite the existence of different proposals, there is no consensus on the best way and on the most suitable assessment methodology for circularity at the territorial level (Wang et al., 2018). Although the lack of harmonized interpretations, it is commonly recognized that the evaluation approach can be enriched with more sensitive techniques that are able to quantitatively grasp the metabolic substances that, when crossing the territory at different scales, shape it, sometimes remaining incorporated as stocks, other times being expelled as waste products and emissions. Definitely, a metabolic-based evaluation approach applied to the territory could enhance a more efficient monitoring of its degree of circularity. It is necessary to specify the evaluation model that is most sensitive to Circular Economy principles. The territorial behaviours and its related drivers—in terms of consumption patterns, residential choices, socio-cultural and environmental features—have a direct influence on the metabolic flows that cross urban areas (Dijst et al., 2018). Traditional evaluation methods used in spatial planning, based on the construction of matrixes of indicators and sometimes on the integration between Geographic Information System and Multi-Criteria Decision Analysis (De Toro & Iodice, 2018), can be combined with Urban Metabolism evaluation methods. These methods allow the integration of resources, emissions and their potential environmental impacts within the same model, providing relevant information on the potential multidimensional impacts deriving from the different planning scenarios of consumption and production (Beloin-Saint-Pierre et al., 2017). Adopting such a type of approach for the analysis of a territory implies a dynamic interpretation of its functioning, linking material flow with social and ecological processes, and taking into account the possibility to modify the actual patterns of consumption and production, towards more sustainable schemes (Broto et al., 2012).

The shift from consumption models to the territory makes it possible to adapt "circular" assessment models, developed for other purposes (such as LCA), to the city's metabolism. Circular evaluation models are consolidated at the micro scale, hence when it comes to assess the sustainability of single products and flows. Material Flow Analysis, Ecological Footprint Assessment, Ecological Network Analysis and Life Cycle Assessment represent noteworthy examples. The application of these models at the territorial scale requires a significant adaptation process and one promising methodology is that of Life Cycle Assessment (LCA), which, taking into consideration the entire life cycle of a product or service, is well suited to represent the evolutionary dynamics of a territory. The LCA approach could prove to be a valid tool for assessing the territorial sustainability, adopting appropriate methodological modifications and hybridizations (Torricelli & Gargari, 2015). It is no coincidence that over the last years there has been an increase in the LCA application field, with the introduction of variations of scale and therefore a distinction between LCA at the level of a single product and LCA at the meso level (for example municipal) and macro level (European Commission et al., 2010). The "Territorial LCA" has been proposed by Loiseau et al. (2018), and its starting point is represented by the presence of a geographical area associated to a territorial planning scenario with the aim of evaluating and monitoring the eco-efficiency of a territory, identifiable as a system of flows. Many difficulties may arise in this transition to a territorial-based LCA and in particular, one of the first obstacles to face is the definition of the Functional Unit, which is the reference unit of the whole analysis. Some applications try to propose a solution; as an example, in the study proposed by Torricelli (2015), where LCA becomes a tool adopted in order to evaluate the sustainability of a protected natural area, it is proposed the concept of "Functional Equivalent". This concept has been adapted from the building sector and refers to the territory as a complex of territorial resources and services belonging to the economic, social as well as environmental spheres. In these terms, the Functional Equivalent of a territory is defined as a system of territorial resources and performances that meet the requirements of a given plan scenario, for a given territory, taken as a basis for the comparison of different scenarios. An alternative to the Functional Equivalent is represented by "Land Use Functions" (LUF) (Pérez-Soba et al., 2008), representable as the economic, ecological and social goods and services that derive from the use of the territory by human society and starting from them it is possible to identify a set of metabolic indicators. Despite the emergence of first evaluation approaches in this sense, this is a primordial field of research, open to new developments. Even though the considerable difficulties associated with this adaptation process, especially due to the enormous amount of data necessary to conduct these kinds of evaluations, it is hoped that new experimental applications can lead to a more consolidated methodology.

Ultimately, the circular economy is not a set of criteria nor a family of tools or materials of the project: it is rather the transformation of a mentality of planning that requires the transformation of the general objectives, linked to the construction of well-being of people and the continuity of the habitat in a new relationship between nature and artifice in the city, where the materiality of the built environment requires to be rethought not so much to increase its life span as to think of a metabolism that can cross the territory "closing the cycles", minimizing waste, building the conditions to renew the potential of use of the different flows of material that cross daily practices, ultimately using the environment, its ecological structures and their survival as an inevitable reference in the design of the territory and the design of urban living spaces. A regenerative design is necessary, attentive to the values of the existing, adaptive, able to draw energy and material balances in every possible transformation and planned layout. This change of conceptual references in the management of the territory also concerns methodologies and tools, the time of planning and its language, knowledge and evaluation, capable of working on life cycles but above all on the socialization of collective values through a methodology that passes through social interaction. Processes centred on the interaction of a plurality of resources and economic and civil society actors.

All of this comes together in the topic of resource management and neglected territories. A circular perspective, preferably even taken from a wider perspective, know from the Doughnut Economies (Raworth, 2017)—linking social aspects to sustainable solutions, ensuring that the circular transition is a just one—could connect their regeneration to regional strategies of empowerment and systemic redesign towards more healthy metabolisms. Such a transformative action approach will also help to better understand how the various principles related to circularity contrast or complement each other in one specific (circular) territorial cluster. Cities than move one step closer in understanding the true pressure of systemic changes on city life. The main advantage from the built environment, or society in general, will then be that it reinforces the aesthetic and functional qualities, makes use of vulnerable, scarce existing public areas, such as parks, squares and public buildings, as well as wastescapes, and enhances the "readability" of solutions. It can help break through the relations that have come about as a result of historical factors, between the internal organization within the administrative organizations themselves and the connections with each other and with the more general social structures in the specific places.

Policy seemingly obvious and independent of the paths chosen, and a role of the dominant participants supportive of a paradigm is prevented in this way. It would also address the rising problem that the spatial policies of the various national authorities suffice less and are less satisfactory; often facilitating standard solutions. Moreover, they often lead to lengthy procedures and delays causing the launching tempo, relatively slow as it is, hardly to be able to follow society's needs, not to mention to guide them. Therefore, a larger differentiation in the planning processes with a closer cooperation between the local, regional and national authorities is necessary. In this matter, a planning which is more regionally orientated may be the answer to the division between town, peri-urban territories and rural hinterland, which is fading away more and more, and the changed organization or network geometry of the mutual connections and spatial planning. The concept of "external economies of scale" developed at the beginning of the twentieth century, and the principle of "cumulatively self-reinforcing agglomerations" (Marshall, 1920; Saxenian, 1994) will have to be the basis for this network approach. Especially the principles of "clustering" and "integrality" (physically and administrative-organizational) are of importance here. It amounts to a correct formulation of the programme and an action plan or agenda, among other things.

To conclude, the use of the principles of circular economy defines a new paradigm for urban and territorial planning, provides methodologies, materials and strategies to face the challenges of the contemporary condition in full consideration of the ecological limits of our habitat. Working on the existing, basing every choice on a thorough knowledge of the values of the territory, interpreting their life cycles, selecting the transformative potential of the places, working on ecology as an infrastructure of urban metabolism, are all resilient and adaptive actions for the continuity of the territory and for the renewal of its resources. Risks, threats, climate change, pollution, pathological metabolism and spatial inequalities are the effects of a society that has not been able to protect its assets, has not been able to enhance them to transmit them to the future, has not been aware of the planet's limits. The circular economy provides planning with the interpretive tools to rationalize the processes of consumption "in" the territory and "of" the territory and its resources, to redirect behaviours within a safe space that is the "doughnut" (Raworth, 2017), intended as the socio-ecological conditions in which it could be possible to find new balances in the use of resources and innovation in designing the contemporary territory. The latter would be a more livable territory, closer to the instances of citizens, and more prone to accommodate innovation in the form of ecological continuity.

These aforementioned principles call for a planning for which, first of all, landscape and environment are, constantly, the value structure of reference: not an exclusively aesthetic-perceptual reference but rather linked to the deeper significances of their structure, relevant from the social and cultural as well as physical and spatial point of view. Secondly, a planning centred on social interaction, on a ductile and open approach, aimed at listening to the demand for change, marked by practices of collaboration, co-evaluation and co-production. Finally, a planning based on an *interpretative approach* able to recycle the material content of the city in a design perspective, but also to rethink the overall forms of dissipative consumption of the territory, limiting the merely "extractive" treatment. This could be done also by placing at the centre of any transformative strategy, the values of continuity and balance between history, community and territory. Values that shape social identity, quality of inhabited space, ecological continuity, stability of coexistence and environmental compatibility of urban infrastructure: indispensable conditions to make the contemporary city more livable, sustainable, inclusive and safe.

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Part I
New Definitions: Amplifying the Perspective of Circular Economy

Chapter 2
Territorialising Circularity

Cecilia Furlan, Alexander Wandl, Chiara Cavalieri, and Pablo Muñoz Unceta

Nowadays, the circularity concept dominates the debate on resource management in cities and territories. The idea is often used as a vehicle towards a more sustainable socio-ecological transition, based on the circular economy (CE) framework. Unlike other sustainability frameworks, CE originates in ecological and environmental economics and industrial ecology. It focuses on developing an alternative economic and technological model for production and consumption, avoiding natural resource depletion and redesigning processes and cycles of materials (closed-loops). However, when CE is translated to cities and territories, its environmental, economic and design agency is often neglected. On the one hand, it demands to acknowledge the need for a relational understanding of space, place and actors involved and, on the other, to explore the spatial specificity of CE. Therefore, there is a need for a broader theoretical discourse on the CE's territoriality as the predominant. Research on circular urban and territorial development demands more than merely upscaling industrial ecosystems diagrams and generating circular businesses. Consequently, what is the role of territory in the CE conceptualisation in the urbanism literature?

C. Furlan (✉) · A. Wandl
Department of Urbanism, Faculty of Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands
e-mail: C.Furlan@tudelft.nl

A. Wandl
e-mail: a.wandl@tudelft.nl

C. Cavalieri
LAB, Research Institute on Landscape, Architecture and Built Environment, Université Catholique de Louvain, Louvain-la-Neuve, Belgium
e-mail: chiara.cavalieri@uclouvain.be

P. M. Unceta
Institute for Advanced Architecture of Catalonia, Barcelona, Spain
e-mail: pablo.munoz@iaac.net

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_2

How to interpret territories through the lens of circularity, which tools, methods are needed?

Therefore, territory, its role and meaning in the CE contribution to urban regeneration is the key focus of this text.

2.1 Introduction

Global economic growth, urbanisation processes and the depletion of natural resources are interrelated systems. Their relationship is grounded by a linear growth model, which transforms resources into waste by reducing values from natural resources and environments (EMF, 2013; van der Leer et al., 2018). However, worldwide there is a recent acknowledgement that this linear way of producing, consuming and disposing of resources is economically, environmentally and socially impracticable. Hence, there is a need to re-plan and deploy new strategies to face this challenge (Turcu & Gillie, 2020). The adoption of a 'circularity' framework is undoubtedly one of such approaches.

Circularity is bound to the circular economy (CE) concept. The CE concept originates in ecological and environmental economics and industrial ecology (Ghisellini et al., 2016). It conceives any waste stream as a resource that can be reused through sharing, reuse, repair or re-cycling (upcycling or downcycling) (EMF, 2013; Marin, 2018).

Despite being an increasingly popular concept among planners and policymakers, the academic and professional debate on CE is only recently emerging within the urbanism field.

According to Turcu and Gillie (2020), how urban design discipline integrates a CE approach in urban and territorial intervention is still unclear, three main streams of criticism emerged. First, most of the understanding is dominated by small-scale economic and technological developments. These developments often stay at the business level, mainly providing end of pipe strategies and solutions, without reflecting on their relations with their surrounding urban environments. Secondly, there is limited knowledge of if and how public administrations, such as municipalities, provinces or regions consider implementing CE strategies at the urban-planning level. Only, little can be drawn from the few well-known examples of Amsterdam, London, Glasgow municipalities, on how to develop policies and governance strategies concretely and on which stakeholders are involved in the process. Thirdly, despite recent academic reflections on the CE, land and territory's role is somewhat absent from the current conceptualisation (Williams, 2019a, 2019b). In this sense the notion of territory as a subject is key: the territory is the space that we live, the way we inhabit its shapes and its dynamics, and ultimately a surface that results from long processes of transformation (Cavalieri & Lanza, 2020). With the long term process of urbanisation, territory increasingly changes its cultural and historical dimension as a subject. It progressively moved from being shapeless technical support, on which placing functions regardless of its form and transformations and ultimately to be administrated despite its ecological framework.

Within this framework, this chapter explores the gap between design thinking and circular economy studies, showcasing how the territorial dimension of circularity may be approached through specific spatial components.

This chapter ultimately aims to reply to two questions, one exploratory and one explanatory:

- What is the role of territory in the CE conceptualisation in the field of urbanism?
- How to interpret territories through the lens of circularity, which tools, methods are needed?

The following text is hence divided into three main sections. Section 2.2 frames the role of territory in the current conceptualisations of a circular approach to waste and resource management in territorial context by examining 29 urban-planning pieces of research on CE. Section 2.3 describes the necessity of representation and the mapping tool to integrate a territorial dimension in the CE debate. Lastly, Sect. 2.4 discloses and discusses a set of mapping operations for the explicit purpose of 'territorialising circularity'. It focuses on the Amsterdam Metropolitan Area (AMA)[1] case study, and it makes use of the tool of 'resource cartographies', a notion that juxtaposes the status quo of flows and stock of a specific flow, namely wood waste, with the territory's ecological and morphological features. This set of cartographic operations allows:

1. to identify alternative images towards the potential CE transition in space;
2. to reframe CE as a multidimensional place-based issue, by the detection of a territorial footprint of waste flows, and by the identification of waste-resource sheds.

Lastly, throughout this reflection and critique, the article ultimately discusses an alternative approach to integrating the territorial dimension in the CE transition.

2.2 Framing the Territorial Dimension in the CE Debate

Nowadays, cities and territories have merged into an original mix in which urban, rural, productive and infrastructural landscapes merge into a complex territorial construction (Cavalieri & Viganò, 2019; Tafuri et al., 1962; Wandl et al., 2014). The contemporary territory is the result of urbanisation processes, one of them the establishment of extensive urban infrastructures. By superseding traditional urban borders and thus embracing regional and national dimensions, the territory suggests a different space of investigation that does not stop at administrative borders but rather follows ecological ones. Defining borders 'i*s perhaps the most instinctive way by which humans have learned to understand the built environment (and also,*

[1] The AMA region consists of the city of Amsterdam, the provinces of North Holland and Flevoland with 36 municipalities, and a population of over 2.4 million inhabitants.

much earlier, natural landscape)' (Habraken, 2000, p. 126). Moreover, a territory is also a geographic and morphological space, a physical collection of qualities and different materials. Lastly, it is a social artefact. Reflecting on the territorial dimension or territorialism of any process means to observe the material nature of a site and simultaneously its appropriation. Moreover, it means to reflect on territory at a high conceptual level as a system of socio-economic and ecological relationships, grounded in a situated reality (Viganò, 2014).

In light of this perspective, reframing the role of territory in CE debates is fundamental. A literature review was used to discuss whether the CE conceptualisation already integrated territorial components. This process highlighted the need to tracing CE theoretical aspects and to track the significant channels of publications. A literature search was conducted using the keywords *circular economy*, *land* and *territory* simultaneously on titles or abstracts of journal articles, books and book chapters published between 2016 and 2020 (January 31st). Following the method adopted by Korhonen et al. (2018), we used the Web of Science (WOS) database. The reasons to follow this method are fourfold:

1. WOS provided a scientifically reliable and recognised search method,
2. WOS gave the authors the possibility to search and filter the findings using several bibliographic parameters,
3. WOS provided suitable navigation possibilities and institutional access to the full texts of the examined papers,
4. despite the limitations of using a single database, the WOS method offered sufficient coverage for our purpose.

Through WOS, we obtained 108 entries in English, of which only 29 papers were scientifically relevant for discussing the actual concept of CE in cities and territories. The selected articles were manually checked. Table 2.1 provides a summary of the identified documents.

The analysis shows that the papers on CE are mainly published in journals in the category of green, sustainable and science technology fields. Urban and planning articles follow this trend, indicating the first attempts to integrate the CE concept in the planning debate. However, they mostly stay on a theoretical level of discussion. Two-third of the total reviewed articles, observe circularity either through existing tools and methods or through case study analysis. In contrast, five papers propose the development of new urban design tools. For instance, Marin and De Meulder (2018) claim the necessity of developing new design tools, as systemic sections and resource maps. These instruments aim to better integrate CE in everyday planning landscape and urban design practice, for which the existing system diagrams are insufficient. On the same line, Turcu and Gillie (2020), highlight the weaknesses of CE in the urban-planning governance policies, emphasising the necessity of systematically studying ongoing practices and simultaneously develop alternative tools.

The remaining five papers propose a different conceptualisation of CE by arguing the limitation of the existing conceptualisation and the necessity to consider the space and land's fundamental role. These papers refer to the particular school of thought of Ellen Macarthur Foundation (EMF) and the ReSOLVE concept. By analysing the

Table 2.1 Publications on CE by journal research area

	Title	Authors	Year	Approach to CE	New tool	Concept
1	A Geodesign Decision Support Environment for Integrating Management of Resource Flows in Spatial Planning	Arciniegas, G.; Sileryte, R.; Dabrowski, M.; Wandl, A.; Dukai, B.; Bohnet, M.; Gutsche, J.	2019	resource flow integration within city	x	
2	A perspective on a locally managed decentralized circular economy for waste plastic in developing countries	Joshi, C.; Seay, J.; Banadda, N.	2019	waste/resource management in city		
3	Advancing City Sustainability via Its Systems of Flows: The Urban Metabolism of Birmingham and Its Hinterland	Lee, S. E.; Quinn, A. D.; Rogers, C. D. F.	2016	resource flow integration within city		
4	Beyond Wastescapes: Towards Circular Landscapes. Addressing the Spatial Dimension of Circularity through the Regeneration of Wastescapes	Amenta, L.; van Timmeren, A.	2018	land as support of CE strategies		x
5	Building Sustainable Cities in China: Experience, Challenges, and Prospects	Kang W.; Wang M.; Liu J.; Lv X.; Zhang Y.; Luo D.; Wang D.	2019	CE as sustainability principle, governance		
6	Changes of human time and land use pattern in one mega city's urban metabolism: a multi-scale integrated analysis of Shanghai	Lu, Y.; Geng, Y.; Qian, Y.; Han, W.; McDowall, W.; Bleischwitz, R.	2016	resource flow integration within city	x	
7	Circular cities	Williams, J.	2019a	resource flow integration within city		x
8	Circular Cities: Challenges to Implementing Looping Actions	Williams, J.	2019b	resource flow integration within city		x
9	Circular Cities: Challenges to Implementing Looping Actions	Prendeville, S., Cherim, E., & Bocken, N.	2018	resource flow integration within city		x

(continued)

Table 2.1 (continued)

	Title	Authors	Year	Approach to CE	New tool	Concept
10	Containing urban expansion: Densification vs greenfield development, socio-demographic transformations and the economic crisis in a Southern European City, 2006–2015	Salvati, L.; Lamonica, G.R.	2020	land as support of CE strategies		
11	Facilitating Circular Economy in Urban Planning	Remoy, H.; Wandl, A.; Ceric, D.; van Timmeren, A.	2019	resource flow integration within city		
12	Global urbanization and food production in direct competition for land: Leverage places to mitigate impacts on SDG2 and on the Earth System	Barthel, S.; Isendahl, C.; Vis, B. N.; Drescher, A.; Evans, D. L.; van Timmeren, A.	2019	land as support of CE strategies		
13	Governing the Circular Economy in the City: Local Planning Practice in London	Turcu, C.; Gillie, H.	2020	CE as sustainability principle, governance		x
14	Industrial Symbiosis in Brownfields in Kranj, Slovenia	Cotic, B.	2019	land as support of CE strategies		
15	Infrastructure for China's Ecologically Balanced Civilization	Kennedy, C.; Zhong, M.; Corfee-Morlot, J.	2016	CE as sustainability principle, governance		
16	Material metabolism and lifecycle impact assessment towards sustainable resource management: A case study of the highway infrastructural system in Shandong Peninsula, China	Guo, Z.; Shi, H.; Zhang, P.; Chi, Y.; Feng, A.	2017	resource flow integration within city\ life cycle		
17	Planning, transformation and development of resource based industrial cities	Pang, M.	2017	land as support of CE strategies		

(continued)

Table 2.1 (continued)

	Title	Authors	Year	Approach to CE	New tool	Concept
18	Proposal of a dynamic model to evaluate public policies for the circular economy: Scenarios applied to the municipality of Curitiba	da Silva, C. L.	2018	waste/resource management in city		
19	Quantifying and mapping embodied environmental requirements of urban building stocks	Stephan, A.; Athanassiadis, A.	2017	resource flow integration within city	x	
20	Regional spatial planning, government and governance as a recipe for sustainable development?	Frank, A.; Marsden, T.	2016	resource flow integration within city	x	
21	Reliability and economic analysis of moving towards wastes to energy recovery based waste less sustainable society in Bangladesh: The case of commercial capital city Chittagong	Islam, K. M. N.; Jashimuddin, M.	2017	waste/resource management in city		
22	Reuse of Waste from the Perspective of Circular Economy	Liu Y.; Zhang S.	2018	land as support of CE strategies		
23	Securing a port's future through Circular Economy: Experiences from the Port of Gavle in contributing to sustainability	Carpenter, A.; Lozano, R.; Sammalisto, K.; Astner, L.	2018	land as support of CE strategies		
24	Social-Ecological-Technical systems in urban planning for a circular economy: an opportunity for horizontal integration	van der Leer, J.; van Timmeren, A.; Wandl, A.	2018	resource flow integration within city		x
25	Solid Waste Management in Ho Chi Minh City, Vietnam: Moving towards a Circular Economy?	Schneider, P.; Anh, L.H.; Wagner, J.; Reichenbach, J.; Hebner, A.	2017	waste management in city		
26	The Circular Economy Concept in Design Education: Enhancing Understanding and Innovation by Means of Situated Learning	Wandl, A.; Balz, V.; Qu, L.; Furlan, C.; Arciniegas, G.; Hackauf, U.	2019	resource flow integration within city		

(continued)

Table 2.1 (continued)

	Title	Authors	Year	Approach to CE	New tool	Concept
27	The imperative for regenerative agriculture	Rhodes, C. J.	2017	land as support of CE strategies		
28	The role of urban agriculture for the governance of high natural values areas. New models for the city of Turin CollinaPo	Genovese, D.; Battisti, L.; Ostellino, I.; Larcher, F.; Battaglini, L. M.	2017	waste/resource management in city		
29	Urban landscape design exercises in urban metabolism: reconnecting with Central Limburg's regenerative resource landscape	Marin, J.; de Meulder, B.	2018	resource flow integration within city	x	x

ReSOLVE framework, Williams (2019a, 2019b) argues that this approach is inadequate when applied to cities, because cities and territories are complex ecosystems, and cannot be simplified as economic structures. Moreover, she observed that land and infrastructure should also be considered scarce resources and directly included in the well-known EMF butterfly scheme. Recognising that cities and territories are constantly adapting complex systems and that the physical structures are artefacts resulting from past interaction of multiple relational systems also influence future systemic relations. Therefore, planning needs to recognise the fundamental role of scales and locations of CE to provide structural continuity and systemic flexibility, for a future economic system, with a still unknown territorial morphology.

Following the same line, Prendeville et al. (2018) list several limitations of current circular approaches to cities including the predominantly focus on small-scale business-oriented economic activities; the limited reflection upon flow dynamics in cities; the absence of going beyond the administrative cities boundaries; and the scarcity of place-specific observations.

In general, the literature review highlights that the territorial dimension in CE debates is still minimal and marginal compared to the technological and economic discussion on the topic. Although territorial dynamics are slightly described, ecologies of infrastructures and territorial morphology are not taken into consideration. The metabolism of cities and regions is only observed within administrative boundaries. Municipal, regional and national boundaries constitute the limits of investigation in each of the seven papers discussing circularity through a case study approach.

Often, territories are considered merely support for allocating products and functions (Wandl et al., 2019). This approach overlooks their intrinsic spatial and physical characteristics, as well as their mutability through time. Territories are therefore not considered resources, but a background where activities take place.

In conclusion, one crucial observation emerges from these criticisms. The studies above acknowledge the gap between CE conceptualisations and implementation, underlining the absence of integration of space, land and territories in CE outline. As Korhonen and colleagues (2018) suggest, there is a need for a new paradigm concerning norms, values and tools. According to this, urbanism requires a reinvention of design investigation instruments that supports new ways of looking at the territory. For this purpose, in the next sections, this chapter approaches the territory as a system of stocks and flows of resources, through the reinterpretation of classical cartographic representations.

2.3 The Necessity of Representation: Towards Spatialising and Contextualising Circularity

If the previous section of this text articulates the need to integrate more territorial perspectives on circularity, section three focuses on the tools of the abovementioned integration: positioning the necessity of representation central.

In other words, this section illustrates and discusses the agency (Corner, 1999) and the capacity of mapping as a research tool. Thereby in complementing and integrating the CE approaches based on numbers-driven economies and technologies as drivers for building circularity in urban territories. The question of representing territories within a CE urbanism framework, that is to say of territorialising circularity, discloses three levels of reflection: that of adequately framing the object of analysis, that of translating flows into space, and ultimately that of activating the different roles of cartography.

First of all, the territorial lens calls for a close reading of urban contexts going beyond the more traditional limits imposed by data-driven analysis. If numerical operations are based upon an understanding of cities as administratively bordered surfaces, within the urbanism field, cities and territories are framed by a different unit of analysis, such as geographical, ecological or morphological units. As it is evident, administrative borders are tied to an undeniable necessity and hence availability of data, including resource and waste management information; however, a territorial approach forces to inscribe the unity of analysis within a larger, and more complex footprint.

Secondly, the method of using cartographies as research tools—mapping operations—calls for reflecting on the diverse role that cartographies can assume in the process of knowledge construction. In the language of architects and urbanists, mapping means at the same time recording, retracing and processing, whereas these operations are not always performed in chronological order. According to Friendly and Palsky (2007), we can distinguish three functional roles for cartographies: exploration, analysis and presentation. The work of the following paragraphs make use of a set of cartographies that responds to this threefold structure, where: exploratory maps refer to the idea of revealing the pattern of qualitative or quantitative information otherwise invisible on the ground; analytical maps respond more to operations such as selecting, synthesising, combining and processing existing features; and ultimately presentation maps are driven by the idea of visualising findings.

Thirdly and most evidently, the notion of territorialising circularity highlights the projective focus of this work: representing dynamics, and drawing geographies that vary in space and time. The following paragraph (4) addresses the often formulated gap, that cities and urban areas are considered '*as metabolic black holes embedded in a functionally subordinate territory*' (Vandenbroek & Dehaene, 2013, p. 5) and therefore, often represented—although not spatialised—as a system of inputs and outputs.

2.4 Resource Cartographies: The AMA Case-Study

This section showcases how to 'territorialise circularity' via four mapping operations. A set of maps highlights specific spatial components that are relevant to the definition of wood waste flows in the AMA under a circular economy approach.

Building upon the definition of resource cartography of Marin (2018), the objective of the mapping exercise is to visually identify the territorial dimension of one specific waste flow, namely wood, and its material stock. By overlapping waste flow data of economic activities, with urban tissues and infrastructures in a map, the exercise discloses the potential to geographically locate future wood resources and stocks from wood wasted material. The final result is four diachronic cartographies (Figs. 2.1 and 2.2), one per each operation.

2.4.1 Mapping the Flow

There were 15ktons of wood waste produced, processed and treated in the AMA in 2016 (Geldermans, 2020). Through the first mapping operation (Fig. 2.1) wood waste flows are mapped according to a methodology called Activity-based Spatial Material Flow Analysis (AS-MFA) (Furlan et al., 2020; Geldermans et al., 2019). Under this method, lines represent flows of wood waste between geographically located actors. The width of the lines is relative to the volume of wood waste. The identification of actors follows the *Activités Économiques dans la Communauté Européene* (NACE) categorisation.

The map (Fig. 2.1 top part) visualises a network space much larger than the AMA extended across the entire country and even beyond, questioning if administrative boundaries are the correct parameter for understanding and analysing waste movement. However, the image presents two main limitations: waste flows are represented abstractly, detached from the surrounding environment, and overlooking potential physical interrelations between them.

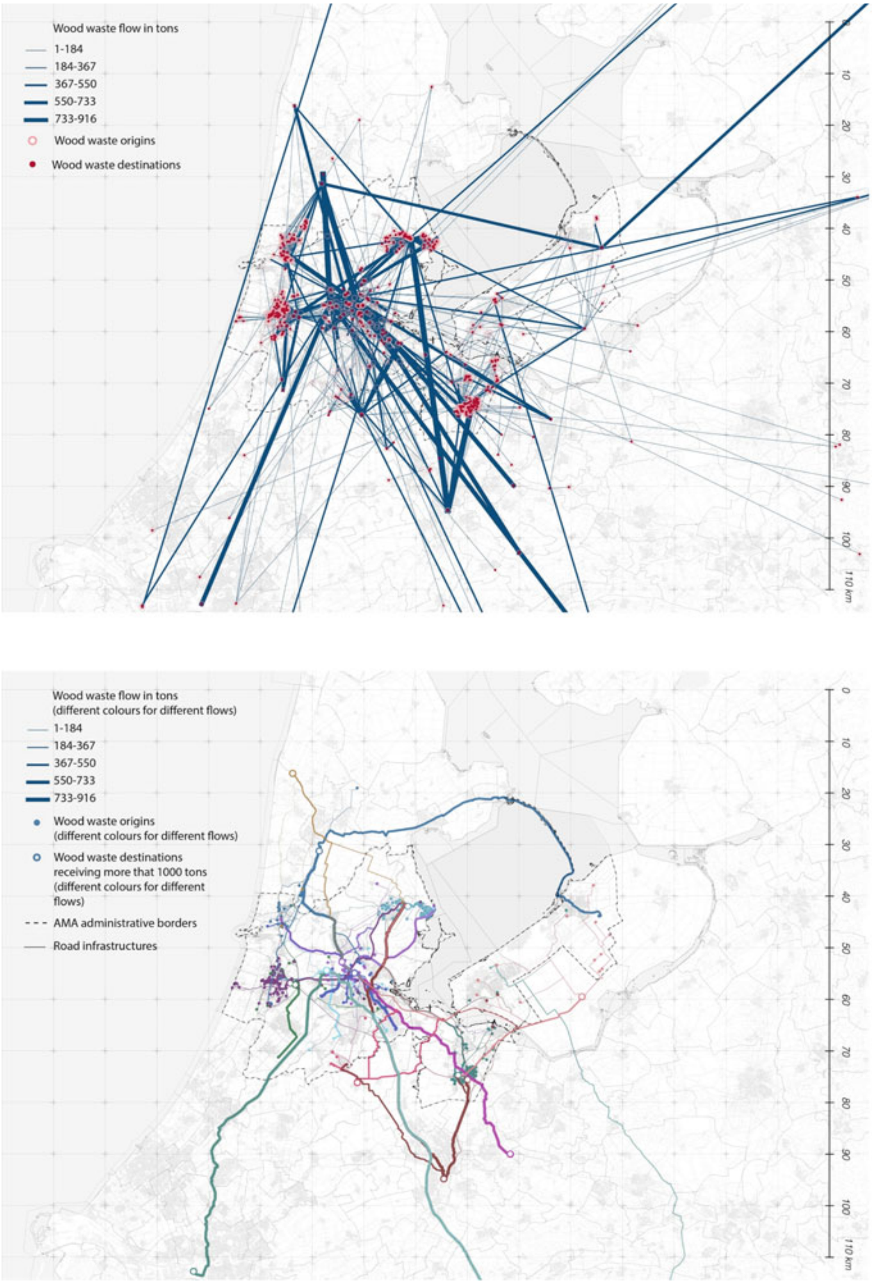

Fig. 2.1 Top: Wood waste flows. Wood waste flows from and to the AMA are represented according to AS-MFA, including origin and destinations; Bottom: Wood waste flows on the road network. Wood waste flows are selected by destinations that received more than 1000 tons of discarded wood material. Flows are represented on the road infrastructure, according to the shortest routes between each origin and destination

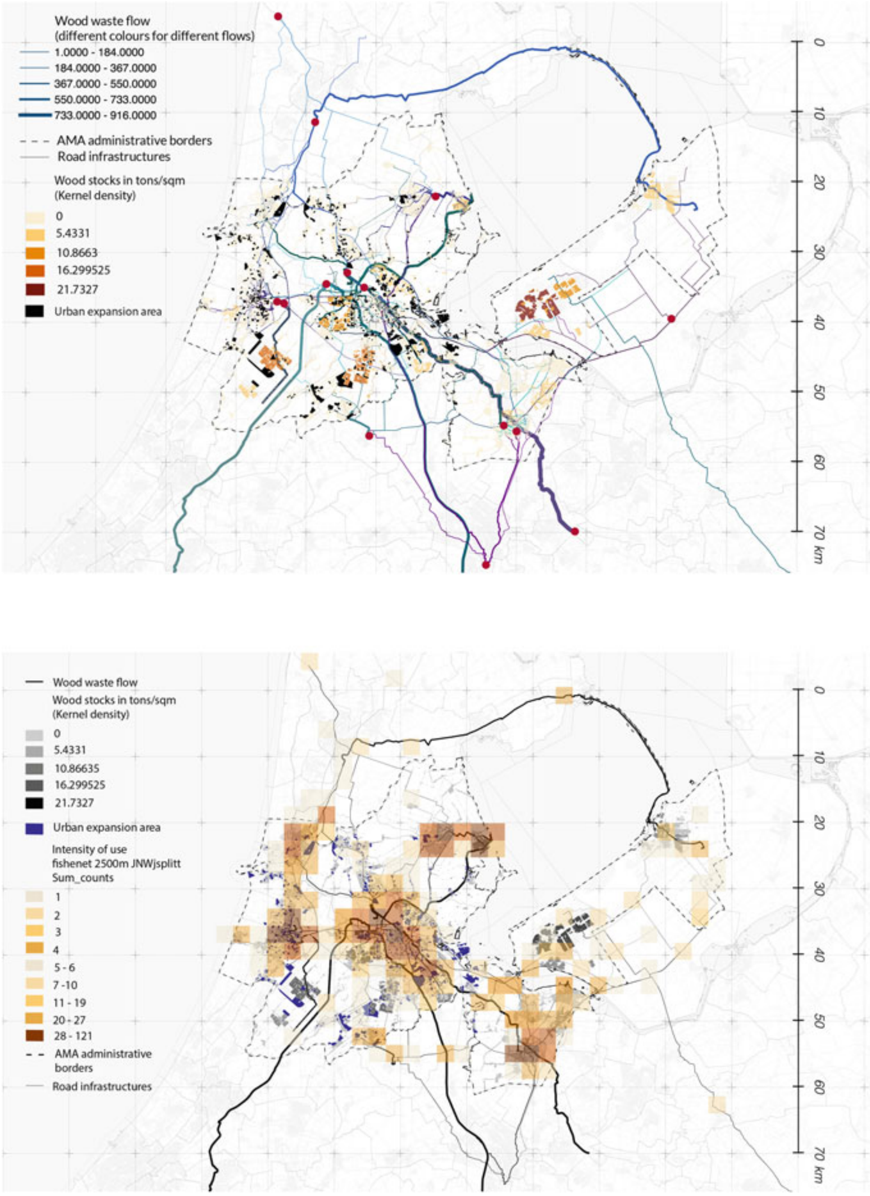

Fig. 2.2 Current wood waste flows and projected origins and destinations. Wood waste flows are represented as in Fig. 2.1-bottom. The existing stock of wood is represented according to the urban mining analysis, and the future building expansion areas are added. Bottom: Map of resource sheds referring in particular to the observation wood material in the AMA. The intensity of the road network's intensity is calculated according to the number of current intersections of flows. The resulting image is juxtaposed on Fig. 2.2-top

2.4.2 Justaxposing Flow and Infrastructural Network

To overcome the limitation mentioned above, this second operation aims at territorialising wood waste flows on the road infrastructure network.

Firstly, assuming that the totality of wood waste in the AMA is transported on roads, wood waste flows were selected according to destinations that received more than 1000 tons of discarded material. The resulting 16 paths were identified by hypothetically selecting the shortest road routes connecting the origin and the destination of each waste flow. Distinctive colours represent the flows to each destination, while the differences in line thicknesses indicate precise ranges of amount of waste, as reported in the legend (Fig. 2.1 bottom part).

This cartographic operation allows understanding on which territorial portions, landscapes, and cities the selected flows intersect. In particular, the map showcases the most used infrastructures, the most pertinent destinations to process and treat wood waste, providing a theoretical understanding of each destination's areas of influence. However, this mapping process highlights two additional limitations of the current approach aiming at including a territorial perspective in CE. The first constraint refers to a structural choice of the AS-MFA method, which considers the location of waste flow origins and destinations only based on economic identification (e.g. the company's headquarters). Therefore, where the waste is produced, processed and treated might not correspond exactly with the mapped points, generating possible misleads on the streams' spatial trajectories of the streams and consequently on the interpretation of the flow basins. Secondly, nowadays there is no interconnection between the use of infrastructure, the points where the waste is treated and the future location where the recycled wood could be used. If streams are dynamic elements that change in time, the process of territorialisation should include a projective dimension that refers to the future origins or destinations of flows.

2.4.3 Unfolding Stock and Flow Relationship

Under a circular approach, demolition and disassembly materials (rather than future construction and demolition materials) can be considered as future wood stocks. These stocks represent materials that can be capitalised in the coming years. The current wood stock can be thus unlocked as an 'urban mine'. Within the Amsterdam case, the notion of 'urban mining' has been integrated into new policy strategies and explorative studies, against the backdrop of regional CE ambitions. Wood materials currently locked inside the built stock of the AMA are approximately equal to 9,000 ktons (Geldermans, 2020).

The third mapping operation (Fig. 2.2, top) aims at introducing a projective dimension by overlapping the trajectories of wood waste movements defined in Fig. 2.2 with the wood materials currently 'in stock' i.e. locked inside the built fabric of the AMA and their potential future destinations.

The method adopted to calculate and map the wood stock is presented and described in the Addendum to the Deliverable 3.3 of the REPAiR project, produced in co-development by the building inspection company SGS Search and the sustainability consultant Metabolic. The method is based on an estimation of the proportions of different building materials according to six building types—'row-houses', 'semi-detached houses', 'apartments', 'free-standing houses', 'offices' and 'other utility'. Buildings in the AMA are then classified under each type and stocks are calculated according to building sizes, using the Dutch Key Register for Addresses and Buildings (BAG). The BAG includes the georeferenced polygons of all buildings, their respective size, how many accommodations (Dutch: 'verblijfsfunctie') are situated within one building, and what is the usage function (Dutch: 'gebruiksfunctie') of each building (Geldermans et al., 2019).

From the 9,000 Ktons of wood stock inside the AMA's built stock, this article only considers buildings constructed after 1945, excluding most heritage structures in the area. In contrast to the use of economic activities, considering wood stocks as potential future origins for the wood waste flows adds a spatial layer to the definition of flow origins, overcoming the potential constraints of economic identification of activities in the AS-MFA method. Under this same rationale, this mapping operation (Fig. 2.2 top part) considers future urban expansion areas in the North Holland Province as potential destinations of the wood waste flows. For the scope of this text and in a circular perspective, the latter represent where the processed wood waste could be redirected, reused and recycled in the construction sector.

In conclusion, this third mapping operation (Fig. 2.2 top part) outlines new spatial relationships, in which business activities, infrastructures, urban conditions and future urbanisation tendencies are brought into proximity within a given geography.

2.4.4 A Circular Stock and Flow Relationship: Defining Resource Shed

Following Marin (2018), the new spatial interrelations described in 4.3 are named as resource shed. Sheds are considered '*geographies within which elements of a specific system retain a high degree of interrelation and interdipendness*' (Thün et al., 2015, p. 31). Similar to watersheds collecting water from a geographical area into the same river or water basin, under a CE perspective, sheds collect potential future waste material that could be processed and redistributed through existing activities and infrastructures as raw material for another application.

The identification of resource sheds adds a spatial layer to an economy-oriented model, usually defined through technical, statistical and organisational factors:

1. By displaying alternative synergies at different spatial levels, resource sheds help identify the optimal operation scale to develop circular strategies.

2. By going beyond administrative borders, resource sheds primarily consider the interrelations between elements in space, i.e. waste flows, in this case, rather than political boundaries.
3. Resource sheds are shaped by variables related to current and potential future interrelations and, therefore, include the temporal perspective.
4. Resource sheds enquire the current definition of economies of scale, in which the cost advantages that enterprises could obtain are only due to their scale of operation (typically measured by the amount of output produced), with cost per unit of output decreasing with increasing scale.

The cartographic representation in Fig. 2.2 (top part) combines linear elements (wood waste flows sorted by destination) with polygons (potential stocks and expansion areas). Nevertheless, current linear flows may change in time. It might, thus, be more relevant to consider their current effects rather than their current paths.

In the fourth mapping operation (Fig. 2.2, bottom part), linear elements representing flows are replaced by the intensity of use of the infrastructural network. The spatial analysis carried out in the last operation provides insights into how a spatial approach could be used in the delimitation of a resource shed. By analysing the intensity of use of the network, specific areas of the territory and their related elements already become differentiated geographies.

The intensity of use of the network is calculated according to the amount of current intersected flows. A grid is used to display the areas where there are additional intersections. In the bottom part of Fig. 2.2, the colour gradation of the tiles corresponds to the intensity of use of the network by current wood waste flows.

The analysis of the lower part of Fig. 2.2 identifies three different types of resource sheds within the AMA:

(a) Firstly, areas like Amsterdam water banks close to Westpoort or cities like Haarlem in the West show a high intensity of use of the infrastructure network as well as a high potential wood stock. Furthermore, the map indicates expansion areas scattered in the regions of Haarlem and Westpoort. This configuration shows potential for these areas to be redefined as resource sheds, by connecting stock, flows and expansion areas at the local scale.
(b) Secondly, areas like Purmerend in the North display a high intensity of use of the infrastructure, a low to medium level of wood stocks and very few expansion areas. In this case, the definition of a resource shed would imply a more detailed evaluation of the stock amount and the definition of new destinations for it. Therefore, the shape and dimension of resource sheds may change according to the inclusion of future materials' origins and destinations beyond the local scale.
(c) Lastly, areas in the east, such as Lelystad or Almere, show a low intensity of use of the infrastructure but a high potential of wood stock. Potential new wood waste destinations in new expansion areas are far from these areas, often across the water. In this case, the definition of resource sheds and a low-intensity use of infrastructures highlight the necessity of considering alternative modes of transport on water, even going beyond the AMA's administrative borders.

These three examples of resource shed's definition illustrate how overlapping in a visual form essential layers of spatial information provides alternative insights to envision new CE coalition and strategies for business companies, urban designers and policymakers.

2.5 Reflection and Conclusion

This chapter unfolds how a place-based analysis of waste flows, and its interrelation with the infrastructural network offers a potential lens to reinterpret the territory under a CE approach.

The literature review in Sects. 2.1 and 2.2 highlights how CE research in urban planning mainly focuses on circular business and indicators, whereas broader socio-ecological and spatial contexts are rarely part of the reflection. Nevertheless, CE is taking place in specific spaces and regions. Consequently, there is a need for understanding the territorial aspect of circularity.

Sections 2.3 and 2.4 discussed a mapping approach to fulfil this necessity. It presents a preliminary method to intertwine material streams, namely wood waste, in the specific territorial and infrastructural context of the AMA. In the AMA study, the provided mapping approach functioned as an analytical and projective instrument towards identifying waste-material flows and the optimal scale in which to develop context-specific circular strategies. Following Marin's (2018) reflection, maps, here named resource cartographies, are optical instruments, synthesising on paper existing dynamics and highlighting future potentialities to explore place-specific transitions to CE and context embedded alternative circular futures. The AMA resource cartographies highlight three main results:

- Waste flow movements exceed the AMA administrative boundaries.
- The visual analysis of waste flows origin, destination and material stock displays alternative synergies at a different spatial level.
- The definition of resource sheds helps to identify the optimal operation scale in which to develop circular strategies.

Unlike other traditional planning policies defining comprehensive regulations, and business-oriented solutions, resource cartographies highlight the essential elements in space, designing and speculating alternative economic-environmental coalition. Moreover, the tool of mapping reframes circularity also as a spatial, territorial issue, addressing interdependencies between urbanisation, resources flows including waste and.

The process of territorialising circularity can act as a medium to imagine alternative futures, to mediate between academic discourse, design and economic oriented and planning policies.

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Chapter 3
Shifting Risk into Productivity: Inclusive and Regenerative Approaches Within Compromised Contexts in Peri-Urban Areas

Francesca Garzilli, Federica Vingelli, and Valentina Vittiglio

3.1 Overlapping Risks in Peri-Urban Areas

Due to the increase in the intensity and frequency of disasters in urban areas, especially related to climate change (IPCC, 2014), the issue of risk has increasingly been debated by academics, policymakers and the general public, along with the growing awareness of the role of people in protecting the planet and the territory.

This section introduces the concept of risk and the evolution of knowledge of its implications on the forms of landscape, affirming that an in-depth understanding of the territorial fragilities is one of the main challenges for designing a sustainable and regenerative development methodology, able to effectively address territorial vulnerabilities.

The issue of risk has strong territorial implications: it can "mark" the territory (positively or negatively) and it can be viewed as a projection into the future of territorial features that effectively endanger the space in question (November, 2004):

The section on "Overlapping risks in peri-urban areas" and "Territorial risks and resources in Campania" was written by Federica Vingelli, the section on "Land productivity: from exploitation toward regeneration" by Francesca Garzilli, the section on "Adaptive remediation approach for peri-urbanity in transition" by Valentina Vittiglio, the section on "The Agency of Waste" by Francesca Garzilli and Valentina Vittiglio, and the abstract and concluding remarks are the result of shared work.

F. Garzilli · F. Vingelli
Department of Architecture, University of Naples Federico II, Naples, Italy
e-mail: francesca.garzilli@unina.it

F. Vingelli
e-mail: federica.vingelli@unina.it

V. Vittiglio (✉)
Department of Architecture and Industrial Design, University of Campania Luigi Vanvitelli, Aversa, Italy
e-mail: valentina.vittiglio@unicampania.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_3

for example an earthquake or a volcano eruption, in the case of natural risks, or industrial accidents, contamination, in the case of human-made risk.

Significant progress has been made in the study of the relations between risk, society and territory since the 1970s. Early conducted on risk were predominantly hazard-orientated, and disaster events were perceived as random, exceptional events or “acts of nature”, as the expression “natural disaster” shows (Burton, 2005, p. 35). Then, in the late 1970s, the United Nations Disaster Relief Organization (UNDRO) globally recognized the social construction of risk (White, 1974). Their definition of risk included three components: hazard, risk and vulnerability.[1] This definition recognizes that disasters are not sudden events, but they are results of the combination of multiple variables including the vulnerability of exposed elements or areas, and their physical, economic and environmental qualities (Peduzzi, 2019). Later, this change of perspective was largely adopted by scientific studies, and by the first Terminology on Disaster Risk Reduction that was published by the United Nations International Office for Disaster Risk Reduction (UNISDR) in 2004 in order to promote common understanding and definitions of risks affecting territories and populations.

The definition also claimed that the concept of vulnerability is thus directly connected to the physical and spatial characteristics of places such as underdevelopment, unplanned urban growth, poverty, deforestation and changing land use. These factors can influence the coping capacity of an area to face and manage adverse conditions, emergencies or disasters by using the available skills and resources (UNISDR, 2009). For example, soil sealing activities have direct repercussions on the water cycle, and they can increase the impacts of meteorological phenomena in hydrogeological risk-connected areas.

Moreover, in addition to natural hazards, the vulnerability of an area is affected by urbanization processes, which have the capacity to generate new hazard events. Such events are considered as man-made hazards that are caused by humans, and they can occur within or close proximity to human settlements. For example, these hazard events are industrial and transport accidents, environmental degradation and pollution. The latter, associated with manufacturing, food processing and construction, can lead to the release of heavy metals, plant nutrients and organic compounds to the environment and soil (Douglas, 2006). They can impose severe impact on the health of ecosystems and the human population (Allen, 2006) living in affecting territories.

In particular, these processes occur and overlay especially in peri-urban areas of the contemporary city. In relation to the issue of risks, in fact, these areas have a double connotation (Galderisi, 2017; Russo & Attademo, 2020): on the one hand, due to its spatial characteristics of hybridization and coexistence of natural, rural and urban components (Wandl et al., 2014), these areas experience overlaps between

[1] Conventionally, risk is expressed by the notation Risk = Hazards x Vulnerability. There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. They are defined as characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR, 2004, 2009).

natural (e.g., floods, landslides) and anthropogenic risks (e.g., pollution due to the release of organic and inorganic waste). Thus, in peri-urban areas, high- and low-density residential settlements could rise near industrial areas, cultivated fields or abandoned landfills. At the same time, peri-urban areas are the places where the impact of uncontrolled urbanization and landscape fragmentation occur.

The increasing awareness that risks are closely related to anthropic activities and urbanization has highlighted the need to frame risk-related issues in a broader framework of urban development and sustainability (Galderisi, 2017). Nowadays, the issue of settlements at risk is one of the main challenges of international policies on sustainable development (e.g., the 2030 Agenda for Sustainable Development; United Nations, 2015). Goal 11 of the Sustainable Development Goals states the need for the improvement of risks mitigation and the resilience of exposed settlements. In Italy, the prevention of natural and man-made risks is also a strategic objective of the National Strategy for Sustainable Development (SNSvS) which promotes integrated and multi-sectoral policies involving the fields of "people, planet and partnerships" (Ministero dell'Ambiente, 2017). It is necessary to emphasize that the goals highlight the need to minimize polluting loads in the soil, the water and the atmosphere.

In this framework, the peri-urban regeneration represents a main challenge for regenerative urban planning, and its project can only start from the knowledge of the risk and vulnerability conditions of the affected areas. In a circular approach, however, the vulnerabilities of settled environments, such as ecological fragmentation and unplanned construction, become resources for the recomposition of the landscape. Through strategies and design actions, they can tackle the emergence of new risks.

3.1.1 Territorial Risks and Resources in Campania

As an example of coexistence between natural and man-made risks in vulnerable territories, this research focuses on Campania region, the third most populous region of Southern Italy with an area of 14,000 km^2 and almost six million inhabitants (Eurostat, 2018).

Given its location and morphological composition, Campania region is affected by a number of natural risk factors. The region stretches between the Apennine Mountains and the Tyrrhenian Sea, and extinct and active volcanic complexes dominate its natural landscape, such as the Vesuvius, the Campi Flegrei complex and the volcanic island of Ischia. Although the natural risk factors are high in these volcanic areas, they have been populated since ancient times, making natural and anthropic risks intertwined. Over the last century, the natural risk determined by the morphological conditions of the region has been worsened by a rapid urbanization process transforming the hinterland from a rural reality to a metropolitan conurbation without a shared institutional vision (REPAiR, 2018a; Russo, 2011) between Naples and Caserta.

The process of urbanization still seems to proceed in spite of the risk conditions of the territory in Campania. In 2019, land consumption in the region reached a record level, with 10% of total land lost in a year (corresponding to 140 hectares). More than 70% of the "lost lands" coincide with areas already exposed to natural hazards (seismic and hydrogeological) (Munafò, 2020).

Furthermore, land consumption processes take place in a very weak and obsolete planning context: only 13% of the Campanian municipalities have approved the Municipal Urban Planning Plan (PUC), as it is defined by the current regional law (L.R. 16/2004). Some remaining municipalities (54%) have initiated the official procedures, while others (33%) have not initiated any steps for the approval of the PUC (Moccia, 2018). In this context, however, it should be emphasized that the regional laws do not establish the mandatory consistency between urban planning and planning tools for the emergency management (Galderisi et al., 2020).

Urbanization processes, including the development of illegal settlements and locations of production activities, have promoted the emergence of new human-made risks such as the contamination of soil and water, hazardous material spills, fires and environmental pollution. These risks contribute to the increase in the marginalization of the area, the decline of local agriculture and other human activities. The result is an extensive conurbation developed around the old towns with many urban fringes and peri-urban areas that are characterized by the coexistence of non-built fragments, discontinuous and low-density-built environments, productive and commercial settlements as well as rural fields (REPAiR, 2018) (Fig. 3.1). The remainder of the countryside is bisected by local and national level transport infrastructures that are poorly integrated with each other, and they draw a "grey arabesque" on the territory (Fatigati & Formato, 2012a).

Such infrastructures in a rural environment have activated a process of abandonment of agricultural production sites. They have also generated agricultural areas that are waiting for transformations and have exacerbated the architectural gap between higher level infrastructures and the quality of the surrounding settlements (Amenta et al., 2018).

Due to these spatial features, such as the availability of open space and good accessibility from urban areas, the peri-urban interface has also worked as a *backyard* (Allen, 2006) for legal and illegal urban waste disposal sites, and for the production and disposal of polluting substances. The degradation of soils and ecological condition of the investigated territory depends not only on the residues of the industrial activities, but upon the irregularities found in the waste management cycle as well. Campania region has experienced several emergencies in its waste management cycle over the past few years. Currently, two thousand toxic substance dumping sites, along with the illegal burning of wheels, plastics, textiles and other residuals, still represent major concerns for environmental and population health[2] (Mazza et al., 2015). The affected areas are included in the registers of contaminated sites drawn up by the

[2] In line with the notion of the peri-urban area as a "backyard", the waste crisis has been partially solved by building a waste incineration plant in the peri-urban area of the metropolitan city of Naples (Municipality of Acerra).

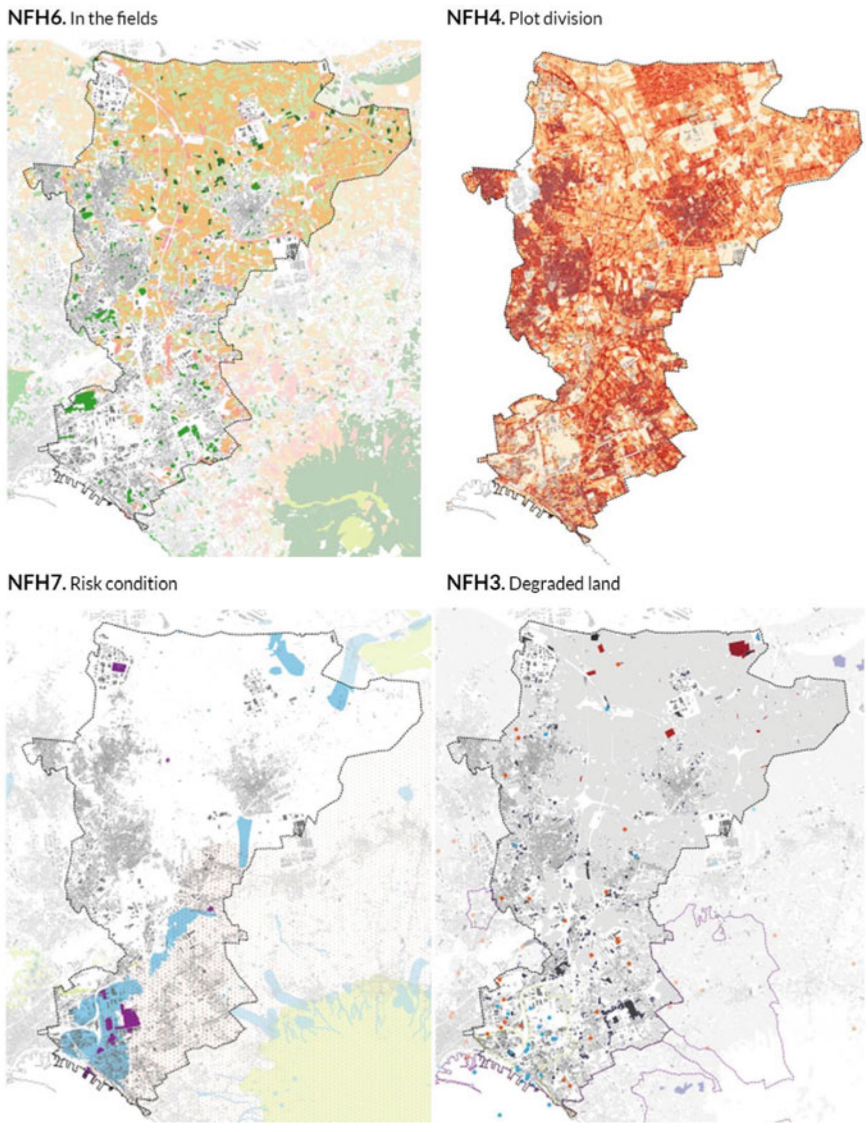

Fig. 3.1 Thematic selection of REPAiR spatial analysis on a Focus peri-urban area in Campania. NFH6: location of agricultural fields surrounding settlements and infrastructures. NFH4: vulnerability of rural areas linked to the landscape fragmentation; NFH6: areas related to natural (volcanic, hydrogeological) and industrial risk. NFH3: potentially polluted and polluted areas (*Source* REPAiR, 2018)

Region of Campania (RL No. 685/2019) and the National Government (Lex No. 426/98).

The area covered by illegal dumping and burning of waste, that was previously so-called the Land of Work ("*Terra di Lavoro*") has become the Land of Fires ("Terra *dei Fuochi*"). The latter term appeared for the first time in the 2003 *Legambiente Eco-mafie* report[3] and later, it has been used by national laws that have recognized the risk of pollution in these areas (Lex No. 6—6 February 2014). For these reasons, as established by these laws, and after surveys and analyses, cultivation for food purposes in affected crops has become prohibited. As a result, the open space, the endless horizon of the countryside has turned into residual space, which is sometimes abandoned, sometimes polluted, and is no longer productive.

Internally, the existence of risk, in anthropogenic and natural terms, triggered a state of crisis, of suspension between the end of a life cycle and the start of a subsequent one. These soils, settlements and water of the peri-urban landscape are often labelled in the literature as wasted landscapes (Amenta, 2015). The term "wastescapes" introduced later by the REPAiR project (REPAiR, 2018a) also signifies a call for urgent regeneration strategies to mitigate the risk of pollution, to repair environmental damage and to reconstruct the peri-urban landscape.

As a result, peri-urban areas have become incubators of major problems linked to a number of anthropic risks mentioned above: waste management, presence of illegal settlement, soil sealing, soil pollution, increasing the level of vulnerability of rural fringe interface.

What results interesting within this contribution, is the dualism of the risks related to this specific territory: despite the above-mentioned risks, the environmental character of the region has a number of advantages. For example, numerous thermal baths and the very fertile agricultural production in the region both have benefited from the volcanic systems and sulphurous soil. In the same way, the risk of flooding and the marshy characteristics of the Campanian hinterland have historically been sources of agricultural fertility. The reclamation works on the marshes have shaped the fertile plain of Campania since the 1500s, when it was called "Land of work" (*Terra di Lavoro*) for its fertility and productivity. This productivity made the region one of the largest exporters of agricultural products such as hemp or flax until the 1900s (Casoria & Scognamiglio, 2006).

Urban agriculture is still at the top of the brown and green global agendas and in scientific research (as detailed in Sect. 3.2). However, focusing on peri-urban agriculture as opposed, for example, to urban or vertical gardens issues, means putting the environmental and landscape dimension of agricultural practices at the centre of research. In this research, peri-urban agriculture is thus investigated in terms of

[3] Legambiente is the most widespread non-profit environmental association in Italy. Among the main activities: "analysis and reporting of environmental crime, eco-mafia, trafficking and illegal disposal of waste, exploitation of animals and illegal building" (source: legambiente.it) through reports and scientific studies, along with active participation and volunteer campaigns.

potentials of recycling of organic and inorganic flows (organic waste, wastewater) and of regeneration of wasted landscapes (wastescapes) in peri-urban areas.

For the above reasons, together with the solid rural culture and the traces of rural landscape that the Campanian peri-urban areas have preserved, the agricultural vocation of the region has been considered as a resource for the regeneration of this land at risk.

3.2 Land Productivity: From Exploitation Toward Regeneration

The countryside is back on the scene!

As stated in the previous section, the risk in Campania region is linked to the latent productivity of its soil.

In particular, the identification of peri-urban, as the principal site wherein shifting such compromise and risky sites into challenging places in which can take place a *sustainable agricultural* practice, has been a common challenge of European agendas for the past 20 years so far. Furthermore, several European and national studies have focused on plans, programmes and research projects on the sustainable productive aspect of peri-urban.[4] Thus, as understood within the EU project PLUREL—*Peri-urban Land Use Relationships, Strategies and Sustainability Assessment Tools for Urban–Rural Linkages*,[5] EUROPE 2020 is a potential driver of policy innovation for "territorial cohesion", using the *peri-urban* as a suitable place to integrate *economic*, *environmental* and *social* aspects (Piorr et al., 2011). Moreover, as emerges from PLUREL, urban expansion is by far the most rapid type of land-use change in Europe, and it will continue at a rate of 0.5–0.7% per year. Following these results on the growth forecast of peri-urban areas, the *European Environment Agency*[6] (EEA)

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[4] Among others, *Urban Sprawl in Europe. The ignored Challenge,* Bruxelles 2006; *New Challenges for Agricultural Research: Climate Change, Food Security, Rural Development, Agricultural Knowledge Systems,* Bruxelles 2008; PLUREL (Peri-urban Land Use Relationships—Strategies and Sustainability Assessment Tools for Urban–Rural Linkages). Coordinated by the University of Copenhagen (2007–2011); PAYS. MED. URBAN. Peri-urban Landscapes (2009–2012) within the European Med Programme (2007–2013), AGAPU (Analisi e Governo dell'Agricoltura Periurbana) research project n. 1724, funded by the Regional Research Programme in the agricultural field (2010–2012), Lombardia Region-Plan20; REPAiR (REsource Management in Peri-Urban Areas: Going beyond Urban Metabolism) coordinated by TU Delft (2016–2020).

[5] PLUREL—*Peri-urban Land Use Relationships—Strategies and Sustainability Assessment Tools for Urban–Rural Linkages*—is an integrated project funded by the 6th Research Framework Programme of the European Union. 32 partners from 14 European countries and China participated in the project. It has been coordinated by the University of Copenhagen. The project started in 2007 and terminated in April 2011. Available at: www.plurel.net.

[6] The European Environment Agency (EEA) is an agency of the European Union, whose task is to provide sound, independent information on the environment. The EEA aims to support sustainable

argues that by 2020, "approximately 80% of Europeans will be living in urban areas". As a consequence, peri-urban, classified as "discontinuous areas", will grow four times faster than "continuous areas", i.e., the urban ones[7] (EEA, 2017).

Based on this overwhelming change of land use, projects and proposals which use *agriculture production* to contrast urban expansion and to rethink the organization of cities are increasingly emerging. In addition, the economic support to agricultural enterprises will no longer be linked to the quantity of production, but a quality production and rural development policy will be rewarded.[8]

Therefore, examples around the worlds, such as the project by Rem Koolhaas, *Countryside: The future* (2020), exhibited in the Guggenheim Museum, or the project for the Lisbon Triennale by Sébastien Marot, *Agriculture and architecture: taking the country's side* (2019) are just a few of the many cases. Such projects contribute to bringing old concepts back into vogue, in particular the once associated with the well-being produced by the countryside and its value as a binder. Concepts that are the sons of the Kropotkin's *collaborative field*, of the Howard's *Garden City*, and even later of the Wright's *Broadacre City* and Branzi's *Agronica*. Those projects have considered *social integration* in various ways to rebuild the relationship between *nature, culture, city and countryside.*

Based on the examples above, how, even in Campania Region, can agriculture be used for the peri-urban regeneration project?

As we have mentioned earlier, the volcanic soil, together with its geographical position, has contributed to the fact that in the past, Campania was known as "Land of Work" (*Terra del Lavoro*) or *Campania Felix*. The adjective *felix* referred to the fertility and productivity of the region. The agricultural hinterland of Campania has always played a fundamental role for the inner city, as a *productive* place on which the urban economy depended.

What is left today? Is it still *felix*? "*Campania Felix* represents an emblematic case study: the waste crisis, the congestion of the coastal city, the transformation of the countryside from land of production to stand-by land (of new settlement, landfills, etc.), the pervasive informal settlements" (Fatigati & Formato, 2012b).

The goal is to explore and analyse innovative ways of agricultural production. Such examples have been considered by the aforementioned PLUREL synthesis report. This report has pointed out that as the levels of urban growth and related agricultural land consumption continue, "land fragmentation, loss of habitats and amenity values will all be more serious in the peri-urban than today" (Piorr et al., 2011).

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development by helping to achieve significant and measurable improvement in Europe's environment, through the provision of timely, targeted, relevant and reliable information to policy making agents and the public.

[7] "A set of *urban areas* laying less than 200 m apart". Those urban areas are defined by the land cover classes considered to contribute to the urban tissue and function (EEA, 2017).

[8] Look at the webpage of the Italian Farmers Association (Cia-Confederazione Italiana Agricoltori). Available at: https://www.cia.it/documenti/lagricoltura-negli-spazi-periurbani/.

As reported by the data of the last Italian census (Italian National Institute of Statistics-ISTAT), the expansion of dispersed built-up areas has increased pressure on peri-urban and rural areas. In peri-urban areas, change in rural land use is mainly due to *land abandonment* and the *transition* to artificial areas. Between 1982 and 2013, the utilized agricultural area (SAU "Superficie Agricola Utilizzata") decreased by 21.5%. In just three years, between 2010 and 2013, more than 400,000 hectares of agricultural land were lost. A further estimate reported that between 2004 and 2009, 7.3% of the national territory passed from "agricultural" to "natural" (3.7%) or "artificial" (0.9%), but also to a not negligible extent from natural to agricultural (1.9%) (ISTAT, 2017).

In Campania, the decrease in the number of farms (−41.6%) was far greater than the decrease in the Utilised Agricultural Area (UAA) (−6.3%) and the Total Agricultural Area (SAT) (−13.8%) between 2000 and 2010. According to this data, the thesis argued in this paper is that working in *rural peri-urban areas*—where the human presence is greater than in the open countryside—can have its advantages, as, right there, agriculture is strongly influenced by urban areas.

Therefore, in order to analyse sustainable agriculture and new territorial strategies, a shift is needed in the *planning* process (Buxton & Butt, 2020).

Such rethinking and development depend on the definition of planning instruments, capable of considering the *structural*, *perceptive, productive* and *social* aspects of the agricultural landscape.

For example, the Regional Landscape Plan for the Puglia Region. In this plan, what is considered as "border condition" can drive a design of what is defined as "deal between the city and the countryside",[9] involving people in the governance process and defining a "new geography" of the territory (Donadieu, 2013; Magnaghi, 2010; Mininni, 2013a, b; PPTR Puglia, 2015).

This suggests that it is necessary to define integrated interventions of *rural development* and *urban* and l*and-use planning* in order to harmonize the city/countryside relationship, and to make those areas more attractive from a social and productive point of view.

As stated above, the problem of agricultural areas on the outskirts of cities is perceived and addressed at European level. Then, the objective to address is a *multidimensional* project able to restore the *ecological* and *productive* qualities, revealing the original vocation of these fields, through a circular approach (Allen, 2003; Bogaert et al., 2015; Chen et al., 2019; EESC, 2004; Gonçalves et al., 2017; Hedblom et al., 2017; ICESP, 2019; Olsson, 2016; Piorr et al., 2011).

In doing so, *local tradition* and process innovation are bound together, with the aim of rethinking how these places deal with the more fragile interface: the peri-urban one. Thus, "peri-urban agricultural areas represent considerable *potential* as agricultural parks, green areas of metropolitan interest, where it is essential not to disregard the encouragement of non-invasive productive activities, increasing the agricultural functions of quality both on the agro-food-biological and on the aesthetic-landscape-cultural level" (Regione Lombardia, 2012).

[9] In Italian: "Patto Città-Campagna", i.e., the main purpose of the plan and its own title.

The potential character of the peri-urban concerning its association to agricultural lands already emerged in one of the first definitions of the peri-urban, i.e., Pierre Donadieu's "*Campagne urbane*" (Donadieu, 1999, 2013). Through this apparent oxymoron, Donadieu explains that peri-urban agriculture must be understood as a *natural infrastructure* of public interest that can be used for several ends: to recycle organic waste coming from the city, as horticultural space, for leisure, educational farms, community engagement, etc. Thus, the built and the unbuilt work together to transform the rural–urban fringes into an available and *productive* landscape (Donadieu, 1999, 2013). Then, to shift the "*agricultural peri-urban space*" into a "*campagne urbane*", it will be necessary for the population who live there to accept its allegory and transform it into a *liveable place* (Mininni, 2013a, b).

Nevertheless, thinking only about the potential that lies in supporting sustainable architecture cannot be separated from thinking about these places in terms of *design* (Hedblom et al., 2017). As Michael Button and Andrew Butt have claimed recently, peri-urban regions hold high *strategic, social, economic and environmental* significance, and *planning* for the future of these areas results in extremely *challenging* (Buxton & Butt, 2020).

How to rethink these territories? How can productivity become a driver for innovation, both technological and spatial? How can its raw elements be useful for its design? And then, how to make *Campania felix* again?

3.3 Adaptive Remediation Approach for Peri-Urbanity in Transition

Acting within fragments of peri-urban territory means dealing both with their intrinsic potential, in ecological and productive terms, and with complex dynamics that distinguish the condition of "waste", exposure to risks, of human and natural matrix, and poor resilience to the pressures and vulnerabilities that derive from it.

Increasing the adaptive capacity of these places "in transition", insisting on their current metabolism, and on the inefficiency of the linear chain (production-consumption-waste), involves their transformation from territorial value producers to promoters of resource flows (van Timmeren, 2014).

In this sense, the transition from a linear to circular chain involves re-reading and rethinking the peri-urban context in a regenerative way through its orientation towards new life cycles, new economies and productivity, contemplating more sustainable and eco-friendly farming practices.

As stated above, a sustainable approach to agriculture contributes to the long-term maintenance of productivity, social utility and environmental protection (Ikerd, 1993; United Nations, 2009) by means of integrated soil management (OECD, 2008), hindering the alteration of its biological composition and preserving its agronomic and environmental quality.

However, the soil quality of the once agricultural rural fringes in Campania is undermined by degradation processes. The main cause of these phenomena is the use of the soil as a mere platform to support improper agricultural practices. These phenomena are also related to the disproportionate land consumption, with significant ecological compromises in terms of contamination and pollution. Therefore, it is necessary to reverse the course, and to turn these premises into pretexts to place agriculture in a more sustainable dimension and trigger regenerative, safety or remediation practices, for profitable future developments in a circular perspective.

To do that, the urban project investigates and insists on the existing condition of the places. It also promotes the reuse of the landscapes, by replacing the concept of expansion with recovery. This also implies a review of the useful devices to implement this transition. The latter, from specific and sectoral ones, are set up as tools for the prefiguration of transcalar, intersectoral and innovative design strategies (Pavia, 2014).

Among these, environmental remediation interventions play primary roles based on an adaptive and ecological spatial interpretation. They reject conventional operational solutions, and they highlight the limitations of traditional approaches. The latter, in fact, conceal synchronous matrices that are aimed at the restoration of primitive and short-sighted conditions not related to any soil design. In this case, the output materializes in fruitless spatial restitutions extraneous to its identity schedule as well as disconnected from the real and concrete needs of the established communities. However, the transition to integrated and sustainable methods of intervention aims to create a context of regenerative and adaptive development. Also, it allows to orient remediation actions in a diachronic key according to an evolutionary approach, in time and space, for the restitution of public space with ecological value (Robiglio et al., 2014).

This premise could be pursued by triggering new processes and approaches to remediation, aimed at intercepting the best solution that maximizes the benefits from environmental and socio-economic points of view (e.g., from a circular perspective, the reuse of the site in question).

In this view, the peri-urban agricultural territory is configured as an urban system that is able to resist and to react to change by reinventing and renewing itself, through the construction of timely social, economic and environmental responses, and becoming productive again but in a different way. The available space is limited and fringed, but the urban interface can be used to our advantage. It can be used as an area where mutual exchange takes place between the city and the countryside, and where innovative development plans are developed. Therefore, it is configured as a new laboratory of experimental production Km 0. Within it, the intervention of reclamation becomes a precondition for the future development of the territory as well as a device able to outline tactical actions of change hinged on shared, ecological and innovative vision for a new peri-urban condition in which communities can recognize themselves.

A sustainable approach to reclamation is a preferred framework in which recovery and innovative solutions optimize the use of resources, and they provide long-term benefits. Among these, there are some technically defined Nature-Based Solutions

(NBS).[10] Placing themselves in a wider eco-innovative[11] frame, the NBS include a series of ecosystem and site-specific approaches, and they are implemented individually or integrated with other solutions combining economic, governance and social innovation. Particularly supported at a global level,[12] they contribute to improving the resilience of peri-urban areas by means of mutually beneficial ecological processes, while increasing the value of the sites, and defining new local business models. One significant step ahead has been made in promoting the ecosystem-based approach by the recent publication of the Decree 46 of 1 March 2019 (Official Gazette 132, 7 June 2019) that has dealt with the *Regulation of remediation, reclamation and safety measurements of agricultural areas*. Despite the Italian situation being regressive in comparison to European trends in terms of sustainable management and regulation of land reclamation, the peri-urban area is the preferential framework in which such measures are implemented. In Annex 4 of Decree, it is established that "…the protection of landscape and of agricultural vocation of an area remain one of the strategic objectives of land management and planning", and "they will be the preferred actions of bio- and phytoremediation with multiannual crops that have many advantages in comparison to physical and chemical treatments".

Such approaches, with an irrelevant economic impact, promote the effective safety of the site, prevent the non-agricultural use of the soil, improve the quality of perception of the landscape, in addition to the improved fertility of the soil.

3.4 The Agency of Waste

The applicability of the issues and concepts introduced was tested in the framework of the European project REPAiR, funded by the Horizon 2020 framework.

Starting from an in-depth investigation of the fragmented peri-urban areas in Campania region, the conditions for the reconstruction of a landscape were verified.

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[10] Nature-Based Solutions are related to living solutions inspired and continuously supported by and using Nature designed to address various societal challenges in a resource efficient and adaptable manner and to provide simultaneously economic, social and environmental benefits (Walters et al., 2016).

[11] Eco-innovation refers to all forms of innovation—technological and non-technological—that creates business opportunities and benefits the environment by preventing or reducing their impact, or by optimising the use of resources. Eco-innovation is closely linked to the way we use our natural resources, to how we produce and consume and also to the concepts of eco-efficiency and eco-industries. It encourages a shift among manufacturing firms from "end-of-pipe" solutions to "closed-loop" approaches that minimise material and energy flows by changing products and production methods—bringing a competitive advantage across many businesses and sectors (EC, 2013).

[12] For further information see EU Research and Innovation policy agenda for Nature-Based Solutions and Re-Naturing Cities to network of national and regional funding organisations like BiodivERsA ERA-Net (EU, 2015).

For example, the environmental rehabilitation intervention was mainly oriented to meeting the safety requirements of the places, the restoration of ecosystem biodiversity and the need for landscape reconfiguration (Vittiglio, 2020).

The operational strategy undertaken also helped to dispel false myths about the *Land of Fires* phenomenon. Recent studies and monitoring carried out by a European Commission project called Life ECOREMED (Ecoremed, 2015, 2017) on the health status of the soil in the Campanian Plains have shown that only 30 hectares of the 50,000 hectares of total land analysed were potentially contaminated. Nevertheless, the quality of the fruit and vegetable products grown in these potentially contaminated areas was also above the national average (Di Gennaro, 2018).

Within the project, the proposed urban regeneration strategy has combined two distinct Eco-Innovative Solutions (EIS; REPAiR, 2018): integrating the treatment of organic waste with potentially polluted soils for the definition of a new system of restoration and remodelling of land, of "new soils" as porous borders between urbanized and rural areas (Garzilli et al., 2020; Russo et al., 2019).

In the first instance, the strategy considers an EIS working mainly on the potential of a traditional approach to remediation. This approach, in addition to the safety of the place compared to the presence of potential contaminants in ecological matrices, aims to facilitate a transition from more consolidated and sectoral remediation approaches to more sustainable ones. In this sense, remediation operations are processes aimed at finding the best solution, in participatory contexts, which maximize the environmental and socio-economic benefits and are placed in a circular perspective, and therefore more sustainable, reuse of the site in question (Vittiglio, 2020).

The context of intervention is a fragmented peri-urban area circumscribed by the road infrastructure of the Median Axis and the water infrastructure of the *Regi Lagni*. In this area between Afragola and Acerra, empty and residual spaces are located, mainly with agricultural focuses.

In this area, there is the landfill called *Scafatella* that has been abandoned for over thirty years. Previously, it was used as a storage site for solid urban and construction waste. The landfill was also included among the potentially contaminated sites in the Regional Reclamation Plan. The choice of a naturalistic approach was the result of soil tests carried out directly on the surface of the landfill and on surrounding areas which have completely refuted this hypothesis, attributing the alterations of the metals intercepted in the soil, including Beryllium, Lead, Zinc and Thallium, uniquely to its geological composition (Ecoremed, 2015, 2017). Therefore, the experimentation has opted for the use of phyto-technologies aimed at the safety of places and restoration of biodiversity, also helping to meet the needs of landscape reconfiguration in an uncontaminated context.

To implement the phyto-remediation process, the EIS selects agronomic proposals typical for the place and suitable for this purpose. Hyper-accumulative species (e.g., Cannabis Sativa, Arundo Donax, Poplar) can function as a high buffer in the presence of potential pollutants. Among the proposed species, hemp, within regenerative practices of landscape, has direct benefits from an environmental point of view, but also indirect effects on the economic and social dimensions. The innovative component of the EIS is not so much product innovation as process innovation, which allows the strategy of action to be oriented towards circular perspectives. As for the product, the use of hemp is oriented towards reuse at the end of the life cycle of the crop.

This perspective is closely linked to what constitutes the EIS innovation in terms of process. As a result, the introduction of a short supply chain allows to combine the agronomic development of new crops with the recovery of the specific area considered. Moreover, the proposed solution aims to promote a local circular economy, potentially improving employment opportunities.

At local scale, the trigger of the short supply chain is also favoured by the second EIS. The latter is linked to the collection and treatment of organic waste, and it was developed synergistically to the previous for the realization of the first mentioned *new soils* (Garzilli et al., 2020; Russo et al., 2019). In this case, the innovative component lies in the hypothesis of placing medium-size treatment plants for the organic waste within "enabling contexts" mapped into peri-urban areas (REPAiR, 2018, p. 26). Such a position between the city and the countryside and the dimension of the treatment plants allow to strengthen that "deal" (PPTR Puglia, 2015) (Fig. 3.2). It can also project this territory into a condition of productive landscape design. The *new soils* not only define new living spaces, but also reshape the territory by defining new morphologies. Dealing with organic waste in treatment plants located in the urban–rural interface (peri-urban) are configured as drivers of new local economies (Allen, 2003). The reuse of organic waste for the production of compost km0 and the creation of a neighbourhood plant (visually and technologically less impacting the territory) can define a thickening of the buffer of this fragile interface.

Thus, wastescapes shift from fragile context to productive land. The treatment and recycling of the material produced on-site are configured as functional to the production of compost to be used for agricultural and productive purposes as well as soil for naturalization and environmental mitigation.

3.5 Conclusions

This paper has investigated a semantic subversion of latent peri-urban space by accentuating its potential value, and encouraging its transition from a risk capacitor to a vector of productivity and innovation on a large scale. By going beyond the established concept of peri-urban territory as a chaotic mosaic of dilapidated and ecologically compromised areas, our paper has proposed a reinterpretation in terms of potential and innovative resources aimed at the urban and landscape project by reactivating the underlying and intrinsic values of the peri-urban.

Particular emphasis has been placed on the mechanisms of regeneration and reclamation of places, because they have been understood as essential processes and materials of the urban project and internalized in a more circular and sustainable operational perspective. We have argued that it is necessary to return the wasted land back to citizens, and to trigger inclusive regeneration processes. In addition,

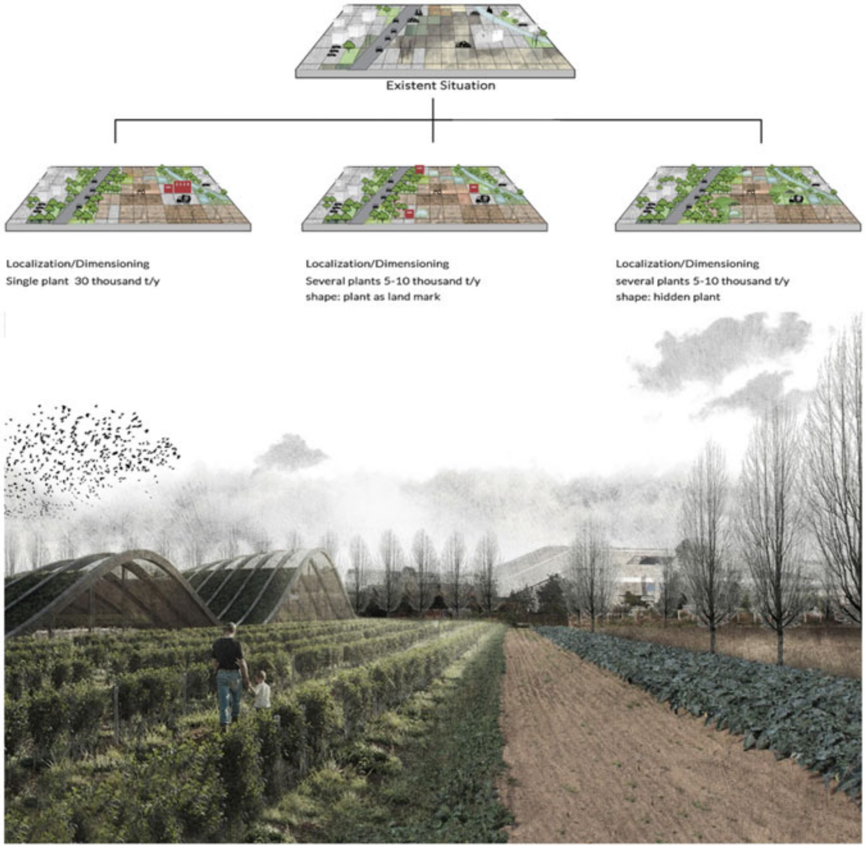

Fig. 3.2 Scenarios for the localization of the treatment plants for the organic waste. Elaborated for the Knowledge Transfer for the REPAiR PULLs. Concept and Graphic by Francesca Garzilli, 2019. Vision of hidden treatment medium-size compost plant, creation of new productive peri-urban borders. Concept image elaborated by Francesca Garzilli and Valentina Vittiglio; Graphic by Luca Esposito, 2019

unlike traditional and sectoral approaches to environmental recovery and regeneration, such operations cease to be regarded as servile fulfilment for project development. On the one hand, they mitigate the risk caused by contamination. On the other hand, they outline a new landscape, made up of common values, future visions, new opportunities and eco-based innovations.

The action in the peri-urban context becomes a driver of proactive change useful to imagine. It also defines operational lines hinged on propositive and strategic vision able to systematize the physical-spatial dimension with the environmental and socio-economic ones.

The technological integration of sustainable products and practices, associated with strategies and processes of territorial regeneration at a larger scale, allows these actions to be included in broader frameworks.

With targeted and integrated actions, a territorial fragility, a scrap of territory, torn and compromised, can be reactivated and stitched. The peri-urban becomes a territory of practices where to test and practices bottom-up and new local economies based on a sustainable and circular development of the territory. Such practices are considered able to face global issues such as the supply of food and energy, which weigh on urban metabolism, or the mitigation of risks related to human activities.

Therefore, this space "in transition" is configured as a preferential and priority field of action. Thus, looking at it through an ecological lens, allows us to orient towards the development of operational strategies that, focusing on sustainable regenerative solutions, lead to new life cycles, helping to increase its resilience.

Acknowledgments This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 688920. This article reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains. Horizon 2020 European research project.

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Chapter 4
The Circular Metabolic Urban Landscape: A Systematic Review of Literature

Chiara Mazzarella and Libera Amenta

4.1 Introduction: The Transition Toward Circular Metabolic Urban Landscapes

This chapter examines some recent issues that emerged in the last ten years with respect to the integration of Urban Metabolism (UM) studies in territorial contexts. Even if the Circular Economy (CE) objectives are at the center of the European political agenda, however, worldwide the circularity gap is still massive. In fact, only 8.6% of the world's production activities are circular (Circle Economy, 2021), while the rest is still following linear and unsustainable paths. This way, the definition of waste as a resource—as promoted by CE principles (Ellen MacArthur Foundation, 2015, 2017; European Commission, 2018)—can be improved and become even wider, by also embracing the need for the regeneration of depleted territories. Thus, it seems relevant to include, in the transition toward circularity, a specific focus on the reasoning on the socio-environmental regeneration of wastescapes (Amenta, 2019; Amenta & Attademo, 2016; Amenta & van Timmeren, 2018; REPAiR, 2018b), which are understood as still open research fields for the investigation of UM and circularity applied to the territory.

This study is rooted in the awareness of the increasing spatial complexity and linear development of European urban systems; these are intermingled with resource scarcity, and a growing level of integrated risks, which embed socio-environmental threats as well as human health-related issues. These challenges are making contemporary cities extraordinary laboratories where it urges to develop, experiment and test Eco-Innovative Solutions and Strategies (REPAiR, 2018a) to enhance the quality of life of all, by reducing risks, and without compromising a flourishing development for

C. Mazzarella (✉) · L. Amenta
Department of Architecture (DiARC), University of Naples "Federico II", Naples, Italy
e-mail: chiara.mazzarella@unina.it

L. Amenta
e-mail: libera.amenta@unina.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_4

the entire ecosystems. In the EU "Eco-Innovation Action Plan" of 2011 (EC, 2011) there is the aim to trigger eco-innovation while reducing environmental depletion. According to the EC definition, "Eco-Innovation is any form of innovation resulting in or aiming at significant and demonstrable progress toward the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources" (from Decision N° 1639/2006/EC establishing a Competitiveness and Innovation Framework Programme).

The management of production and material disposal chains is deeply influenced by design choices, both on a small and large scale, from interior design to spatial and landscape planning. In this direction, this study explores the state of the art on UM, integrating the spatial dimension of landscape planning and design, considering some open issues, practices and solutions useful to support the work of designers (architects, engineers, planners and landscape architects, conservators) for the transition to circular cities. To achieve this goal, this research aims to show, through a Systematic Review (SR) of the literature, how CE investigations cannot be decoupled from Urban Metabolism (UM) studies, keeping included the landscape dimension, and the planning and design approach. New challenges and different skills are required for designers and planners for understanding and managing sustainability and CE in urban landscapes. To implement a *regenerativescape* (Cerreta et al., 2020c), the focus is no longer just on the built environment; otherwise, the latter can be seen in a systemic perspective, including also the landscape of flows that pass through it, and considering the territorial dimension of UM (Grulois et al., 2018).

Thus, the need for urbanists, architects and decision makers to solve the lost balance and equilibrium between resource management and healthy living conditions for all, means to focus on several aspects at the same time, by working throughout different scales and from different perspectives to contemporary territories.

First of all, the sustainable functionality of the UM (Ferrão & Fernandez, 2013; Kennedy et al., 2007, 2011; van Timmeren, 2014; Wolman, 1965) can be explored to experiment effective ways in which to implement a real shift from the actual linear model to a circular one (Amenta et al., 2019; Lucertini & Musco, 2020). The operational capacity of the urban landscape depends on the nature and management of its metabolic flows, also including the flows of people. Permanent and temporary dwellers of an area determine the economic activities that take place in urban areas, and vice-versa. Buildings define the inhabited environment in its material component, which includes architecture, infrastructure, and every area of the urban landscape. Altogether they define the urban ecosystem, which strives for circularity to be able to be more resilient over time.

Secondly, for implementing an actual transition to a circular city model, there is the need to apply a closure of production processes through looping actions, by improving and connecting supply chains, re-cycling avoidable waste and transforming them into new resources. This approach is founded on the CE conceptualization (Geissdoerfer et al., 2017; Kirchherr et al., 2017; Korhonen et al., 2018), which originally was developed for industrial processes and did not have a spatial dimension yet. Finding its main origins back in the 1970s, the concept of CE has been continuously enriched over the years by the contribution of different authors belonging to different schools of thoughts (EC, 2014) in the contexts of e.g. Green and Bio Economy (D'Amato et al., 2017), Cradle to Cradle (Braungart & McDonough, 2009), Industrial Ecology (Ayres & Ayres, 1996), Regenerative Design (Lyle, 1994), and Doughnut Economy (Raworth, 2017).

Even if a clear definition of circular city is still missing (Paiho et al., 2020), however there are several examples of European cities moving toward it. Particularly, the city of Amsterdam, in the Netherlands, is working in the direction of an actual implementation of circularity principles in its policies, with the implementation of the "Amsterdam Circular Strategy 2020–2025"; in this policy, the Municipality of Amsterdam recognizes the importance to prevent waste and to develop within the planetary boundaries (Gemeente Amsterdam, 2020). Recently, scholars like Williams (2019) showed the importance to explore the urban dimension of circularity and the need to focus on cities and land, besides that only on materials when working on CE.

Both the approaches of UM and CE are based on the use of circularity to move toward sustainability, hinting that circular solutions are not in themselves always sustainable; as an example, UM and CE have been recently coupled in an integrated approach indicated as the "New Urban Framework", useful for interpreting and planning the contemporary cities, which are becoming increasingly complex (Lucertini & Musco, 2020).

This research aims to show how closing resource loops of production cycles is just not enough; in fact, the implementation of a circular metabolic resource management in urban areas involves the restoration of a balance between citizens well-being, urban structure and the natural environment from which it draws (often non-renewable) resources, materials and energy.

Recovering metabolic wasted resources and territorial waste ask for a systemic approach, which implies the employment of the different skills belonging to different disciplines. Yet the application of the CE principles to the territory to achieve a circular city requires the combination of strategies foreseen within the UM and Landscape approaches, e.g. human ecology of social sciences, industrial ecology with the study of the Material Flow Analysis, urban political ecology, as well as the Landscape Ecology (Grulois et al., 2018).

To do so, this research poses the following main research question:

RQ1: Which study and research topics on Urban Metabolism (UM) and Circular Economy (CE) are significant in the practices of architects and planners for the transition to *Circular Metabolic Urban Landscapes*?

This main research question is unpacked through the following sub-research questions:

RQ2: Which methodological approaches and tools have been implemented in the field of resource-based urban studies linked to the spatial planning and design?

RQ3: Which are the main research strands related to circular UM and spatial planning to be considered in the transition toward circular cities?

In Sect. 4.2 of this chapter, the methodology and the research design are presented; Sect. 4.3 gives the results of the research themes emerging from the Systematic Review (SR) of the literature, and in the end, in Sect. 4.4, results are discussed, and future open lines of research are presented in the conclusion.

Overall, this chapter, by exploring the Circularity in Urban Landscapes, deals with a perspective able to operationalize sustainability in cities; by doing so, the upcycling of material and territorial waste is integrated and it can be understood as a potentiality for the sustainable regeneration of cities.

4.2 Methodology and Research Design

This research has been developed through a Systematic Review (SR) of the recent literature, aimed to establish an overview of the research on UM studies over the last ten years. This has been done with a specific focus on urban studies oriented toward the transition to the CE. The approach identified in this paper follows the 4-steps methodology of the reviews set out by scholars like Yigitcanlar (Yigitcanlar et al., 2019) and Md. Golam Mortoja (Mortoja et al., 2020). Both ways are consistent with the objectives of this research, as they are SRs based on qualitative and not statistical analysis and have a research question related to the city and studies on the territory.

Thus, the research methodology of the SR carried out follows the following steps (Table 4.1): (1) Identification, (2) Screening; (3) Eligibility; (4) Inclusion.

The identification step (step 1) was about the selection of appropriate keywords. The keywords identified are "urban metabolism", "circular economy", "circular city", "planning", "landscape", "architecture", "design", "wastescape". They were determined and set as search string criteria to address the main research question by pointing out significant topics in the urban planning and design for the transition to circular cities. The research has been run through the Scopus database for the last 10 years (2010–2020). The Boolean search has been used as an effective way for information retrieval, allowing users to combine keywords with operators such as AND to concatenate, NOT to exclude and OR to include either all the keywords (Bello Aliyu, 2017). It was set up as: (["urban metabolism"] AND ["circular economy" OR "circular city" OR "planning" OR "landscape" OR "architecture" OR "design"]), to 15 September 2020. This search initially produced 323 results (step 1). As inclusion criteria, only scientific articles published in English scientific journals indexed by Scopus and available online were selected. Thus, books and reports were excluded, reducing the number of papers to 250 results in the screening (step 2) (Table 4.1).

Eventually, from the resulting matrix, all titles, abstracts and keywords were read using the eyeballing technique to elect some relevant articles deemed useful for answering the research question. Following the selection criteria (Table 4.2) the final group of articles has been outlined.

Excluded studies correspond to those that are not immediately related to the disciplines of urban studies and design of the built environment, being, for instance, merely associated with resource management, without exploring at all the spatial dimensions.

Table 4.1 Literature selection procedure

N.	Methodological step	Description
1.	**Identification**. Definition of search criteria and literature database	Records identified through the database Boolean search ([“urban metabolism”] AND [“circular economy” OR “circular city” OR “planning” OR “landscape” OR “architecture” OR “design” OR “wastescape”]) Database: Scopus ($n = 323$)
2.	**Screening**. Funnel selection from the total number to those read and analyzed for relevance to the research question	Records excluded (books, chapters, conference proceedings, editorials, articles not in English) ($n = 250$ Scopus)
3.	**Eligibility**. Critical selection of articles on the basis of their relevance to the topics related to the research questions	Full articles assessed for eligibility ($n = 44$) [The records excluded have been considered less relevant to the research aims]
4.	**Inclusion**. Selected articles	Full extra articles included in qualitative analysis ($n = 5$). The total number of selected articles ($n = 49$)

As an example, most articles that deal exclusively with solutions for the engineering management of water and energy have been dismissed from this study, even though the authors acknowledge the relevance in the context of metabolic processes. This aforementioned selection aims at restricting the analysis to some significant issues and aspects related to the transition toward circular cities. In addition to exclusion criteria, the SR foresees a subjective selection made by the authors, which could be a weakness point in the methodology by excluding articles that are apparently not coherent in relation to the research question (Snyder, 2019). The third step resulted in a group of 44 articles. Finally, with respect to the group of selected articles, it was considered appropriate to include some articles from the literature that indirectly emerged from the search carried out. The final number of articles studied and analyzed was therefore 49.

The papers identified were read and reviewed according to the identified criteria (Table 4.2). Following the research question, this SR pinpointed the main fields of

Table 4.2 Selection criteria for the screening of the papers

N.	Selection criteria
1.	Determination of the key issues and open questions on UM in recent urban studies (last 10 years)
2.	Identification of approaches and tools useful for a better management of UM in urban contexts
3.	Relationship between the main research and interdisciplinary topics
4.	Applications and tests of UM research in urban studies and research projects
5.	Research and studies that explore the paths to follow for the transition toward circular cities

investigation on the UM topic, addressing it either directly or indirectly.

From the aforenamed identified criteria, the SR has been developed. Therefore, the selected papers (i) address the key issues and the open questions on UM in recent urban studies, (ii) explore developed and tested approaches and tools useful for a better management of UM in urban contexts, and (iii) define the still open topics dealing with the UM research in urban studies and research projects, as well as (iv) explore the paths to follow for the transition toward circular cities. They raised numerous topics, comprising theoretical and methodological issues, instruments of investigation and applications in case studies. At the end of the iterative study process, the subjects have been classified into five categories:

1. Theories and goals, including theoretical developments, targets and approaches to the topics;
2. Planning and design approaches, materials, methods and tools, that mainly focus on urban issues considering UM;
3. UM approaches, materials, methods, and tools, that start from resource management to deal with spatial planning or design;
4. Interdisciplinary research and applications, that combine the previous categories (2) and (3);
5. Open issues: some unresolved problems raised from research, that can be the basis for future investigations.

The analysis has been carried out with the platform Atlas.ti (Scientific Software Development GmbH, 1997). It is a software supporting qualitative analysis (Hwang, 2008), that also allows the construction of clusters of codes, that are resembling categories of subjects. Codes are specific words by which the most common and important subjects of the papers have been highlighted, after the quoting phase in Atlas.ti. Grouped in the five categories pointed out, the codes (i.e. subjects) have been identified both in a deductive approach, based on ex-ante considered research questions, and in an inductive approach, resulting from the study of the selected papers. The final 80 subjects coded in the study of the papers in Atlas.ti were grouped into the mentioned five groups (i.e. categories). The system of relations linking the different subjects is expressed through a semantic network of subjects, in a global vision on the landscape of literature.

4.3 Results: Themes and Challenges of UM Studies for Circular Cities

The research topics in the reviewed literature mainly include studies and applications that combine several fields of knowledge; moreover, they primarily pose the challenge of integrating tools for analysis and support of different disciplinary fields. To carry out the SR, the subjects identified in the study have been grouped into five wide categories (Fig. 4.1): (1) theoretical issues, (2) UM materials and methods,

Fig. 4.1 Groups and codes of the review in Atlas.ti

(3) Planning and Design materials and methods, (4) interdisciplinary studies and applications, (5) open issues.

The theoretical frameworks considered in the literature review identify similar theoretical backgrounds. The objectives of sustainability, resilience and/or circular city pursue the common goal of improving environmental quality and well-being in urban areas and reducing negative impacts on the surrounding environment (Agudelo-Vera et al., 2012; Amenta & Qu, 2020; Roggema & Alshboul, 2014; Saha & Eckelman, 2017; Serrao-Neumann et al., 2017; Van den Berghe & Vos, 2019; Venkata Mohan et al., 2020). This is consistent with sustainable development and green growth ideas, both at the macro and the micro-scale. In fact, none of the papers reviewed considers the concept of degrowth or other CE diverse visions of the sustainability concepts (Calisto Friant et al., 2020), neither they put current economic growth models into question (Hickel & Kallis, 2019). Social issues, urban equity and social fragility are considered sometimes together with urban planning than resource management (Kasper et al., 2017; Ramaswami et al., 2012; van Timmeren et al., 2012). Social dimension of CE is also recognized as an important field of study to be further explored (Kennedy et al., 2011). The Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) is also considered significant since it put together the social study of changes of human time in labor and land use patterns (Lu et al., 2016).

The increasing relevance and complexity of the UM concept is due to the many different disciplines which it encompasses, and also to the several opportunities for sustainability implementation on cities (Broto et al., 2012), but synergies between networks are increasingly required. Even if circularity is not always the core of UM studies, the multidimensional benefits over the dominant model of linear metabolism are evident (Agudelo-Vera et al., 2012; Broto et al., 2012; Chrysoulakis et al., 2013; Ivanović, 2020; Kennedy et al., 2011; Leduc & Van Kann, 2013; Roggema & Alshboul, 2014). Theoretically, Van den Berghe and Vos (2019) recognize that the concept of circularity could balance both functioning and design of cities, but the dichotomy between design and functioning is paradoxically accelerating the use of *space as a location*, more than the *organization of space* in the urban transition toward circularity (e.g. in their cases studies in the Netherlands).

Urban and landscape planning and design studies implicate multiscale and multidimensional approaches. It is relevant to carry out the metabolic analysis at regional planning (Galan & Perrotti, 2019) as well as at different scales including urban metabolism principles in decision-making (Longato et al., 2019) and in design.

Land use changes the impact of residents and the metabolism of an area (Wang et al., 2016), while land use planning and design can be a significant tool to improve the Circularity of UM. For this reason, impact evaluations depend on urban form, functions and building stock (Ivanović, 2020). Looking at which components of the urban landscape and which urban-related topics are most investigated, through this study emerged that they are regional infrastructures, green infrastructures (Perrotti & Stremke, 2020), buildings (Arora et al., 2020), commercial centers (Sgobbo, 2017), city ports (Cerreta et al., 2020a; Gravagnuolo et al., 2019; van Timmeren et al., 2012), urban topics and landscape design (Juwet & Ryckewaert, 2018; Marin & De Meulder, 2018a), urban landscapes (Pistoni & Bonin, 2017) and wastescapes (Amenta & van Timmeren, 2018; Castigliano et al., 2020).

To assess projects performances, ecological indicators for UM (D'Amico et al., 2020), Ecosystem Services (Elliot et al., 2019; Penazzi et al., 2019; Perrotti & Stremke, 2020) and circular cities indicators (Cerreta et al., 2020a; Gravagnuolo et al., 2019) are analyzed in many cases as tools for monitoring the performance of plan and project choices.

Many of the software and platforms for spatial—decision support systems (DSSs) use GIS-based tools for landscape mapping and spatial data management. For instance, the Spatial Allocation of Material Flow Analysis (SAMFA model) is a DSS to allow multiple stakeholders to identifying significant material and energy use in the development of targeted planning strategies, and visualizing different scenarios (Roy et al., 2015). In a similar way, the Geodesign Decision Support Environment (GDSE) is a Spatial DSS based on collaborative process, that enable multiple stakeholders in resource flows and stock, including materials and waste management in spatial contexts, by implementing *eco-innovative solutions* for looping actions at intermunicipal scale (Arciniegas et al., 2019; Remøy et al., 2019). These kinds of tools represent significant Spatial DSSs to be further implemented in future developments, and combining evaluation maps for the spatial circular regeneration of urban areas, landscape and wastescapes (Cerreta et al., 2020b). The studies analyzed consider the social dynamics and the social involvement in planning in different ways: the co-creation processes in Urban Living Labs, allow stakeholders and local actors from provate and public sectors to take part in urban strategies development oriented to circularity (Amenta et al., 2019; Remøy et al., 2019), study workshops with students (Amenta & Qu, 2020), or involving stakeholders in real case studies implementing eco-solutions (Sgobbo, 2017).

The basis of UM studies is the awareness of the limitedness of ecosystems and the optimization of their available resources. Metabolic resources, i.e. energy, water, and materials, and in the CE perspective also all related waste, production and consumption need to be assessed. Thus, the Life Cycle Assessment (LCA) and the Material Flow Analysis (MFA) are the main methods for estimating the impacts of supply chains and balancing the resources used by a system. In urban circularity, materials stocks and flows management need to be mapped and described, to make them available for second uses. Harvest of resources techniques are widely explored, for water and energy management (Agudelo-Vera et al., 2012), for urban mining (Kuong et al., 2019) and the sustainable construction industry (Hossain et al., 2020); they are the premise for a resource-based design (Jongert et al., 2011).

Energy issues are at the heart of urban studies aiming for greater urban sustainability (Juwet & Ryckewaert, 2018; Lombardi & Trossero, 2013; van Timmeren et al., 2012). Beyond energy, the available resources are water, materials and, from the circular economy paradigm, waste, but also space, land and the built environment in general. The management of resource flows and stocks affects every spatial fragment of the city and landscape and determines its environmental performance.

The interdisciplinary studies and applications address resource management in spatial contexts, both for efficiency and for the implementation of sustainable technologies and the best urban form and design.

Evaluations are at the core of interdisciplinary researches and applications, as The Metabolic Impact Assessment for urban planning (Pinho et al., 2013) proposes a synthesis of evaluation methods and considers the land together with the metabolic resources in the SUME project (Davoudi & Sturzaker, 2017). Similarly, landscape design (Marin & De Meulder, 2018b; Oliveira & Vaz, 2020), wastescapes regeneration (Amenta & van Timmeren, 2018) and built environment as resources for improving UM set a nexus between UM, planning and design (Davoudi & Sturzaker, 2017; Liu et al., 2017). The use of UM models for design is cogitated (Roggema & Alshboul, 2014), also jointly with the regenerative design approach by Thomson and Newman (2018).

Several research projects explored resource management in urban contexts and have been case studies in the selected papers of the literature review, i.e. DIEMIGO 2.0 (van Timmeren et al., 2012); SWITCH—Sustainable Water management Improving (Agudelo-Vera et al., 2012); SREX—Synergy between Regional Planning and Exergy (Leduc & Van Kann, 2013); BRIDGE—sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism (Chrysoulakis et al., 2013; Mitraka et al., 2014); REPAiR—Resource Management in peri-urban areas (Remøy et al., 2019). These studies consider territory, landscape, wastescapes and the built environment as resources for an improved metabolism (Amenta & van

Timmeren, 2018; Amenta & Qu, 2020; Arora et al., 2020; Ivanović, 2020; Marin & De Meulder, 2018b; Tanikawa & Hashimoto, 2009). The characteristics of interdisciplinary research and applications are demonstrated by the different DSSs and software developed ad hoc, but also through the combined use of classical UM and spatial analysis tools. GIS-based tools are fundamental in the management of mapping working with spatialized data, as well as for the monitoring of environmental data related to landscape projects. The issue of resource management is at the basis of UM integration in planning. In fact, resource-based design means both starting from the evaluation of a balance of metabolic resources available in a certain urban or territorial area, but also considering the building stock and soil as finite resources to be optimized in their ecosystem performance.

Open issues on the transition toward circularity are mainly about the lack of a clear and unique definition of CE, and of what is a circular city. The regulatory level is lacking clear norms about how to implement circularity principles. In fact, public policies are not specific yet about that, and more clear indications on it would help stakeholders and architects in their daily practice.

Another important finding of this research is that the use of data for indicators depend on national, regional and local monitoring and data availability.

All the identified subjects can be analyzed through the semantic network of relationships (Fig. 4.2). The latter has been assembled by linking the 80 codes identified in the five groups, defining their mutual relationships, in a semantic network. Some subjects are key concepts in the perspective of reviewed studies: the relevance of circularity, the centrality of the resource flows and stocks and their integration in planning, the idea of space as a resource, the evaluation of land use functions, finally tools and DSSs that link UM assessment with spatial planning.

Starting from a UM interpretation and centralizing it in the objective of this research, the relationships emerging from the semantic network show a convergence of research in addressing the multidimensional and multiscale topic of the resource management with multiple tools, with the aim of pursuing sustainable development.

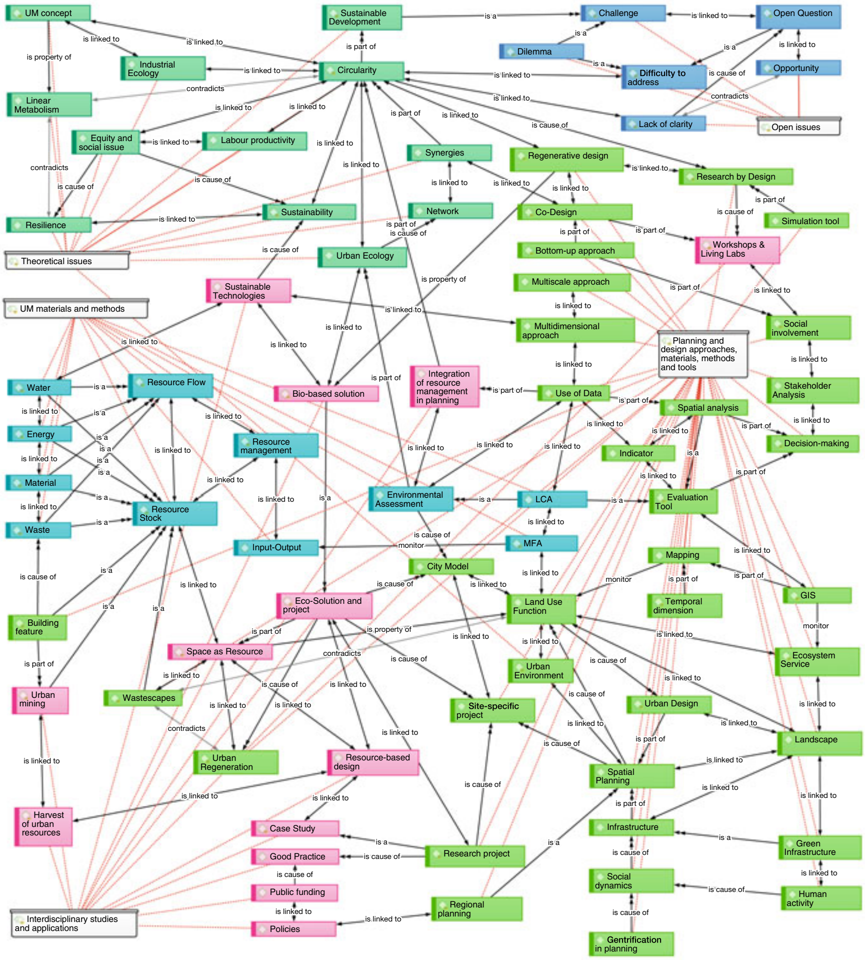

Fig. 4.2 Semantic network of groups and topics emerging from the Systematic Review of Literature elaborated with Atlas.ti

4.4 Discussion and Conclusions

This research has investigated the (still open) research fields which have been focusing recently on the transition toward circularity. To do so, through a Systematic Review of the scientific literature of the last ten years, it analyzed a group of papers that addressed the issues of Urban Metabolism (UM) management in the spatial perspective of the Circular Economy (CE).

The investigation started from a main research question (RQ1):

RQ1: Which studies and research topics on UM and CE are significant in the practices of architects and planners for the transition to *Circular Metabolic Urban Landscapes*?

Circularity and sustainability are seen, in this research, as two increasingly overlapping wide goals and associated with systemic and regenerative design objectives in studies with a holistic approach to metabolism.

The analyzed literature revealed that the main theoretical and open issues, explored in the selected literature, are about the integration of resource metabolism management in urban studies and associated applications. Indeed, UM material management and related methods of material balances (input–output, MFA) and impact assessment (environmental assessments, LCA), have been combined with approaches, methods and tools for planning and design of landscapes, wastescapes, cities and buildings, like mapping and spatial strategy design. This study unraveled how certain researchers have combined several methods to create spatial decision support tools, useful for the assessment of metabolic resources (MFA) and assessment of impacts of supply chains (LCA), and considering land use functions, which highlight the resources available on a certain territory.

Following, the study carried out in this chapter focused on the two sub-questions below (RQ2 and RQ3):

RQ2: Which methodological approaches and tools have been implemented in the field of resource-based urban studies linked to the spatial planning and design?

In the ecosystem approach, networks and synergies lead to the consideration of multiscale and multidimensional approaches. According to the different case studies, strategies for CE are applied both in bottom-up (as it is happening for circularity in China) and top-down strategies (through e.g. workshops and co-design Urban LLs in Europe).

The disciplinary integration is supported by GIS tools, which allow to manage spatial data, and which can be combined with the study of urban and landscape morphology, by integrating sustainable urban technologies, spatial planning, regenerative design, and green infrastructure design.

RQ3: Which are the main research strands related to circular UM and spatial planning to be considered in the transition toward circular cities?

Some model frameworks and tools as general methodological approaches to CE implementation and DSSs have been developed aiming to clarify the links in processes and to simplify the understanding of the resource at stake. While the mapping of land use functions and spatial data are globally used systems in planning, conversely, the mapping and understanding of metabolic resources is still fragmented and depends on the quality and quantity of open data available in different geographical areas. To cope with this issue at the local scale, mapping systems for resource harvest can significantly support urban mining and resource use optimization. The reviewed studies clarify that resources stocks and flows for circular cities are both metabolic and spatial. Thus, resource-based design, or design with flows, is possible through the tools and integration of methods, developing interdisciplinary studies and learning from applications in different case studies. Good practices, eco-solutions and projects, bio-based solutions, sustainable technologies are not only of concrete value, but also represent a learning experience. The social dimension is highly present in these processes, whether considering human activities, labor productivity, the effects of planning policies on inhabitants or involving different public and private stakeholders in the Urban Living Labs environments. Much of the application and research experiment by combining the classical methods of metabolism study (MFA, LCA, energy balances) are connected with different planning methods (models, GIS, collaborative/participatory planning, mapping, spatial study projects). Theoretical research mostly tends to define new frameworks to facilitate synergies and networks.

Therefore, the implementation of the CE in urban areas requires a series of strategies starting from the revalorization of all the available resources, including waste and wastescape, to be integrated within policies and programs for the management of urban ecosystems.

Given the delicate balance of coexistence between anthropogenic dynamics and the environmental system, urban challenges and metabolic processes should be re-oriented as integrated processes in the transition toward circular cities. UM resources shape the scenarios of human activities that determine trade and land use functions; metabolic flows are themselves raw materials for the construction of sustainable landscapes and urban environments.

The challenges related to that are multidimensional: on the one hand, national and local policies are still unclear with respect to circular (material and territorial) resources management; on the other hand, many large cities are oriented toward sustainability but not ready yet to comply with the many challenges of the CE approach. Besides, the role of cultural aspects do not yet seem to be sufficiently addressed yet in the discourse of resource management for UM optimization in spatial contexts and urban environment.

In conclusion, this research points out the necessity to make CE, including its spatial dimension, even more operational on the ground. This could be done, first of all, by including the concept of land and landscape as resources, by including the wastescapes in the wide shared conceptualization of waste, and understanding their value as innovative resources; secondly, it seems necessary to clarify regulatory ambiguities, to improve the integration of tools and DSSs to simplify the resource management, planning and design processes. Many countries are waiting for laws to facilitate looping actions. Analyses of UM with urban studies and design cover different disciplinary fields to manage the spatial impacts of circular solutions on landscapes. Understanding and integrating these disciplines can enable engineers, environmentalists, architects, urban planners, politicians and local stakeholders to work together on common ground for regeneration toward a more circular urban landscape, increasingly taking into account the needs of local communities.

Acknowledgements Authors thank Professor Maria Cerreta, from the University of Naples Federico II, for her feedback on this paper.

Author Contribution Both Authors Chiara Mazzarella (C.M.) and Libera Amenta (L.A.) substantially contributed and agreed to the final version of this chapter. Specifically, Conceptualization, C.M. and L.A.; Methodology, C.M. and L.A.; Software utilization C.M.; Validation, C.M., and L.A.; Formal Analysis, C.M.; Investigation, C.M.; Resources, C.M. and L.A.; Data Curation, C.M.; Writing—Original Draft Preparation, C.M. and L.A.; Writing—Review and Editing, C.M. and L.A.; Visualization, C.M.; Supervision, L.A. However, L.A. wrote the part "4.1 Introduction: The Transition Toward Circular Metabolic Urban Landscapes"; C.M. wrote the parts "4.2 Methodology and Research Design" and "4.3 Results: Themes and Challenges of UM Studies for Circular Cities"; the final part: "4.4 Discussion and Conclusions" is the result of a joint writing process by C.M. and L.A.

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Chapter 5
Urban Manufacturing for Circularity: Three Pathways to Move from Linear to Circular Cities

Birgit Hausleitner, Adrian Vickery Hill, Teresa Domenech, and Víctor Muñoz Sanz

5.1 Circular Economy in Cities in the Making

The world has become increasingly urbanised. Around 60–70% of the world's resources are consumed in cities and cities produce around 50% of all waste. More importantly, these trends are expected to exacerbate in the future, meaning that cities play a key role in leading the transition towards sustainability and more circular pathways of resource consumption (UNEP, 2017). Cities are the places where the distance between supply and demand can be shortened and where the concept of waste can theoretically be thrown away. Despite many cities launching circular economy policies, many are ill-equipped to roll it out because of the lack of suitable space and instruments to realise this.

Traditionally, the space and skills for processing large volumes of materials and goods were associated with industrial land and manufacturing. Urban manufacturing and manufacturers play a vital role in delivering circular economy ambitions through processing materials, providing skills and technology for repair or reconditioning goods and the capacity to deliver innovative technology (Domenech

B. Hausleitner (✉) · V. Muñoz Sanz
Department of Urbanism, Faculty of Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands
e-mail: b.hausleitner@tudelft.nl

V. Muñoz Sanz
e-mail: v.munozsanz@tudelft.nl

A. V. Hill
Osmos Network, Amsterdam, The Netherlands
e-mail: adrian@osmosnetwork.com

T. Domenech
Institute for Sustainable Resources, University College London, London, UK
e-mail: t.domenech@ucl.ac.uk

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_5

et al., 2020). However, since the 1960s and particularly since the 1970s, manufacturing was offshored (Urry, 2014). As a result, the footprint of manufacturing has shrunk radically in many developed cities, in favour of service-oriented and more mono-functional spaces. This has resulted in the separation between production and consumption spaces, with highly linear urban systems that rely heavily on their hinterland.

Despite volumes of policy and ambitions (Hill et al., 2018), there are very few signs that radical change is occurring (Circle Economy, 2020). This is unsurprising, considering that urban real estate is generally expensive (Van den Berghe & Vos, 2019; Williams, 2019) and large sites are scarce. Not all aspects of a product cycle are profitable, meaning that regulation or subsidies are required to cover the shortfall (CoM Brussels, 2019). Furthermore, there is often a need for new forms of collaboration (Sposato et al., 2017) to occur and to change policy and consumption habits (Sesini et al., 2020). Finally, public policy may be necessary to counter impulses that generate waste in the first place. Cities that are now looking at industrial-scale production to address circular economy locally are faced with a range of complex challenges such as defining how it should happen, where it should happen and what will be required to make it happen (Hill et al., 2018).

Urban environments are complex systems. The three narratives we address in this chapter, (1)circular economy, (2)spatial and (3)social and institutional, each have their dynamics and influence each other. Understanding the forces and problems occurring between these narratives requires the integration of knowledge from different realms. Urban manufacturing, and by extension, the circular economy, draws on a vast range of issues, such as logistics, resource management, urban planning and design, business and entrepreneurship, financing and innovation. Addressing such a complex topic requires academics, practitioners and local actors to look outside of disciplinary and institutional (or organisational) boundaries (Brandt et al., 2013). This presents a fundamental question: how can collaboration occur between actors with very different interests, expertise and knowledge?

The main challenge is that actors generally carry institutional and disciplinary baggage that influence how problems are interpreted and solved. This means that each actor involved will bring a different focus, priorities, mindset and language. Diversity of perspectives can render a project complex, but this complexity can also provide a richness to strengthen dialogue, collaboration, and even alignment if harnessed (Ramadier, 2004). The articulation of these different ways of reading and interpretation is a relevant step towards an integrated approach for both urban manufacturing and circular economy in cities.

However, transdisciplinary thinking can also result in further complexity or oversimplification. A framework is necessary that allows for both an exchange of knowledge and the capacity to address (technical) detail. Within the context of the research project Cities of Making (CoM), Hill et al. proposed in Foundries of the future (2020) a framework to facilitate the dynamic interactions between these layers and create leverage points for urban reindustrialisation towards circularity. A pattern language forms thereby the transdisciplinary mediation and co-creation instrument.

This chapter elaborates how different actors from different backgrounds and interests, read urban conditions differently (part two of this chapter) and how their readings can converge into a transdisciplinary instrument via collaboration (part three of this chapter). The developed instrument can help to address circular economies in cities with urban manufacturing more integral.

5.2 Three Readings of Urban Conditions

Over the following pages, we illustrate three pathways—three ways of addressing urban manufacturing, and by extension, circularity, within urban areas. These pathways were put central in the research of the CoM project to triangulate the facilitation of urban manufacturing from the perspectives of (1) material flows and technology, (2) spatial design, (3) people and networks.

The circular economy narrative often focuses on the flows of resources and understanding how these resources are extracted, processed and managed (during and after their use life). All these processes are mediated by technology, including know-how and technical competence, and importantly, considering the value network associated with the way resources are used and recovered. We refer to this dimension as 'circularity and technology'. Planners and researchers moving from theory into action, or policy into practice, commonly note that it is challenging to connect available meta-scale data about resources with the reality on the ground about how those resources are transformed, used and then disposed of.

The spatial narrative is concerned with where manufacturing can take place and what qualities a place has to offer. These issues are becoming increasingly crucial for achieving circularity in cities. This narrative is associated with urban design and planning and is referred to as 'urban integration'. It comprises the volumes of spaces, the flexibility of structures, the logistics of using space, the design of the public street space and network, the accessibility to key infrastructure, the environmental qualities, and altogether how the different urban functions can build a sustainable, liveable environment.

The social and institutional narrative relates to the policy, business and working conditions that allow for the production process to occur. This is what we have referred to as 'people, networks and policy' which is connected to sociology, governance, finance and (human) geography. This is a topic that is possibly the most challenging of the three to qualify as it depends heavily on how people interact with space and technology, the workplace culture, taxation and subsidies, local markets but also knowledge of production processes and materials.

Below we will illustrate how each pathway reads manufacturing and by extension the circular economy in cities. The research (2020) was conducted in Brussels, London and Rotterdam/The Hague involving mapping, extensive qualitative interviews and data analysis.

5.2.1 Circularity and Technology

Quantified assessments of the urban metabolism reveal that even highly developed cities such as London or Brussels, not only are producing large quantities of waste but are also very significantly growing their built-in stock, with huge amounts of embodied carbon being added to the socio-economic stock of cities every year (Ekins et al., 2020).

Innovative perspectives introduced by urban sustainability, urban metabolism and circular economy approaches prompt a new interpretation of the urban space. These perspectives offer new ways to reduce consumption of primary resources and minimise waste generation for which maintenance and nurturing of the urban and peri-urban productive base is key. Some characteristics of urban areas linked to scale and agglomeration economies provide the right set of conditions to enable circular approaches and new business models.

While much attention has been given to waste and waste treatment, most transformative elements of circular approaches lay precisely in avoiding waste and management of resources and building stocks. The concentration of structural elements of the technical and built-stock of societies in cities creates new opportunities to extend the life of technical materials and transform cities into resource reservoirs. Electronics is a good example of the opportunities unleashed by the circular economy. Waste electronics is the fastest growing waste stream in the EU. A large fraction of electronic goods is consumed in cities. The use life of electronic products, especially IT equipment, is rapidly decreasing due to changes in technology quickly producing obsolesce. While Extended Producer Responsibility regulations introduce obligations for producers to increase recycling and recovery of waste of electrical and electronic equipment (referred to as Waste from Electrical and Electronic Equipment), based on our observations, a large fraction of these products will not enter formal recycling processes. A range of high-value resources, including precious metals and rare earth, is lost or leaked to the environment (Hill, 2020).

Cities can break the cycle of linearity by nurturing inner loops, of repair and maintenance or outer loops of refurbishment and recycling. For this to happen though, cities have to provide spaces for making that allow bottom-up initiatives to emerge (e.g. Repair cafes) or more formal production spaces to support the recovery of products, materials and components, in a way that they can be recovered back by the city.

This and other examples in areas such as building and building components, textiles and plastics call for a rethinking of the flows of resources in cities and highlight problems associated with the disconnection between consumption and production processes. Greater circularity can only be achieved through a regenerative productive base in cities that help retain components through maintenance, repair and refurbishment, and enhanced data systems that increase traceability of technical components in cities and recover nutrients and energy from biological elements.

This requires a profound rethinking of how cities are organised and a reconsideration of the balance of activities in cities. Diverse cities need manufacturing, regenerative urban manufacturing that is nested in regional and supra-regional networks of manufacturing. The role of urban manufacturing in a circular economy is instrumental in:

- Enabling maintenance and repair activities which are part of circular 'inner loops'
- Providing opportunities for remanufacturing and refurbishment of elements of the built-stock to extend their use life and reduce further consumption of raw materials, especially for elements such as building materials where proximity to consumption is critical to ensure feasibility and adaptability
- Transforming waste materials through a) recycling, b) digesting and c) composting processes into resources for the city, helping to close the loop of cities (e.g. recycling of plastic bottles back into plastic bottles).

What is the current contribution of urban manufacturing to the circular economy? Despite the potential, fieldwork undertaken under the Cities of Making project (Domenech et al., 2020) indicates that the level of circularity in EU cities is minimal. While a manufacturing base is still maintained in cities, urban manufacturing, its diversity and capacity, are being compromised by approaches to planning and regeneration that rarely consider the needs of manufacturing or provide the right set of conditions for manufacturing to transform towards more regenerative forms of making. The research has revealed a diverse sector, including food production, textile manufacturing, furniture making and construction material fabrication. Urban manufacturing also demonstrated high levels of flexibility, customisation and innovative business models that blur the boundary of manufacturing and services. In most cases, urban manufacturing is also inextricably blended to high-value urban activities, such as R&D, design and culture or construction, providing the necessary material base for these other city sectors to develop.

These activities consume a large fraction of the cities' resources and are important generators of waste. Waste from manufacturing activities tends to be homogenised and therefore has greater potential for recovery. Also, the concentration of diverse activities and connections with commercial use has enabled synergies and opportunities to transform waste into resources. Food-related production is showing pioneering examples. Breweries such as Toast in London and the Brussels Beer Project brew beer using surplus bread from bakeries. Biohm in London uses food waste produced by food and drink manufacturing for the production of a range of insulation, packaging and construction materials. Rotterzwam in Rotterdam and Permafungi in Brussels use used-coffee grounds from local cafes. However, these examples are the exemption rather than the norm, and a large fraction of industrial waste still follows non-circular routes and ends in landfill or incineration. Inefficient resource flows are in many cases the results of a combination of lack incentives, poor infrastructural dotation and planning and, very importantly, almost absolute lack of detailed, geographically specified, data on how city resources and manufacturing resources flow in the space through the city and beyond.

Domenech et al. (2020) demonstrate how the reduced backyard spaces in manufacturing land and deficiencies in waste infrastructures mean that most industrial waste is collected non-segregated in single skips. This leads to cross-contamination and reduces the ability to introduce high-quality recovery and recycling of industrial and commercial waste. Similar conditions also affect the ability to recover resources from waste in Brussels and Rotterdam. Lack of awareness of the potential value of waste resources and lack of incentives to engage in collaborative initiatives to pool resources and minimise waste in industrial areas is also common. Despite potential, none of the industrial areas investigated had systems for heat recovery, water harvesting, cascading or penetration of renewable technologies. However, pressures to control potential negative emissions have led to greater electrification of processes, linked with reduced GHG emissions and local air pollution.

Our research has also shown that digitalisation of urban manufacturing is still limited and mostly concentrated in high-tech sectors, including chemical, pharmaceutical or medical devices. This slower rate of penetration of digital technology is not detached from spatial issues. Uncertainty linked to short leases and shrinking of manufacturing space creates a reluctance to invest in machinery and equipment. Digital technologies may provide opportunities for better use of resources and reduce processing waste and increase traceability of production, which may enable new business models to focus on customisation, the extension of life through maintenance or refurbishment. However, this potential is rarely realised in cities.

To sum up, this all means that while the manufacturing sector has potential for greater digitalisation, a transition to performance-based models and industrial symbiosis type of approaches to waste reutilisation, progress enabled by policy and adequate planning is required to ensure that urban manufacturers seek the opportunities and collaborate towards addressing local circular economy challenges.

5.2.2 Urban Integration

Industrial activities relate to and are dependent on the qualities a place provides. Until recently, manufacturing was often considered noisy, polluting, a generator of heavy traffic and thus separated from the everyday city. Most manufacturing companies are currently not integrated into populated parts of cities. Urban manufacturing and production are now commonly concentrated in industrial areas, and business parks. These specialised areas are often separated from housing and other 'incompatible' land uses at urban peripheries.

Two trends are changing the location of production in cities. Firstly, with increasing demand for housing, cheaper and low-density industrial land is under pressure for rezoning. Many cities are exploring 'mixed-use' zones to retain industrial surfaces while allowing for traditionally incompatible land uses to occur. Secondly, new and cleaner manufacturing and building technologies are being developed that are more compatible with other land uses. They have reduced the likes of noise, air pollution and other nuisances. This opens up new possibilities for integrating urban manufacturing (Muñoz Sanz, 2018; Muñoz Sanz et al., 2018) and offers opportunities, particularly for addressing the circular economy. Due to the high urbanisation of Europe's metropolitan areas, manufacturing companies may end up at closer proximity to urban functions seen as non-compatible at first sight, like housing. How these different functions can be integrated requires an understanding and differentiation of the different environmental qualities essential for urban functions as diverse as housing and manufacturing.

Protecting or creating space for manufacturing and production in urban areas remains challenging. One serious statistical challenge for manufacturing is that it occupies a lot of space: consuming on average 250 m^2 per employee than an average of 30 m^2 in general workplaces (ORAM, 2019), resulting in larger building footprints. As a result, there is a tendency to reduce the size of industrial areas while replacing space for production with other activities. Van den Berghe and Vos (2019) describe another aspect that reinforces the pressure on manufacturing space: strategic planning lately focuses on 'place as location' driven by 'finance and real-estate driven regime'. Consequently, historical locations for manufacturing, such as those along waterfronts, have become a prime location for high-end housing. Such processes reduce the amount of available space for manufacturing and impact its wider social and industrial ecosystem.

The urban integration pathway has three central questions. First, what are the main (potential) spatial settings of manufacturing in cities? Second, what spatial structures can provide conditions for urban manufacturing with proximity to other functions, and third, what local qualities allow liveable and affordable proximity? We approached these questions with synchronic and diachronic analyses. The synchronic analysis clarifies the relations and dynamics between spatial characteristics, and the diachronic analysis enables understanding places and their transformation dynamics through time.

Activities depend on the (urban) space provided. Research in urban morphology from the last years showed that the structure of urban form has a relation to the urban programme (Chiaradia et al., 2009; Hausleitner, 2012; Marcus, 2010; Nes, 2005; Wandl & Hausleitner, 2021), indicating what kind of space can afford what kind of function. The CoM synchronic urban morphological analysis focussed on the differentiation of building types, parcel sizes, built density, the centrality of locations, the landscape structure, and the transport infrastructure system.

The analytic mapping of all layers for the typical manufacturing locations in Rotterdam showed that manufacturing businesses have a wide variety of spatial needs. Proximity to transport infrastructure for efficient logistics is vital for all businesses. What kind of buildings, parcels, how much open space manufacturers need and what kind of neighbours can settle next to manufacturers differs. Some companies require larger floor space, which usually correlates with larger parcels and broader streets. In contrast, an increasing share of manufacturing companies, like design and 3d-printing hybrid businesses, benefits from shared premises, or smaller business units, which can be mixed with other land use more easily. Industrial areas containing a variety of business unit sizes provide possibilities for the shrinking and growing of companies and can accommodate a diversity of manufacturers and related services.

Urban configuration typologies (Hausleitner & Berghauser Pont, 2017) can indicate where the best spatial conditions for different types of manufacturing can be found. The CoM typology (Hausleitner et al., 2021) was based upon built density and network centrality. The typology describes the different but complementary spatial conditions within an urban system and indicates different urban environmental qualities. The design of the urban structure also sets the main spatial conditions for what kind of functions can be mixed where (Hausleitner, 2019) with manufacturing. The typology visualises where different structural qualities are in proximity. This allows an assessment of whether transitions are present or have to be created to organise transitions in environmental qualities from large to smaller footprint functions, noisy to quieter, more central to less central.

The diachronic mapping provided insight into the long-term dynamics of place and function. It showed that manufacturing commonly was located at the (inner) urban edges, while mixed-use is related to high streets (Hausleitner, 2019; Hausleitner et al., 2021). Both synchronic and diachronic mapping allows distinguishing three main urban settings that afford manufacturing: (1) the inner cities, (2) the highstreets and (3) industrial areas. Each of these three represents a different location in the urban agglomeration, namely core, transition or periphery. Each is related to different kinds of infrastructure, with locally different built densities and urban mix, indicating how much space is likely available, accessible and affordable. Providing gradients between central streets and urban edges creates livable transitions between the main functions on city and district scales.

From the spatial design perspective, it is important to understand how we can diversify the spatial conditions so manufacturing, related and complementary services, and other urban functions can be integrated with relative proximity. Larger buildings have to be possible next to smaller buildings. An example of this is the site of the Manner sweets factory in central Vienna, Austria that covers a building block in the regular nineteenth-century street grid and is organised vertically across six floors. This vertical intensification allows keeping the regular street grid which maintains the neighbourhood's permeability, and therefore walkability. The factory has public entrances and a shop along the main street, contributing to liveable street life. At the same time, the factory provides district heating through the exhaust air for 600 houses in its direct neighbourhood. Hence, the circular city ambition can take advantage of bringing manufacturing in closer proximity to other functions. Thus, local urban design should enable synergy effects and reduce conflicts between functions, to achieve liveable, cities that also 'make'.

5.2.3 People, Networks and Policy

Businesses and skilled workers are essential for manufacturing. Some manufacturing businesses are also important, if not critical to cities, particularly to address circular economy ambitions. Businesses can be attracted to cities, but they can also be costly places to work. Public authorities are under increasing pressure to ensure businesses that are vital for the cities remain, which may require correcting market trends through policy and planning instruments. However, few city-scale public authorities have been involved in understanding or engaging with local manufacturing processes or industrial land until recently.

The ‘people, networks and policy’ pathway is positioned between ‘circularity and technology’ and ‘urban integration’. Public institutions and private organisations (particularly unions, chambers of commerce and industry alliances) are generally the actors involved in protecting and supporting economic planning, innovation and business development, education and training.

Manufacturing and production depend on a range of conditions including relationships between producers, suppliers, retailers, availability of skilled workers and staff, local environmental policy, availability of industrial subsidies or the impact on taxation, the cost of logistics and a raft of other issues that can influence the viability of production. What makes this so complex is that there is no standard list of conditions required by all businesses. Creating suitable conditions to attract and support city-oriented manufacturing businesses requires nuanced public planning and coalition building.

Businesses the city depends on and businesses that need the city. Despite the difficulty and danger in generalising, city-oriented urban manufacturing businesses may fall into two groups. Firstly there are those businesses that the city depends on. ‘Regional processing’ refers to close links between the place of production and the place of use or consumption. For example, cement plants are often located within inner cities due to legislation limiting the time between mix and pour. Bakeries also often produce onsite to adjust for demand and minimise waste. The ‘foundational economy’ (The Foundational Economy Collective, 2018) refers to the mundane—things that the city requires daily—such as food, construction, transport or repair. By virtue of dependence on these activities, cities that cannot provide suitable space will likely result in paying higher prices (particularly the case for food) or simply being unable to provide certain services (particularly for repair, construction or waste management). Urban manufacturers focused on waste processing, repair and food production often operate on narrow margins, as some of these businesses provide the city with a certain service, such as managing waste. They may depend on government support to access affordable land, train staff, subsidise wages, purchase technology, and provide an adequate service level to the city. For example, in Brussels, CF2D is a social economy business that provides a public service by treating electronic waste, which depends on subsidies to cover wages, real estate costs and the investment in new equipment. An organisation like CF2D needs to be located near public transport and accessible for logistics.

Secondly, there are those businesses that depend heavily on the city. They are prepared to pay the costs of operating in a city due to reasons such as having access to a large pool of talent, a link to suppliers or clients and a close connection to research and development. Production and manufacturing businesses attracted to the city are often involved with innovation or in high-value production, which can be particularly important in developing local solutions to material demands. These types of businesses are increasingly looking at technology (automation) to cut labour costs and seek workers that have a combination of technical skills and expert knowledge. These businesses need the right incentives or market to be attracted to urban areas.

Those actors concerned with ‘people, networks and policy’ generally are interested in finding a clear place for manufacturing within economic planning to ensure it is suitably supported through policy such as a circular economy plan. Business networks and relationships with suppliers are also important as businesses can develop complex interdependencies. Many manufacturers feel isolated; a community manager or facilitator could support them. Furthermore, considering the limited amount of space in cities, businesses may require support in moving or growing and depend on a public real estate broker’s support. Skills are critical, as manufacturing businesses often depend on a skilled workforce; education and training are essential for existing and future staff. This is particularly important for the circular economy in terms of reskilling the workforce. Finally, actors concerned with this pathway may be interested in using financial instruments to guide businesses. To move the local economy towards circularity, economic support can be critical.

5.3 Developing an Integral Approach Through Participation and Collaboration

The readings of the three pathways differ mainly in whether the spatial or the process dimension is emphasised. The pathway of urban integration is dominated by the spatial dimension, while the process dimension is, to some extent, underrepresented. On the other side of the chart, the circularity and technology pathway shows a dominance of the process dimension regarding the flows of resources and the technology used. However, it is challenging to grasp how much and what space is required to perform manufacturing processes. The pathway of people, network and policy, does not show dominance but embraces how the human or organisations fit within both dimensions.

In practice, it can be challenging to combine both a spatial and process-oriented thinking. The aim is not to eliminate the differences, but rather build upon the qualities of the different ways of reading. While urban integration could benefit from increasing its process dimension, the other two pathways could benefit from a clearer understanding of how they relate to spatial conditions, as this would help define where they could occur and what types of spaces they would need. The integration of the three pathways requires convergence while retaining the richness of the three perspectives. How can a dialogue be created between these pathways?

In the previous section, the three different ways of reading urban conditions were described. These pathways apply different approaches and have different goals. As introduced at the beginning of this chapter, the challenge is to find a common language that provides a comparable, operative framework for exploring possible solutions.

The CoM project (Hill, 2020) introduced three main considerations in approaching transdisciplinarity: (1) reducing the complexity of information, (2) reducing the complexity of combinations of possible solutions and (3), applying an accessible, applicable instrument for the solutions. This resulted in developing a pattern language following Christopher Alexander's seminal work (Alexander et al., 1977), integrating the three pathways.

A pattern language is a system that comprises individual solutions (patterns) and the relations among them. The CoM research developed 50 individual patterns based on policy and literature review, and interviews with key stakeholders, each initially embedded in the one discipline. In workshops with different types of stakeholders, in interviews with businesses, and discussions within the multidisciplinary research team, we established and verified relations between the patterns. Then, we sharpened each pattern through knowledge via the complementary perspectives that were not involved in the first draft. This process contributed substantially to the definition of the 'context', 'problem' and 'forces' that enable or hinder different types of 'solutions' possible in realising one pattern.

The pattern language is not only co-created in a transdisciplinary setting but is also an instrument enabling transdisciplinary collaboration. The information related to the three pathways is made accessible in the form of a set of cards and a companion book, with each pattern presented in a comparable way (see Fig. 5.1a). In current urban development practice, one of the main challenges is the high degree of specialisations, that steers thinking about solutions and binds budgets very much in silos of disciplines. One consequence is that complex problems are approached from a limited perspective of a discipline's or institutions' frame. The indication of relations among the patterns enables actors to understand which other patterns have to be implemented to make a solution work, as shown in Fig. 5.1b along with the example of 'Local collection points of segregated waste'.

The use of the cards and book are analogue tools to encourage dialogue. As experienced through testing the tools in workshop settings, it has allowed a high diversity of actors to participate in the development and decision-making process.

5.4 Discussion and Reflection

This chapter has described how there is potential for urban manufacturing to enable a circular economy transition in cities. However, competition for land uses in cities means that space for manufacturing is under pressure. The availability of urban spaces for maintaining manufacturing depends on designing legally binding, long-term planning. Long-term planning creates security of space, which promotes capital and personal investments of companies on a site. Since urban areas are in constant change, a robust spatial framework, which considers the diversity of land uses is essential. Such a robust spatial framework has to guarantee the availability of space with favourable conditions for making.

Urban manufacturing provides the potential for further explorations of innovative ways to connect production and consumption. Cities need a productive base to close the loops in a city. For that to be possible, spatial plans need to reserve sufficient

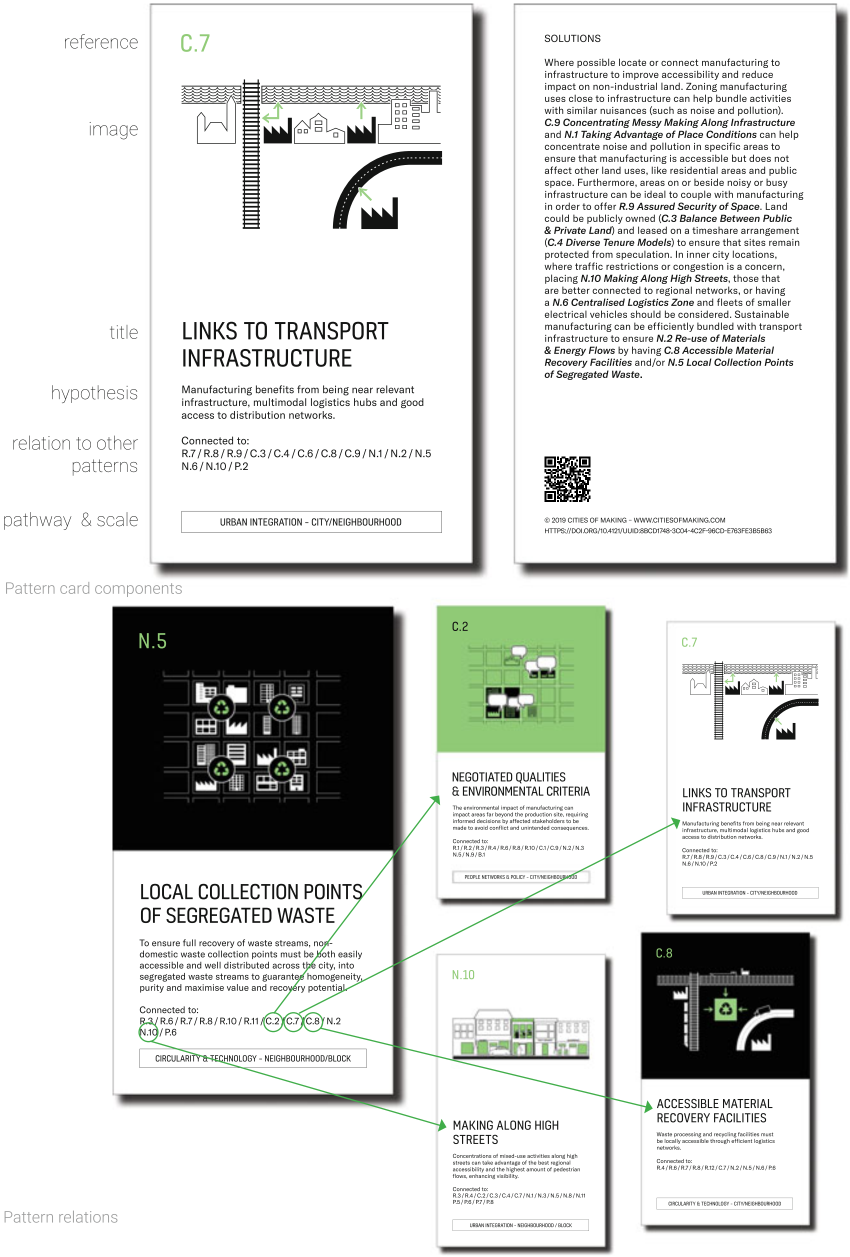

Fig. 5.1 **a** The pattern card with a comparable, operative frame for presenting solutions (@CoM). **b** A network of solutions-related patterns bridging needs from different pathways—C&T (black), UI (white), P,N,P (green) (@CoM)

space for circular processes to be realised (e.g. temporary storage spaces for resource recovery) locally which depends on a detailed understanding of how resources move in space.

To enable both urban manufacturing and the circular economy, a new form of dialogue is needed between stakeholders. Firstly, a better understanding of the role of manufacturing in cities is needed. Secondly, the provisions of adequate planning and spatial conditions for the opportunities mentioned above to crystallise are required. We presented, therefore, a pattern language, which addresses the requirements of space, production, and resources, generates dialogue and enables innovative planning approaches to create new, highly diverse and mixed-use areas.

In this chapter, we argued for the need for both expert knowledge and transdisciplinary collaboration. Firstly, we have presented three pathways for addressing urban manufacturing, and by extension, the circular economy. Secondly, to enable transdisciplinary collaboration, we have presented an instrument, based on patterns, which provides a flexible guide for integrating resources, planning and design. This guide safeguards the processes of manufacturing and the sustainable and liveable integration of manufacturing with other urban functions.

Such an approach allows for integrating a range of important actors such as academics, institutional actors, businesses and community interests. The pattern language is an open, accessible system, which can be adapted over time. Each pattern can be further developed, based on evolutions of knowledge. New relations between patterns can be established. The already defined relations help ensure consistent and holistic pathways of how separate patterns may be embedded and contextualised with related patterns. This approach provides a foundation for dialogue, which is critical in dealing with complexity. However, it depends on a suitable process facilitation. The role of 'The Curator', is one of the fifty patterns described by Hill (2020) which may act as a fundamental agent of change.

Acknowledgements This research has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857160 in the framework of the JPI Urban Europe ERANET Cofund Smart Urban Futures (ENSUF) Call. The authors would like to acknowledge the Cities of Making team for the contributions to the project: Ben Croxford (UCL London), Han Meyer (TU Delft), Alexandre Orban (Vrije Universiteit Brussel), Fabio Vanin (Vrije Universiteit Brussel) and Josie Warden (RSA London). We also like to thank all makers and institutional actors for participating in interviews and workshops that made the outcome of this research possible.

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Part II
The Spatial Scope of Circularity

Chapter 6
Evolving Relations of Landscape, Infrastructure and Urbanization Toward Circularity

Bruno De Meulder, Julie Marin, and Kelly Shannon

6.1 Introduction

A great deal of the contemporary discourse around circularity revolves around waste—the elimination of waste (and wastelands) through recycling, renewing and reuse (3Rs). In line with industrial ecological thinking, the discourse often focuses on resource efficiency and the shift toward renewables. The reconstitution of numerous previous ecologies is at most a byproduct of the deliberate design of today's cyclic systems. Individual projects are often heralded for their innovative aspects (both high- and low-tech) and the concept has become popularly embraced in much of the Western world. Nevertheless, contemporary spatial circularity practices appear often to be detached from their particular socio-cultural and landscape ecologies. There is an emphasis on performative aspects and far too often a series of normative tools create cookie-cutter solutions that disregard locational assets—spatial as well as socio-cultural. The re-prefix is evident for developed economies and geographies, but not as obvious in the context of rapidly transforming and newly urbanizing territories. At the same time, the notion of circularity has been deeply embedded in indigenous, pre-modern and non-Western worldviews and strongly mirrored in historic constellations of urban, rural and territorial development. This contribution focuses on two contexts, Flanders in Belgium and the rural highlands, the Mekong Delta and Ho Chi Minh City in Vietnam, which reveal that in spite of the near-universal prevalence of the Western development paradigm, there are fundamentally different notions of

B. De Meulder · J. Marin · K. Shannon (✉)
OSA, Department of Architecture, Faculty of Engineering Science, Katholieke Universiteit Leuven, Leuven, Belgium
e-mail: kelly.shannon@kuleuven.be

B. De Meulder
e-mail: bruno.demeulder@kuleuven.be

J. Marin
e-mail: julie.marin@kuleuven.be

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_6

circularity in history and regarding present-day urbanization. Historically, in both contexts, the city and its larger territory formed a social, economic and ecological unity. There was a focus is on the interdependent development of notions of circularity in the ever-evolving relations of landscape, infrastructure and urbanization. In the development of contemporary circularity, there are clear insights that can be drawn from the deep understandings of historic interdependencies and the particular mechanisms and typologies utilized. The research questions addressed are in line with territorial ecology's call to incorporate socio-cultural and spatial dimensions when trying to understand how territorial metabolisms function (Barles, Revue D'économie Régionale and Urbaine:819–836, 2017). They are as follows: how can case studies from two seemingly disparate regions in the world inform the present-day wave of homogenized research on circularity? How can specific socio-cultural contexts, through their historical trajectories, nuance the discourse and even give insights with regard to broadened and contextualized understandings of circularity? The case studies firstly focus on past site-specific cyclic interplays between landscape, infrastructure and urbanization and their gradual dissolution into linearity. Secondly, the case studies explicitly focus on multi-year design research projects by OSA (Research Urbanism and Architecture, KU Leuven), which underscore new relations of landscape, infrastructure and urbanization and emphasize the resourcefulness of the territory itself. The design research has been elaborated in collaboration with relevant stakeholders and experts and at the request of governmental agencies.

6.2 Flanders: Embracing the Circular Economy

In Flanders (the northern part of Belgium), integrated resource management, landscape, infrastructure and settlement development were strongly intertwined until industrialization and its twin urbanization radically restructured the order of things in both rural and urban areas. This included the dramatic disruption of production and consumption cycles, resulting in the massive issue of waste (to dispose of). Until the end of the nineteenth century, the Limburg region—the easternmost part of Flanders, west of the Meuse River—was a territory where rural economies were largely embedded within and anchored on the resources of the (natural) environment. By the early twentieth century, coal extraction was the primary driver of the economy and the region witnessed an overwhelming rollout of railway and canal infrastructure and development of mining settlements. This drastic induction catalyzed a generalized urbanization of the scarcely inhabited and mostly rural region. On the other hand, until the nineteenth century, in Antwerp, Flanders' largest city, water-bound transportation of urban waste provided the sandy countryside of the adjacent Campine region with nutrients which were then returned as food to the city. Introduction of modern sewage systems, treating household water as waste to dispose of, halted this cyclic mechanism. In countryside and city alike, historic cyclic mechanisms of production and consumption have been systematically disconnected. However, today circular economy transition is high on the Flemish policy agenda. Despite thriving innovations in technology and business models, the complex interconnectedness of natural and human systems complicates the transformation of twentieth century linear infrastructural systems toward territorial circularity. Over the course of the past decade, design research by OSA (Research Urbanism and Architecture, KU Leuven) has explored strategies to revive cyclic interplays between resources in urban areas and hinterlands and ways in which they can (re-) connect Flanders' circularity transition. There was an emphasis on particular socio-cultural and landscape ecologies.

6.3 Campine: Past and Future (Water) Cycles

Central Limburg's river and pond constellation (de Wijers) still embodies a layer of circularity that integrates landscape, infrastructure and urban development, drawing from the territory's specificity and resourcefulness. In the nineteenth century, a constructed water system turned the inhospitable heath and swamp 'wasteland' into productive land, structured by parallel swampy brook valleys (Nolf et al., 2016). Following local topographic and soil conditions, a mesh of man-made pond complexes, pond cascades, natural fens and meadows, connects to natural waterways through intricate systems of in- and outlets. Originally, pond water management was strongly synchronized with agriculture, respecting natural cycles and capacities. As such, ponds were alternatingly emptied to allow soil to rest and regenerate after productive periods, a variation of the Medieval three-field system. Similarly, in the same region, fertile topsoil 'podzol' slowly formed through the interplay of directed sheep grazing and cyclic nutrient recovery (Kaland, 2014).

Nevertheless, this territorial layer of cyclic water and landscape management and agriculture in Central Limburg was subsequently superimposed with very disruptive water manipulations, infrastructures and systems. Coal extraction in the early twentieth century introduced increasingly one-way extractive relationships between humans and natural resources. The practice of incorporating time and space for natural systems or soil to replenish or regenerate was lost. A disruptive economic era of 'resource extraction urbanism' (Correa, 2016) began with the introduction of extraction sites at the edge of the sandy Campine Plateau. The coal mines were complemented with mining cities as well as railway and canal infrastructure to efficiently transport it to industrial centers in Antwerp and Liege. Urban and infrastructural development—and particularly its morphology form—was explicitly organized for the purpose of efficient and large-scale resource exploitation. However, coal extraction caused significant land subsidence, associated water table disturbances and pollution as a result of coal washing, as well as the generation of gigantic amounts of mining waste, piled up in now largely overgrown (and often flattened) slag heaps. At the same time, what is left of the region's pre-industrial river and pond network is now widely acknowledged as a vital structure to develop a resilient and adaptive territory in the wake of climate change (including droughts that are expected to increase). There is a regional water platform gathering different local, regional, public and private stakeholders managing, monitoring and maintaining pieces of this regional natural and man-made water systems. The platform coordinates their actions, initiates synergies across administrative silos and more importantly rethinks water management in line with the natural water cycles (Stuurgroep De Wijers, 2019).

Today, some of the ponds still function as water buffers draining swamps, or as fish farms, simultaneously supporting biodiversity, recreation and soft mobility networks. Pilot projects have been initiated to recover biomass and waste flows related to the ponds: sludge from pond maintenance becomes agriculture fertilizer. Old water mills have been reactivated and there is a pilot project which generates energy from cultivated reed root ends which border the ponds. A quantitative study mapped water stocks and reserves to support a provincial strategy to prepare for extreme situations of drought as a result of climate change (Bodemkundige Dienst van België et al., 2020). OSA produced a comprehensive 'water atlas' to support the water platform's ambitions to reinforce regional cyclic and integrated water management (OSA KU Leuven, 2019) (Fig. 6.1). The atlas built on previously developed design research supporting a shift from 'planning' to 'profiling' in this water-bound territory, through urban landscape design strategies such as inverting valleys, collecting water in gardens and flood chambers (Nolf, 2013). Other design research (Marin et al., 2020) proposed to connect biomass recovery from landscape maintenance to educational and employment programs, as well as the planned restoration of an ecological corridor.

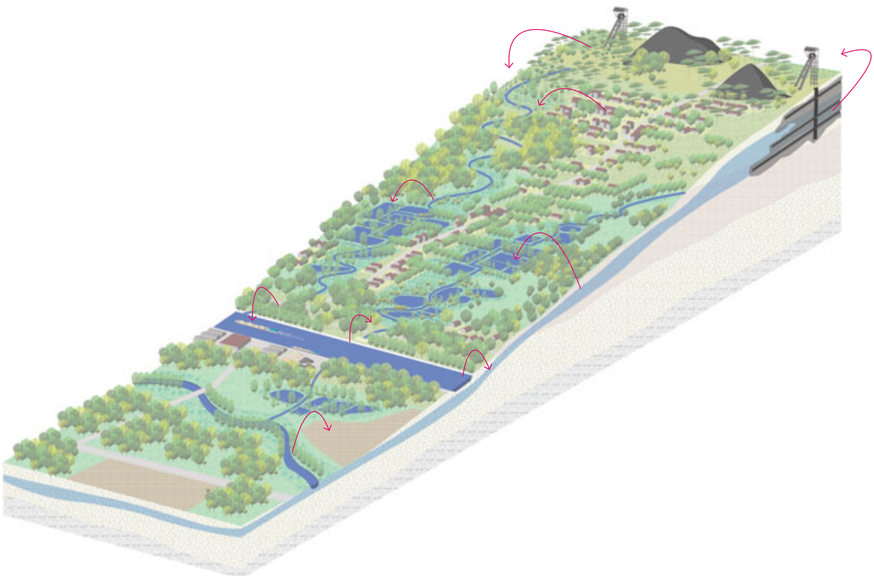

Fig. 6.1 Wijers, Limburg, Belgium. Integrated water management is sequenced from the sandy Campine plateau (with its cascade of artificial fish ponds and natural water pools fedby water seapage) to the Demer River Valley and interrupted by the Albert Canal (Antwerp-Liege)

Also in Limburg, Atelier Track Design, developed by WIT Architecten in collaboration with OSA, Lateral Thinking Factory and Technum in 2016, proposed a gradual redevelopment of an abandoned Ford car manufacturing site in Genk as a circular economy hub. Evolving soft and hard infrastructures were developed to strengthen cyclic interplays between the industrial site and the natural environment. In addition to the reinforcing of existing rail and water infrastructures as the most suitable mobility means in a circular economy, planted areas were proposed as reserve space for water and the extension of an existing poplar landscape could slowly clean historical groundwater pollution through phytoremediation. In all the OSA design research, there was an objective to embed the circular economy agenda within broader place-specific social and ecological questions and structures.

6.4 Antwerp: Waste and Wastelands

In Flemish urban areas, historic development also offers insights for the contemporary transition to circularity. In Antwerp, wastelands throughout history reveal how (largely) circular pre-industrial circular 'nutrient' flows gradually dissolved into linear flows of waste. This change introduced, nor the least because of scale increases, previously non-existing spatial and infrastructural demands for waste. As French professor of urban planning and development Sabine Barles notes, the first European industrial revolution from the eighteenth century onwards motivated the reuse of urban byproducts partially feeding industrialization, but chemistry innovations such as artificial fertilizers gradually made urban byproducts obsolete and 'invented waste' (Barles, 2005; Landsberger, 2019). In the eighteenth century Antwerp, urban waste and manure was collected in urban places such as the *Mestkaai* (manure quai) and transported over water or rail to the countryside where it served as fertilizer. One argument to construct a new canal to Antwerp in 1748 and to improve an existing canal (*Herentalse Vaart*) was the possibility to ship up to 4000 waste loads to the countryside (Poulussen, 1987). The same countryside produced food for the city, supporting circular nutrient flows between city and hinterland (Beyers & Van Damme, 2016). The implementation of centralized sewage before the First World War made a return to the previous cyclic system almost impossible without major infrastructural adjustments and a systemic shift. Before the creation of the Flemish Waste Agency (OVAM) in 1981, waste management in Flanders was organized at the municipal level. As in the rest of Flanders, in Antwerp (that is today the fusion of a multitude of previously independent small municipalities), this resulted in a dispersed constellation of waste disposal sites and landfills across the city's periphery (Feys, 2011). Many of those sites were located in the *Groot Schijn* riverbed, historically the limit between municipalities and at that time considered as unproductive 'wasteland' in the sense that architecture historian Vittoria Di Palma has investigated (Di Palma, 2014). However, in line with mid-twentieth century globally increasing environmental awareness following works such as Rachel Carson's *Silent Spring* (1968) and the Club of Rome's report, *The Limits to Growth* (1975) causalities between waste disposal and environmental problems such as soil, water and air pollution became very obvious. Growing incidents around waste and pollution led to the first Belgian toxic waste law in 1974. From the 1980s, the Flemish Waste Agency rationalized the scattered Flemish wasteland, cleaning sites and upscaling waste processing facilities (to intermunicipal and even regional level). This technocratic waste management centralization remained problematic and increased the burden of increased waste handling by fewer communities. The construction of an intermunicipal waste incinerator *ISVAG*, 5 km south of Antwerp in 1975 immediately incited protest by inhabitants. The increase of health issues led to a temporarily shutdown in 1994.

After about a century of breaking cyclic mechanisms intertwining Antwerp's landscape, infrastructure and urbanism, today the city demonstrates a renewed interest in closing resource flow loops by a multitude of initiatives. A water plan proposes integrated reuse, infiltration, buffering and making room for water within urban fabrics, replacing radically the former policy of evacuating water out of the city as quickly as possible (Stad Antwerpen, 2019). The recent urban development on 'Nieuw-Zuid' employs digital technologies to minimize materials, water and energy losses (Stad Antwerpen, 2018). Bluegate aims to reconvert a brownfield into a climate neutral industry park for circular economies, employing industrial symbiosis (Blue Gate Antwerp, 2020). The 'urban metabolism Antwerp' study (Fabrications et al., 2018) provides insight into how (material) flows in the city could be better aligned to guarantee a sustainable urban future while exploring spatial and landscape integration of circular flows and infrastructural carriers (Bergers & Van Acker, 2018). Additionally, as in many European cities, an increasing amount of small-scale waste recovery practices such as flea markets, repair cafés and gift cupboards give second and third lives to clothes, electronics and food in circular, social, local sharing economies. Vanmaercke and Rosso (MaUSP/EMU2015) explored alternative infrastructural constellations supporting circular economies building onto these community practices. Breaking with centralized sewage and other waste handling systems, they proposed overlapping closed materials loops while restructuring space and connecting to locational assets.

After decades of centralist waste handling outside the collective urban realm and consciousness, the circular economy transition in Flanders has begun to reconnect waste flows to daily urban lives, economies and urban forms—instigating synergies between varying social, economic and environmental public agendas. The challenge is now, after at least half a century of awareness of unsustainable waste production, to fully grasp the opportunity of this transition in order to radically re-envision infrastructural networks supporting material flows toward truly cyclic relations between landscape, infrastructure and urbanization. Besides technological innovations and political capacity for sustained and radical change, the heart of this challenge undoubtedly is about acknowledging the earth and its natural resources as the fundamental framework for a 'balanced co-existence between humans and nature' (Escobar, 2008) and to stop pretending nature is a machine with man at its levers (Klein, 2014).

6.5 Rural Vietnam: Culture, Economy and Ecology Tied to Locational Assets

On the other side of the world, in Vietnam, most early settlements were, by necessity, intimately tied to the rhythms and opportunities of the natural environment. Human life was primarily a response to geography and a cosmological view deeply rooted in Buddhist-Taoist-Confucianist ideology. There was an undeniable interconnectivity, reciprocity and synchronization of settlement and nature. Two-thirds of Vietnam is mountainous and inhabited by a minority of the population; 53 ethnic groups have historically clustered in the highlands of north and central Vietnam. They lived by foraging, hunting and fresh-water fishing or by dry-farming agricultural techniques on labor-intensive terraces and developed profound relationships to self-renewing (and in that sense circular) forest and mountain ecologies. Although the State viewed the mountainous territories as wastelands (with the exception of the few mining areas), they were invaluable for various local highland ethnic groups not only for their productivity, but also for the site of spirits and shrines. Additionally, many families strategically developed settlements and productivity on lands at different altitudes (different ecological floors) (Biggs, 2018).

Meanwhile, the Kinh ethnic majority initially settled in the Red River Delta and coastal plains. More than a thousand years of human occupation obliterated the natural landscape. Abundant, warm rains brought by summer monsoons supported a cultural landscape of what has been termed a rice or vegetable (Gourou, 1972) or hydraulic civilization (Wittfogel, 1956). The population was localized as 'swarms on the plains' (Gourou, 1975, p. 29) and villages formed as densely clustered and bamboo girdled agglomerations within productive paddy fields. A Chinese-influenced administration was capable of requisitioning enormous masses of labor for collective irrigation works, primarily without mechanical assistance. In the Red River Delta, ever-stronger and higher dykes protected settlements from seasonal flooding. Deltaic and coastal village boundaries most often coincided with irregularities of the ground, river courses, lanes, bushes (or delimited by markers in the absence of natural landmarks) and were often founded upon the land cushions left by strongly flowing river vegetation (Nguyen, 1993). Village sizes and distances from one another had a direct correlation to the productivity of nearby wet-rice cultivation and ecological footprints. Like many parts of the Far East (also including China, Korea and Japan), density and proximity were determined by a self-sustaining relation of consumptive and productive landscapes (Gourou, 1975). Historically, the Red River Delta has supported one of the world's largest (predominantly rural) population densities and in 2018 there were 1014 persons/km2 (GSO, 2020).

The dense rural populations occupied the territory intensely and simultaneously supported urban centers of power and privilege. Countryside and city formed a coherent whole. With the expanding size and might of Hanoi, there were ever-more elaborate and intimate linkages to the countryside. The city and its larger territory formed a social, economic and ecological unity. The entirety of the Red River Delta was dotted with small-scale, highly specialized villages with traders and artisans organized into guilds and heavily taxed. In many instances, the handicrafts provided seasonal occupation for farmers in the flooding and fallow periods; it also prevailed in villages where land was scarce (Fanchette & Stedman, 2016, p. 21). They were primarily located along navigable waterways helping with the import of raw materials and export of goods. Systems emerged with geographical groupings of villages specializing in the same sector with businesses interconnected and within which there was a high degree of labor division (Fanchette & Stedman, 2016). The productive landscape corresponded to various agro-ecological regions and micro-topography and specific village crafts were directly tied to natural resources and locational assets: ceramics, brick and tile production near rivers and clay soils; pottery and earthenware on the banks of the Red River; ironwork and bronze products in the mountains; flower and silk villages in relation to specific soil types; paper near lakes since it required large amounts of water; woodcarving and shipyards near forests and rivers, etc. Since the seventeenth century, handicrafts were networks connected to the capital, Hanoi and its so-called '36 Streets' (in fact roughly one hundred streets), each named after the goods it sold: Tin Street, Drum Street, Cotton Street, etc. The crafts fed the city, but also brought off-farm wealth to the countryside.

In the so-called 'March to the South,' the step-by-step occupation of the coast, marked by citadel cities nested in subsequent deltas (Thanh Hoa/Ma River, Hue/Perfume River, Saigon/Saigon River) culminated in the Mekong River Delta, where a vast network canals and irrigation ditches drained the quagmire and settlement adapted to and lived-with monsoon rhythms. In each of these stops along the 'march', the interdependency city-countryside was reproduced. This was literally done in the case of Hue, when its citadel became the capital of the Nguyen Dynasty in 1805, and centrally marked the ever-progressing Vietnamese nation-building. As in the Red River Delta and coasts, humanity was omnipresent in the rural landscape. At the same time, the more southwards the inner colonization progressed, the less strict the Kinh traditional domestication of territory through dike building prevailed, until the point of the Mekong, where living with and within the seasonal flood was the norm. Since in the Mekong Delta the land is gradients of wetness—with the land saturated with water and the water full of land, variations of water urbanism prevailed. Constellations of dispersed, yet linear, settlements were not only tied to the ecological footprints of wet-rice cultivation, but also to cities' interdependency through tidal regimes of waterways. In fact, the distance between Mekong Delta cities was consistently 60 km, corresponding to tidal rhythms and boat speeds. For centuries, the primary economy in the Mekong Delta was low-land wet-rice farming and alluvial high-banks of waterways that are appropriated intensively for orchard cultivation and settlement. However, Vietnam's period of collectivization severely affected the delta and led to a series of dramatic socio-economic crises. Nonetheless, the southern delta, similar to the one in the north, was always densely occupied. Yet, very peculiar for the Mekong Delta is the absence of a real socio-economic center and its interdependence with Ho Chi Minh City (HCMC, formerly Saigon)—which operates as the dislocated center for the delta. In a certain sense, the deltas of the Mekong and the Dong Nai Rivers merge in one vast alluvial plain that was easy to unify by canals, which explains the central role of the external, and older Saigon for the Mekong Delta. The granaries of Cholon, its Chinese settlement and market adjacent to Saigon were stocked with rice from the delta, transported via extensive canals systems. The waterways were expanded and complemented by a road network during the French conquest. To this day, as if it demonstrates a paragon of path-dependent development, HCMC (now Vietnam's largest city) operates as the absent presence/present absence of the delta.

6.6 Urbanizing Vietnam: Torn Between Two Worlds

In 1986, *doi moi* (renovation) reforms were instituted and Vietnam shifted from a centrally planned system to a 'socialist-oriented market economy.' Subsequently, as the country modernized during the past few decades, through the interlinked processes of mechanization, industrialization, there has been significant rural–urban migration and massive urbanization. The result is an extremely unequal dependence between its ever-expanding urban cores and vast rural areas. At the same time, there has been an increased pressure for settlements and territories to become ever-more productive. The mountainous areas have been aggressively internally colonized by the dominant Kinh population and mature tropical forests have given way to monoculture plantations (either acacia, pine or rubber trees) with associated biodiversity loss. Taking Ho Chi Minh's remark that 'forests are gold' to heart led to a generic tinsel of monocultural forests, with a short rotation of crops (*Acacia* mainly for the world paper market) (McElwee, 2016). In the Red River Delta, the handicraft villages, which suffered gravely during the nation's period of collectivization, remerged with an increasing export demand and an accompanying depletion of raw materials, soil degradation, forest degradation, increasing levels of air and noise pollution, contamination of water supplies (Konstadakopulos, 2008).

During the 1990s in the Mekong Delta, the government developed numerous policies to increase productivity and increase livelihoods. As the natural fish catch in rivers and sea decreased due to dramatically manipulated water regimes of the Mekong and overfishing in the East Sea, aquaculture was aggressively pursued. At the same time, policies pushed for 'VAC farming'—the diversification and nutrient linkages among V (orchard), A (pond) and C (animal pens) components. The waste from one component becomes inputs to another, increases production and short-circuits the need for chemical fertilizers and pesticides. Homesteads are included in the system and it is called VACR if fish is stocked in the rice fields connected to the pond (Dang et al., 2005). Clearly, for the delta's immense productive landscape such models, that originate from times when large-scale import of fertilizers or its own production was out of reach, can be non-nostalgically upscaled, along with updates that the introduction of new technologies allows. A reduction of footprints of settlements (that always consume irreplaceable productive land, decrease replenishing of water tables and increase pollution) is thereby a major concern. It can be achieved primarily through the development of new housing typologies and increased densities.

Through OSA's extensive work in the Mekong Delta over a time span of more than two decades, a number of projects have developed strategies for urbanization which is guided by accentuating specific locational assets and strengthening ecological structures. Strategies were developed as site-specific approaches to circularity, regenerating the territory. Until today, the Mekong Delta has a low degree of industrial development and remains predominantly an agri- and aqua-cultural economy. The question is then if the inevitable urbanization and desirable development in the already very densely occupied (and exploited) region can be steered by an endogenous development strategy to capitalize on its natural (and renewable) assets and resist the incessant calls for generic economic industrialization. Can it leapfrog such 'progress' and thrive toward its own form, anchored on its assets and fueled by the IT/AI revolution of the twenty-first century—an e-endogenous strategy? It is, in this respect, noteworthy that many of the twenty-first century technological advances (IT and other) reverse the necessity of hierarchy and centrality that was so typical of the of nineteenth and twentieth-century infrastructures. Indeed, the new goal is the development of decentralized and heterarchical systems (energy, water, mobility, etc.). It is evident that such an e-endogenous strategy for the Mekong Delta would at the same time acknowledge the mutually complementary and (absent) central role of HCMC. The *Revision of the Mekong Delta Regional Plan 2030 and Vision 2050* (developed with the Southern Institute of Strategic Planning [SISP], 2014–2018) accentuated the region's underlying geography of six broad agro-ecological subregions to develop both unique competitive advantages and complementarity as productive systems. In that plan, as well as the Revised Cantho Masterplan 2020 (also co-produced with SISP, 2010–2013), specific degrees of upscaling of VAC farming (ranging in degrees of intensity/extensity of orchards and aquaculture input levels in relation to agro-ecological environments, geographical locations, household contexts and size of animal husbandry) (Dang et al., 2005) are fundamental to build economic and ecologic resiliency in the vulnerable territory. The hybridization of programs can as well be extended to include 'agricultural solar sharing' a Japanese-invented method of generating electricity on farmland using solar panels mounted to a raised framework with crops growing underneath (Sekiyama & Nagashima, 2019) and must consider projected flooding. This is evidently only one hint of how an e-endogenous development strategy can be implemented—inverting old hierarchical systems while shifting from industrially designed monofunctional land-uses to layered (and rotating) systems of multiplicity that are expected to evolve into more resilient ecosystems of production. Supported by the AI revolution, this e-endogenous strategy recalibrates the balance between quantity/quality and the distribution of mass/specialized production.

As rural areas are anyhow forced to increase productivity, urban areas are faced with unprecedented expansion. In Vietnam, it has been stated that people living in urban areas use 2–3 times more natural resources than rural inhabitants (Schneider et al., 2017, p. 1) in addition to producing significantly more pollution, waste—and landfills. In order to meet rising consumer demands, particularly in its larger cities, increased resource extraction occurs from more remote hinterlands. Urban growth amplifies the vulnerability of land in both the city and countryside. Vietnam's inherent circular interdependence loop has been broken. The urban system necessitates a radical new development model. In 2019, HCMC held an invited competition, which sought to develop the city's expansion across the Saigon River (in Districts 2, 9 and Thu Duc), essentially doubling both its surface area and the city's population. It sought a concentrated development, reversing the ongoing process of ever further and further consumption of the productive countryside.

The project of OSA and the Vietnamese Institute of Architecture and Planning (VIAP), *Smart Swarms in the Swamp*, developed flexible and adaptable constellations of economies and ecologies which follow various rhythms—natural, man-made and demand-driven. It built on the logics developed in recent plans for the Mekong Delta and HCMC Regions, both of which sought to re-establish a balance between economic exploitation of natural resources and ecological integrity. The project specifically tackles climate change challenges by radically rethinking the three most carbon-emitting sectors: electric power, construction and oil. Energy transitions are developed toward renewables and cyclic models, rethinking waste to resources. Construction and materiality transitions are addressed through a shift from concrete and steel toward wood (cross-laminated timber [CLT]). Hence, building the city goes hand-in-hand with a massive (urban) forestation program, that simultaneously improves the micro-climate, mitigates pollution, prevents water evaporation and, simply generates a healthy and pleasant environment, in which building materials are by definition part of cyclic system of recuperation and renewal. In short, e-cyclic building is necessarily part of and inscribes itself in an economy of multiplicity. Post-oil transitions are reached through an emphasis on renewable and water- and electric-based and app-supported transportation. The envisioned e-water-transport—a 'wetro' complements the under-construction metro and is completely demand- instead of offer-driven, with flexible trajectories instead of fixed lines and heterarchical instead of hierarchical organization. It capitalizes on the enormously extended net of natural and man-made waterways existing on the development site, which it uses (rather than overrunning it with extremely expensive asphalt road systems that are incompatible with the load-bearing capacity of the water sick soil), even extends it (to increase economically the mobility infrastructure, while simultaneously increasing the dearly needed water retention capacity) and enlarges the self-regenerating biological capacity water system, etc (Fig. 6.2). The multiplicity of spaces and their uses is fundamental to the new socio-ecological environment in the making, weaving the built and constructed nature. The approach capitalizes, in general terms, on locational assets, natural ones in the first place, and works with the forces of nature (rather than, for example, following the ongoing, unholy and, extremely expensive megalomaniac and doomed to fail dyke building program that supposedly one day will protect HCMC from flooding).

Working with the forces of nature often implies embedding within nature. The urbanity in the making is hence one in which conventional role divisions are reversed and landscapes become the primary infrastructure. Overall, the project focuses on transformation of the territory with increased urban density, diversity (particularly in terms of programs, footprints and scales) and increased open space (water and green systems). It fixes what is necessary to fix, gives direction to what has to be directed

Fig. 6.2 Highly Interactive Innovation District (HIID) Vision, Vietnam. The existing, fine-mazed water system is the basis for the creation of a water transport mesh and an app, on-demand basedsystem of transport that combines WETRO, METRO and personal mobility mechanisms (image RUA 2019)

and leaves open what is unnecessary to fix or at the moment uncertain. It sought to move from linear systems toward constellations in order to achieve 'grab' on demand mobility systems, mixity (of size, program and density), high floor-area-ratio (FAR), the highest provision of open space per capital in SE Asia (now the lowest), climate change resilient networks and innovation ecosystems.

6.7 Toward a Twenty-First Century Circularity

To date, the circularity discourse focuses on the elimination of waste (and wastelands) through the 3Rs—recycling, renewing and reuse. However, there inescapably remains another underlying set of economically driven 3Rs—risk, return and reward. The classic contestation of ecology and economy is surely at work in the shift to circularity and it will only become normalized when both its associated technologies become more affordable and there is a fundamental value shift where the environment trumps economy. Integrated resource management and twenty-first-century circularity is a consensually-driven objective, but far from being achieved, regardless of context, east or west, north or south. At best, it is 'in the making' and has been initiated through a diversity of initiatives, projects, programs, plans and policy changes exploring new balances between different circularity agendas. Technological innovation and optimization play a key role; nevertheless, political shifts (necessarily emancipation oriented) and, last but not least, contextualization are indispensable (Marin & De Meulder, 2018).

What is clear from the emerging practices in Flanders and Vietnam is that a starting point for any transition to circular practices is the context, the space itself: its recognition as a non-renewable reserve and acknowledgment of the resourcefulness of space use (Loeckx & Shannon, 2004). It is clear that the geography, climate and history of land occupation and practices vary greatly in the two contexts. It therefore follows that the new modes of circularity must remain nuanced. There are abundant lessons from history which underscore the interdependencies of the city and its larger territory which formed a social, economic and ecological unity. Evidently, in the contemporary world, space is a receptacle of uncountable flows of materials, people and data. Circularity and cyclic thinking are an invitation to transform function as well as the meaning and value of space. The shift from a resource-based linear economy (cradle-to-grave system) toward a resource-cycling circular economy (cradle-to-cradle system) implies the capacity of space to accommodate a multitude of uses and power of natural ecologies to regenerate. It is imperative though, that technocratic and performance-based solutions do not indiscriminately blanket territories. The richly layered 'landscape as palimpsest' (Corboz, 1983) instills particularity to places. The socio-cultural practices of the past and future must necessarily inform the tools and types of circularity. Not surprisingly landscape urbanism traditions, which consider landscape as an infrastructure, match seamlessly with circularity. Clearly, such 'infrastructure' is an enduring element (as all structure is by definition) that while spatially structuring practices and uses, adapts itself to changing circumstances of seasons and epochs, interacting with the cycles of natural processes and waves of development. It is also not unexpected that the reversal from linear to circular practices goes hand-in-hand with an exchange of old nineteenth and twentieth century (industry-initiated or inspired, unfortunately wasteful) hierarchies and centralities toward heterarchical and decentralized systems, flexibly adapting themselves to circumstances, sites and cultures.

Acknowledgements Julie Marin's research is funded by the Research Foundation Flanders (FWO—grant number 12Z9420N). An earlier version of the text about Antwerp was presented at the IPHS conference at TU Delft in 2015.

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Chapter 7
Circular City: Urban and Territorial Perspectives

Giulia Lucertini and Francesco Musco

The United Nation's 17 *Sustainable Development Goals* (SDG) can be considered as the lighthouse of the great challenges which humanity will be confronted with. Many of these goals are related to our behaviors and our "take, make, and dispose," namely, the linear dominant economic model that, in the last centuries, is leading to an ongoing increase of resource consumption and, consequently, a huge generation of waste. In fact, the rate of both natural resource consumption and waste generation are urgent issues, especially in the urban and peri-urban areas that will require proper solutions. The city is and will be even more in the future the most affected and the major drivers of resource consumption since it is expected that by 2050 more than 70% of the population will live in urbanized areas, and cities will grow in number and size. It means that land, water, food, energy, and other natural resources are increasingly necessary, but because resources are limited, it is required to change the linear consumption model in a new circular model of use and consumption where waste is avoided. In the last few years, it has emerged that waste management practices are improving according to the European Waste Hierarchy guidance, but there is still a wide possibility of improvement.

This chapter explores, on one hand, what the circular city means, and on the other hand how to build it suggesting some policy recommendations. Considering urban and peri-urban areas as the space of material and people flows, thus optimizing the space used by flows and improving their interactions, it will be possible to construct another step toward circularity. In that view, the circular city acquires an urban and territorial perspective that can be managed with the urban and territorial tools, measures, policies, and plans, able to link also issues like climate adaptation, resilience, and sustainability. Finally, we argue that important work must be done in the immediate future in order to re-think and re-design urban spaces, urban practices, and infrastructures, thus shift from linear to circular city.

G. Lucertini (✉) · F. Musco
Iuav University of Venice, Venice, Italy
e-mail: glucertini@iuav.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_7

7.1 Introduction

Up to now urban population is more than 50%, and the projection tells us that by 2050 it could overcome 70%, although urban areas occupy just 2% of the global land area (The World Bank, 2019; UNPF, 2018). Such rapid urbanization and population growth, over the last few decades, put intense pressure on the use of urban and global resources. Cities consume about 70% of global resources and energy produced, and at the same time, they produce about 70% of all greenhouse gases and global waste (Paiho et al., 2020). Cities are, and probably will continue, to be the problem but also the crucial subject for the resource and environmental issues solutions (Bina et al., 2016). Cities are recognized as essential in achieving the objectives of the Sustainable Development Goals (SDGs). The transition toward a more CE is considered very interesting because CE is supposed to contribute conjunctly to several SDGs, especially to SDG 12—sustainable production and consumption patterns, SDG 6—water, SDG 7—energy, SDG 8—economic growth, SDG 11—sustainable cities, and SDG 13—climate change (Geng et al., 2019; Schoggl et al., 2020; Schroeder et al., 2019). Efforts are needed to make the city sustainable, avoiding over-extraction, consumption, and degradation of resources, toward a resilience system. Thus, cities are called to re-think and re-design themselves and think up new ways to achieve efficiency (United Nations, 2020). Cities have the potential to engage within their community partnerships among the administration, private sector, consumers, and research organizations to implement new development models that will drive the transition to a more sustainable and circular city. The Urban Agenda for European Cities Development identifies 13 priorities considered fundamental, one of which is the CE (European Commission, 2020).

The CE is seen as a new development model that closing flows and reducing the consumption of virgin materials can produce positive impacts on environmental and social contexts while maintaining economic growth (Reike et al., 2018). CE is based on optimization, up-cycling, and enlargement of the lifetime of resources. There are no wastes but only secondary raw materials. Meanwhile, Urban Metabolism (UM) studies and analyses urban flows to support decision-making and transform flows from linear to circular (Kennedy et al., 2011; Wolman, 1965). CE and UM, although, address both the circularity issues, are hardly used in conjunction. While the CE is associated and developed mainly in industrial and business companies and is referred primarily for waste management and industrial symbiosis, the UM is seen as an accounting tool for cities or regions, referred primarily for energy (Cui & Zhang, 2018). However, these two approaches should be overcome and abstracted in order to move from sectorial approaches to the general city organization and development model. In that way, it will be possible to conceptualize and develop the circular city, a city able to re-think and re-design its urban spaces, its management process and transform its UM from linear to circular following CE principles.

This chapter aims to explain how the "circular city" means and suggest policy recommendations from an urban and territorial perspective by identifying a comprehensive overview of the most important city sectors and city development aspects.

Additionally, the chapter aims to highlight the steps toward the circular city constructions. In order to do that, the following questions are addressed: What means circular city from an urban and territorial perspective? What are the principal sectors and flows for a circular city? What tools and actions should be used to planning the circular city?

7.2 Approaches: Circular Economy and Urban Metabolism

Discussion about resource efficiency, waste reduction, and zero land consumption is connected with the circularity concept. Related to the circularity concept, two main approaches have got attention: Circular economy (CE) and Urban metabolism (UM). Both are centered on changing the development paradigm from an unsustainable, wasteful linear model to one that is sustainable, resilient, and circular. Still, if CE is seen as an alternative development model based on material-flows (Geissdoerfer et al., 2017), the UM is seen as an accountability tool to assess material-flows (Lee et al., 2016).

Circular Economy (CE) "can be interpreted as a new approach to deal with waste issues, but, more broadly, it provides an alternative development model to the - take, make, and dispose - dominant economic model" (Longato et al., 2019). CE was defined in several ways, Kirchherr and colleagues (2017) identified and analyzed 114 CE definitions. However, the best known definition is probably provided by the Ellen MacArthur Foundation (2013, 2015). In all these definitions, CE is mainly described as a mix of activities (reducing, reuse, and recycling), where the emphasis is biased toward economic growth, rather than environmental quality and social equity. It refers especially to how resource flows can be closed (close the loop).

In recent years, attention and interest to Circular Economy (CE) have grown significantly among policymakers, economic actors, and scientists (Merli et al., 2018; Ruiz-Real et al., 2018). An increasing amount of literature upon the conceptualization of CE, the development of "circular solutions," circular business models, and CE policies have been produced (Milios, 2018). Nevertheless, the number of publications on the CE has proliferated, most of the relevant studies concern the application of the CE to the improvement of business management and administration (Lewandowski, 2016; Ormazabal et al., 2018), or the opportunities presented by the CE in companies (Veleva & Bodkin, 2018). In parallel to the academic approaches, there is also a clear trend at the governmental level of promoting the CE (Camon Luis & Celma, 2020).

At this stage, CE continues to be discussed primarily in the productive and industrial fields (Korhonen et al., 2018). Little attention was given to the circular spatial dimension. It means that the city, with its management, processes, and structures, received limited consideration. Some attempts to talk about the circular city have been made (see: Cavaleiro de Ferreira & Fuso-Nerini, 2019; Eurocities, 2017; Fusco Girard & Nocca, 2018; Williams, 2019), but the discussion is in its infancy, and CE remains fundamentally an economic concept.

Almost in parallel with the diffusion of the CE approach, another approach, the Urban Metabolism (UM), was rediscovered and repurposed. The UM consider cities as living organisms that use the resources in input and produce wastes in output as a result of the process of consumption. One of the leading scholars defines UM as "[…] the total sum of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste […]" (Kennedy et al., 2007). Although UM was developed earlier and independently from CE, they share some principles. The circularity of flows is relevant for both approaches, resource consumption should be limited, and waste production must be reduced close to zero (Haas et al., 2015). UM considers flows of natural and industrial materials, energy, people, and information (people and information are not usually considered in CE). Moreover, UM explicitly considers city space as a critical element. City morphology and boundaries are needed to represent flows and define urban–rural relationships (Lucertini & Musco, 2020).

UM approach, up to now, has been understood and used mainly as an accountability method, a tool to analyze and assess flows. UM, researches and applications have the goal of creating quantitative information and knowledge about the city's metabolism. These accountability methods are of two typologies. The first one accounts for material or energy flows like the Material-Flow Accounting (MFA), while the second one attempts to identify indicators able to understand the changes in resource use, the city ecosystem relations, and the city metabolism environmental impacts, like the Life Cycle Assessment (LCA) (Ghisellini et al., 2016).

Several authors (Castan Broto et al., 2012; Pincetl et al., 2012; Thomson & Newman, 2018) claim that the UM approach could have possible positive impacts on urban planning and management. The UM is seen as a tool able to support a process toward a sustainable and circular city. However, considering the UM approach just as an accountability and assessment tool for material and energy flow, there is the possibility to lose an opportunity. In fact, the circularity expressed by the CE should be integrated with the theoretical aspects of the UM, considered as a sustainable development model and not only as a knowledge tool (Elia et al., 2017). Thus, CE and UM together must be considered as a uniquely proactive approach to re-think and re-design urban spaces and support urban planning. Studying CE and UM means have necessary instruments to develop better and manage the complex relationships among the city and its peri-urban areas (Amenta & Lucertini, 2019).

7.3 Urban Areas and Urban Flows

Cities are complex systems made up of the unique economy, infrastructures, landscapes, networks, resources, and culture, in which different stakeholders (businesses, public sector, knowledge institutes, citizens, and communities) are moving and operating in an interconnected way. Up to now, in CE and UM context, urban and peri-urban areas are considered only marginally, sometimes as an external entity but not as a direct agent in their spatial and physical morphology dimension. Studies on CE and UM have a spatial disconnection. Physically space is not just a “context” but an “agent” that makes circularity happen. It means that to achieve circularity of flows the spatial system has to be shaped for this task. The spaces and relations between spaces of urban and peri-urban areas have been designed in a linear perspective, like our style of consumption, but in order to change perspective and move toward circular physical space play a fundamental role.

Urban and peri-urban spaces need to be conceived and re-designed in terms of the cycles of energy, water, materials, and people; the way to do that is to understand and re-design urban flows. Re-think flows are a spatial and socio-political transformation, with high impacts on the economic, social, and environmental aspects of the city. Flows are processed and exchanged between a city and its surrounding (Magnaghi, 2000). Objects and artifacts’ life cycle and material flow find in urban and peri-urban areas their main application because urban use and rural use are here interconnected physically on space (land). Linear metabolism consumes land and landscape while circular metabolism improves their resilience and sustainability.

The flows, that move shaping the urban and peri-urban physical space, are the focus of the circular city. The challenge is to understand, scale, and especially localize them, in order to create synergies and circular nexuses. Many UM types of research have studied the singular material urban flow (food, chemical products, plastic waste, etc.), but there are no relevant analyses about flows interlinkage, trade-off, and synergy (Paiho et al., 2020). Moreover, there are no studies that consider the physical space as a factor that can support or limit circularity.

In order to build the circular city, re-design urban and peri-urban areas require understanding and assessing what happens inside and outside the city boundaries. City boundaries could be of different typologies like geographical, activity-based, temporal, and life cycle (Iveroth et al., 2013). In a circular city, context is relevant to understand the geographical boundaries, which on the one hand, are easily definable, but on the other hand, it may not be advantageous. Geographical boundaries can not represent the place of extraction, production, emission, or discharge; all these activities can take place outside. Having unclear urban inner structures can be a serious limit for flow analysis and the circularity assessment. However, geographical boundaries should be the objective of any circular flows. It means that a circular city works to reduce any flow exchange with the outside. It will work not to consume its unbuilt land since it is necessary to produce food and manage organic waste; it will support the vertical farm and urban gardens. It will work on produce as much as possible renewable energy from its rooftop and make more efficient buildings and transports. At the same time, it will work to reduce waste as much as possible, reusing and recycling all the materials that come from outside. Urbanization and globalization link cities close to their rural and surrounding areas, which acquire a great value. Obviously, some flows will necessarily continue to come from outside, and it will be impossible to achieve zero waste, but the circular city should tend to make all its flows circular within its geographical boundaries. These difficulties probably limit also the general knowledge of material and energy flows. In fact, there is a severe lack of commensurable data of flows. Cities have difficulty to know the flows which enter and pass through their territory. Statistics on material flows and waste streams are usually available at the region or national level. While at the city level, statistics are usually incomplete or unexisting (Zeller et al., 2019), and not useful for the small administrations. The lack of data could be one of the reasons why the city flows have not been analyzed in an interlinked and holistic way. In literature, many times, studies and comparisons are made considering only two or three flows, like water-energy-food nexus (Voelker et al., 2019).

Flows move through different urban and peri-urban areas crossing internal city borders, which means that flows influence urban morphology, but at the same time, they are themselves affected and modified by city structure. Materials and energy stocks or material for reuse and recycling depends on the localization of flows. Re-thinking and re-designing the city should replace linear processes with circular processes, and long-term connections can be established between different flows. Urban planning should significantly contribute to triggering flows of materials, services, energies, and people to support circularity and CE.

7.4 Circular City

The premises for a circular city are strongly connected with sustainability, resilience, and climate change (Wang et al., 2018). Talking about the circular city is critical to underline that, currently, there is no clear and shared definition of what constitutes a circular city (Paiho et al., 2020). Prendeville et al. (2018) define a circular city as "a city that practices circular economy principles to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city." Ellen MacArthur Foundation (2017) says that "a circular city embeds the principles of a circular economy across all its functions, establishing an urban system that is regenerative, accessible and abundant by design." Regardless of the several possible definitions, in general, as argued by Fusco Girard and Nocca (2019), "The circular city is a metaphor for a new way of looking at the city and of organizing it."

In recent years, many cities have proposed strategies or roadmaps toward circularity (e.g., Petit-Boix et al., 2017; Prendeville et al., 2018). Additionally, many local initiatives, also if without dedicated circular strategies, were identified by Climate-KIC, C40 Cities, and 100 Resilient Cities. All these initiatives can be categorized into four typologies: local strategies; urban refurbishment; public procurement; and waste management (Paiho et al., 2020). The studies on these initiatives show that cities are only in the early stage of transition toward a circular model (Campbell et al., 2018).

It is important to underline that, in all these initiatives, the spatial approach to circularity is almost absent. The spatial and structural component of the city is only marginally considered in some specific activities of urban refurbishment, or as a limit for urban metabolism analysis. The city's areas are not viewed as the main component for circularity. Circularity in the city keeps the characteristics of industrial and business circularity. However, this approach is fundamentally wrong because the city has structure, processes, and goals wholly different and much more complex than a company or industry. At the same time, cities should not be seen as facilitators or financiers of enterprises intended to implement CE projects (Prendeville et al., 2018).

Circular cities should be themselves the main actors of their transformation toward circularity. That can happen only by acting on the urban morphology and structure, on the infrastructure connections and interdependencies, and services (ecological, social, and economic) provided by the different urban and peri-urban areas. Circularity in the city is a concept that has to consider primarily urban space and the political/governance components, then all the administrative sectors (not only waste) in an integrated and holistic way, without forgetting the city objectives (environmental, social and economic). Some usual practices linked to recycling and recovery activity of buildings and infrastructure materials do not necessarily promote circularity since destroying them could be more environmentally harmful than reusing them. Thus, having a new and more efficient building or infrastructure could have limited benefits if considered its Life Cycle Assessment (LCA). The trade-off, synergies, and complementarities must be fully considered. Complex systems theory defines urban ecosystems as a set of multiple interlinked subsystems in permanent interactions among them and with outside the system (Alberti, 1999).

Different from CE in industrial production and supply chain that focuses on reducing waste to maximize profits, circular city development should be a pathway with environmental and societal goals focuses on enhancing the urban ecosystem and urban people. Thus, spatial planning potentially has a fundamental role in the circular transition and circular city development. Paiho et al. (2020) argue that "Circular principles should therefore be applied in all urban planning decisions." However, there are no clear definitions or methodologies to implement the circular principle in urban planning and the urban space of the city. The circular city should be based on system integration, redundancy, and flexibility, cooperative and intelligent behavior. Within a circular city, any structure and infrastructure should be designed for several purposes in order to be reused or re-cycled over time (Circular Cities Hub, 2017).

Urban structure and infrastructure affect the production, storage, distribution, and consumption of resources in cities; they directly affect urban circularity, adaptation to climate change, and environmental resilience (blue-green infrastructure) (Williams, 2020). Understanding the spatial characteristics that influence all the urban flows and their circularity in the long term should be the first step to develop an "urban circular system." A system able to plan, design, and manage urban areas, considers urban and peri-urban areas as a complex and interrelated system. There is a need to re-imagine and re-define actions like reuse, recycle, and recovery in the city context. Cities' infrastructure and urban form should be re-designed in order to be adaptive and resilient, enabling urban systems to evolve with changing needs (Williams, 2020). Moreover, it is crucial to apply the circular approach in specific sectors, such as waste, wastewater treatment, building regulation, etc., but also considering the city as a system.

Some of the core issues in the circular city are:

- Identify space for urban farming and bio-economy in order to close the food waste loop and reduce transport;
- Identify space to support industrial symbiosis and win–win relation between industry and residence;
- Identify space and policies for logistics to support and facilitate reuse, repair, and re-manufacturing;
- Identify space and policies for a sustainable mobility system in order to be clean and shared;
- Buildings should be modular, designed for disassembly and material value recovery, and shared;
- Wastewater infrastructure should be flexible and intelligent, designed to recover water and secure urban areas;
- Build infrastructure and policies in order to digitalize urban services (smart city);
- Define space and policies for local and renewable energy production.

Planning should work to ensure space for closing the urban flows and to support circular activities, creating an interconnected system with a combination of uses, avoiding land speculation, gentrification, and zoning. Nexuses and trade-offs should be recognized, valued, and supported with planning. The whole planning system should guarantee that urban morphology enhances actively circular flows.

7.5 Conclusion

Resources consumption and waste production are issues that require great attention, especially in the urban and peri-urban areas, in which these issues are relevant and concentrated. The CE end UM approaches attempt to understand and solve such problems that are demonstrated to be urgent and connected to sustainability, resilience, and climate change. Despite the increasing number of research and studies, the operationalization of these approaches in city management and administration is still limited and in its infancy.

Throughout this chapter, we try to answer the research questions presented above, underling the CE is an approach that at the city level should be integrated with the UM because cities have different characteristics, goals, and complexity than companies. Waste should be eliminated by working on processes, improving infrastructures, and creating sectoral interrelations, as much as possible. Moreover, the circular city is not a set of CE projects implemented on the same territory.

Improving the circularity means working to avoid the dispersion and dissipation of resources like water, energy, and materials. The circular city means to achieve circularity considering and re-design the physical space and urban morphology.

In the circular city, the main sectors and flows are probably buildings and infrastructures, mobility and transports, but also food, agriculture, and ecosystems. In this context and perspective, urban planning and policies can be considered the principal tools to transform the actual linear cities into future circular cities.

These new circular cities should have a long-term and holistic vision to shape their flows in a circular manner, through the implementation of structural and governance actions, but also through the re-design of the physical space. There are many practical challenges for developing a circular city that is related to business, policy, technology, and knowledge.

In the future are need research and practical application aimed to understand the connection between flows and urban morphology, but also research on intangible flow, circular lifestyle, and circular wellbeing. Moreover, future projects should be aimed at understanding the links and the coevolution among spatial structure, infrastructure, and economic activities.

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Chapter 8
New Urbanization Phenomena and Potential Landscapes: Rhizomatic Grids and Asymmetrical Clusters

Enrico Formato

8.1 Foreword: Territories of the Circular Economy

More and more nowadays, the Circular Economy is at the heart of European public policies.

Crucial is the "New Green Deal", presented by the European Commission (2019) to implement the Agenda2030, and the UN Sustainable Development Goals. This program is significantly guiding the way in which the funds allocated for post-pandemic reconstruction will be used in the coming years through recovery plans ("Next Generation EU"). The action plan, in brief, is based on two axes: (1) promoting the efficient use of resources by moving towards a clean and circular economy; (2) restoring biodiversity and reducing pollution. The ecological transition is based on a "new deal" between the productive sector, governments and citizens. A character of solidarity and social justice underpins the development strategy, which specifies that: changes «should leave no one behind» (p. 18), that changes in the production system should be such as to increase employment, and that technological, process and product innovations should be designed to «address the risk of household energy poverty» (p. 7). Paragraph 2.1.4 focuses on the construction sector, its energy and resource efficiency, and the need to «initiate a wave of renovation of public and private buildings» (p. 10). The territorial dimension contributes to the strategy far beyond the mere focus on the quality of buildings. First and foremost, importance is recognized for the need to increase sustainable urban mobility, by strengthening public transport, reducing traffic congestion and encouraging the use of non-fossil fuels. Equally important is the way in which the concept of circularity is applied to the waste and agricultural sectors. With reference to the way in which territories operate, to their metabolisms, what stands out is the prospect of radically shortening the supply chains: in the agricultural sector, by promoting the direct relationship

E. Formato (✉)
University of Naples Federico II, Naples, Italy
e-mail: e.formato@unina.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_8

between consumer and producer (p. 13 et seq.); in the waste sector, by recycling waste as a secondary raw material. Specific attention is paid to construction waste (CDW), for which the Commission is currently amending Regulation (EU) No 305/2011 in order to facilitate its reuse. The second strategic axis, based on the "restoration of biodiversity", includes, firstly, the recognition of the essential function of ecosystems that «mitigate natural disasters, fight pests and diseases and contribute to climate regulation» (p. 14). Building on certain existing measures, such as the one that established the Natura 2000 network of protected areas (Directive 92/43/EEC "Habitat"), the document highlights the importance of reforestation and the sustainable use of fundamental "common goods" such as water and soil. On this last point, in 2016, the European Commission's Office for Scientific and Environmental Policy, in its document "No net land take by 2050", called for urgent measures to prevent new urbanization from consuming the remaining natural and rural territories. The strategy is based on three guidelines: (1) preserve, avoiding the transformation of urban open spaces and agricultural land into new settlements; (2) recycle, recovering abandoned urban areas that are no longer active, reconverting them to new uses or promoting their renaturalization; (3) compensate, balancing the building of previously undeveloped areas with the renaturalization of built-up areas where soil sealing is no longer necessary.

All these concepts are at the basis of the Recovery Plans called "Next Generation EU", now being drafted in every European country, to stimulate post-pandemic recovery. With these plans, an amount of financial resources comparable only to those of the Marshall Plan after the Second World War will be available in the coming years to profoundly change the territory and the way of life in the old continent, shaping the "ecological transition" that is nowadays more necessary than ever.

This is a huge challenge that calls for responsibility and cooperation from town planners, architects, scientists, local development experts, but also politicians and citizens: all those who are motivated to search for new points of sustainable balance in the relationship between production, consumption, environment and quality of life.

At the same time, radical vision and operational concreteness are needed.

8.2 Status Quo: Analogies and Differences

In order to strengthen the territorial dimension of public policies aimed at ecological transition, it is necessary to consider the status quo of the European territory, looking for recurring elements and differences in relation to which define technological and process solutions, spatial and landscape models. It is not enough to implement a basic knowledge atlas, using common standards across countries, as so far developed through mapping systems such as Copernicus, the European Union's Earth observation program.

What is weakly outlined today, and with respect to which an effort of synthesis should be made, is an interpretative framework capable of considering the "materiality" of places: able of understanding the reasons behind their current conformation and use, going back to the structural relationship between the economic and social conditions in which their physical and environmental organization has developed. In this perspective, a return of "hard" urban studies, focusing on the issues of land ownership, land parcelling, infrastructural and urbanization procedures, (and their relationships with the environment and the landscape) should be conducted at the European scale. These in-depth studies should be able to answer certain fundamental questions, so as to target interventions, avoiding errors and inefficiencies, which are unfortunately still widespread in the implementation of Community programs.

A sketchy list of questions: Why are some territories similar and others not? Why are some public policies more successful in some areas and not in others? How have our cities developed since the second half of the twentieth century? And finally: is it possible today to define stadardized urban planning policies to implement the goals set out in the New Green Deal?

It is not a history of European urbanization, of course, that is missing. Instead, the aim is to investigate the relationship between the new phenomena of urbanization and the material conditions from which they originate and in which they are developing. The purpose is to outline a critique of urban space, based on the interpretation of the relationships between production systems, land and natural resource management, landscape, environment and ways of living. Without this basic work, preparatory to a reflection on the reform and transformation of territories, it will be difficult to achieve the ambitious goal of the "ecological transition" and the concomitant urban revolution necessary for it.

8.3 The Fringe: Two Models

Undoubtedly, a central role for the future of contemporary territories is played by the territory of the so-called "fringe area", the part of the urban region where patterns of building development and unbuilt open spaces interweave (Attademo & Formato, 2018). The fringe has neither features of an urban compact city, nor of suburban village ones. Its topographies, are in turn defined as: peri-urban area, urban sprawl, dispersed urban development, widespread city (*città diffusa*), territories in-between, transitional-belt, etc. Many contemporary urban challenges converge in this place, «and, at same time, can be solved in the fringe» (van Tuijl, 2018: 35). Because of the structure of contemporary urban regions (post-rounded, widespread, increasingly polycentric), the fringe area is not a perfect match with the surrounding area of the city. However, its intermediary character, as a place between the compact city and the suburban countryside, makes this zone particularly favourable to the definition of spaces of collaboration between the two worlds. In addition, its easy accessibility from both the denser contexts and the outer areas makes it the place to locate the equipment required to create short supply chains so relevant, as mentioned above, for the circular economy and the ecological transition.

From a quantitative point of view, several indicators can define fringe areas: some are depending on physical features (number of buildings and surface, built-up volume, parcel fragmentation, etc.); others are derived from the way in which these areas are used (e.g., housing, factories, infrastructures). Landscape-reading shows territories characterized by high fragmentation, lack of urban and ecologic continuity, hybrid (not-rural, not-urban) conditions, dispersion of a sense of place caused by continuous overlapping of sectorial elements and flows. That is a non–isotropic spatial structure. It is determined by iterations, rips, spatial accumulations of scattered uses and buildings. As seen from above, the boundaries delineating the end of the city region are not clear. The internal difference between compact neighbourhoods and fringe areas is usually highly unclear. Moreover, the dynamics of the fringes shape building settlements in a fluid manner and enable the functional mix and the local hierarchy of urban elements. Physical boundaries rarely coincide with administrative borders. In some cases, boundaries match with geographical or morphological differences (the presence of a river, mountains, the difference between historical settlements and contemporary ones, etc.). At other times, boundaries coincide with main infrastructural paths (railroads, highways, etc.), as well as with built precincts and dikes (walls, fences, etc.). Finally, internal boundaries often match with social features and functional characterizations.

The morphology of fringe settlements is characterized by spatial fragmentation and poor quality of public space. The boundaries between private parcels and the public realm are rather strict: fences and walls are key elements. Moreover, fringe areas are often car-based: people rarely meet in the streets, but rather turn to shopping malls, pubs, discos and restaurants. Functional and social integration, density of population and a wide range of meeting possibilities in physical public spaces are traditional values of the urban realm (in other words: traditional values of European cities); these values are not so strong in the fringes of the contemporary cities.

Within the common characteristics of the different situations mentioned above, however, profoundly different urbanization patterns emerge, depending on the European context in which the peri-urban areas are located. It is possible to distinguish two prevailing models, respectively, in the countries in which the role of the state in urban planning and implementation has been, since the Second World War, more or less relevant. The two cases studied as pilots of the REPAiR project are paradigmatic examples in this sense: the metropolitan areas of Amsterdam in the Netherlands and Naples in southern Italy.

In Italy, the weakness of public urban planning has determined significant effects on the way in which the urbanization of fringe areas has taken place. In fact, in the contemporary expansion of the cities, there has been a lack of coordination on a general scale, capable of providing unitary frameworks on an urban and regional scale, putting transformation initiatives of different kinds and types into a system. With reference to the land regime, there has been a split between areas subject to public initiative and privately owned land, left to individual initiative. In the latter, only rarely land recompositing preceded urbanization, which, instead, tended to rely on the pre-existing territorial frameworks: it spreads in the peri-urban contexts in a dispersed way, taking fields plot and dirt roads as its basic frame. This process, burdened by the land rent, has led to congestion, systemic incoherence, low quality of environment and settlements. Not infrequently, the settlements have been built in violation of the urban planning rules. These areas are burdened by many internal contradictions, but their material features also present a strong link with the "environmental pre-existences"; the communities that inhabit them generally retain a certain rootedness, recognizing themselves in the landscape that they have incrementally contributed to create. The contrasts are of a dimensional and topological nature, due to the lack of systemic rationality between the distribution of land uses and land cover and the uncoordinated nature of higher-level infrastructure policies (railways, motorways, etc.) contrasting with the informal proliferation of basic local infrastructure, which is haphazard and not infrequently built "ex post", following the urbanization. Underuse and abandonment proliferate. When the life cycle of a space or a building ends, impervious is its reactivation. It remains as a memory of the past; it can be taken over by the "third landscape" after a few years of abandonment. On the other hand, further territorial resources are consumed in order to create new activities.

An expansive phase of urbanization was followed by a phase of infrastructural development, which can be conceptually compared to the way in which the urban "hygienists" (from Haussmann to Piacentini), through massive public works, realized the urban renewal. Motorways and decontextualized public facilities have been inserted into the territory of dispersion, still without a general plan, creating further asymmetries and polarizations. The scenario is also difficult because the uncoordinated and diffuse urbanization has left ruins on the field: portions of disused, underused or decaying building and territorial heritage, whose transformation is now truly complex. The result is an expansion that leaves behind decaying "pieces of territory", generating chaotic topologies in which expanding settlements intermix with discarded, abandoned territories in crisis.

Completely different is the second fringe model. In the Netherlands, as in many other industrialized Northern European countries, the urbanization of the fringe took place (and still takes place) through some steps typical of what French scholars call *planisme*: preventive acquisition of land (and land consolidation); infrastructure of the areas—through the construction of roads and technological systems but also of public spaces and buildings; finally, construction by public or private initiative (Vayssière, 1988). This procedure, to be framed in the economic approach of Keynesian tradition, seems to be able to calm and direct the land market, ensuring coherence between the transformation project and its implementation. In this centralized organization, the procedure of urban substitution (as well as those of new urbanization) generally passes through the creation of a tabula rasa condition. In the case of new construction, the land is first recomposed and then an urban design is superimposed on the pre-existing traces of the territorial palimpsest. In the case of building replacement or settlement transformation, is required a prior demolition of the pre-existing buildings.

On the one hand, therefore, this procedure ensures increased systemic efficiency and the containment of differential passive rent: even in the case of the resale of land plots to private developers, their cost is determined by calculating the financial resources advanced for the acquisition of the land and the realization of the urbanization works. On the other hand, it risks to be authoritarian and self-referential, producing abstract spaces, separated from the context, disconnected from the geographical and historical context and from the expectations of local communities. In this model, the wastescape territories seem to derive mainly from two phenomena: the oversizing of the infrastructural system, which in this model is carried out prior to urbanization; the negative effects of the metabolism of the urban and productive system, in terms of environmental and landscape damage and of strong segregation and social conflict, especially within social and affordable housing districts.

8.4 New Greenbelt Scenarios

The issue of limiting soil consumption has been on the political agenda for years, as well as in the thinking of urban planners. However, the relationship between limiting land take and densification cannot be considered direct. It is not enough, in fact, to promote the densification of "what is there" to prevent the proliferation of rural land consumption. On the contrary, without urban planning correctives (Garreau, 1992) densification in the centre of an urban system always corresponds to a fermentation on the edges. This is true even when the centres are dispersed and geographically peripheral, as in the contemporary post-metropolis (Soja, 2000).

There are several reasons why densification of the existing cannot be resolved in a "flat" thickening of quantity and functions; nor involve a widespread "reactivation" of underused and abandoned areas with traditional urban purposes. First of all, the progressive value of openness, distance, thinning and biodiversity must be recognized. Contemporary cities cannot be configured as compact realms but must adequately accommodate and shape certain fundamental principles: the propensity for suburban living (Secchi, 1999), the need for contact with "wild" nature evidenced, as early as the nineteenth century, by Olmsted (Beveridge & Rocheleau, 1998), the possibility of the countryside returning as a way of life (AMO & Koolhaas, 2020).

This need is particularly evident today, after the lockdowns caused by the pandemic, when everyone has been able to appreciate the power and value of space, especially when the confinement took place in a house placed between other houses.

The fact that the relationship between densification and the containment of soil consumption is not direct means supporting a broader strategy of territorial redevelopment. A strategy that promotes a progressive transformation of urbanization, both of the one based on the systemic rationality of zoning, and of the "città diffusa" (also unauthorized settlements) rather common in Mediterranean countries.

This strategy must be declined locally, case by case, on the basis of a wide sharing. However, it should always focus on rethinking fringe areas, the margins of contact between settled systems and the rural environment. These transition areas, accessible from town and country, crossed by large infrastructures, are exposed to further proliferation of soil consumption. In reverse, they need to be rethought as new collective spaces, areas for the biodiversity, inhibited from settlement proliferation and subject to restrictions on car traffic. In them, the circular dimension of the new green economy can give shape to certain spatial conditions and new landscapes.

Qualitative densification needs to be shaped in them: promoting social uses, stimulating agricultural production, experimenting new sustainable habitats and uses.

By analogy with what happened in Great Britain in the twentieth century with the institution of greenbelts, these peri-urban areas should be delimited and subjected to a new urban planning regime aimed at their territorial reconfiguration (Sturzaker & Mell, 2018). Once the peri-urban territories have been delimited, the following should be encouraged: the collective use of a network of paths and fields, the maintenance or replanting of agricultural crops (and/or woods), the inhibition of land fencing, the promotion of land recompositing and ecological reconnection.

New economies can also emerge in these fringe areas, closely linked to the life of the city and the countryside, not only in terms of food supply or activities related to waste treatment and recycling.

This kind of contemporary greenbelt has rather different characteristics from those usually associated with these types of space. In particular, in the low-density areas of the so-called "horizontal metropolis" (Cavalieri & Viganò, 2019), the geometry of these new peri-urban parks would take the form of a continuous serpentine of local belts, thickening the boundaries areas, with infiltrations into denser urban systems. These spaces, relying on the hydrographic network, would also define new conditions of resilience of the built-up area to natural risks, linked to the presence and criticality of the hydrographic network.

Is not this "serpentine" a hopeful space with which to shape the New Green Deal?

8.5 Spatial Models: "Asymmetrical Cluster" and "Rhizomatic Grid"

Two main spatial models are useful to describe the future process of sustainable reform of the peri-urban territories, shaping the challenges of the fight against climate change and the New Green Deal.

The first model assumes the figure of the "cluster": a territorially and functionally defined region with one or more reference centres and an edge marking the discontinuity from other clusters. This spatiality is generally constructed from a basic hierarchical tree-like infrastructure (De Carlo, 2008; Zuger & Christiaanse, 2018). The second model is based on the figure of the grid: an unlimited mesh, tending to be isotropic and isoriented, which gives measure and organizes space according to a replicable and open system. This spatiality is built on a redundant and slender infrastructure, devoid of hierarchy, which can give rise to a sponge rich in pores, with neither internal nor external boundaries (Secchi & Viganò, 2011).

The cluster give shape to the need to shorten flows, seeking defined spatial regions in which to close food and waste cycles (urban and agricultural), raw materials needed for construction, as well as to shape local energy communities. Each of these clusters is asymmetrical because it includes different portions of territory, "transects" (Duany, 2021) that reach from the dense city to the countryside and natural territory.

The peri-urban fringes, are the core of these territorial sections: the place where to locate plants, services and infrastructures necessary to regulate the new flows-cycles of matter, people and energy.

A similar model was tested during the REPAiR research as part of a proposed solution for the treatment of organic waste (REPAiR, 2019). In that case, it was imagined that the size of the waste treatment plant would be adapted to territorial areas coinciding with urban districts and overlooking portions of rural territory, in order to close the loop of collection-treatment-recycling of the materials processed by the composting plants. In that solution, moreover, the compost produced by the plants, which is of good quality because it is also fed by agricultural production, is reused to stimulate the return of nature and biodiversity to areas that are now artificial and to stimulate the phyto-purification of polluted soils.

The cluster model focuses on the specificities of places, on contexts—both in their material constitution and in their use. In these mixed regions (urban-peri-urban–rural), in accordance with the above-mentioned tree pattern, driveways should be limited as much as possible, focusing instead on slow transport modes and driveway movements exclusively linked to routes to residential areas and production activities.

A spatial movement of "closure" of clusters is proposed to be counterbalanced by a concomitant movement of "opening" at all scales. This openness takes shape through the work that must be done on the level of the territorial grid. This weak infrastructure is in fact a basic condition, necessary to stimulate the public use of the greenbelts, allowing for conditions of pedestrian and cycle accessibility.

The grid should be established, conceptually and operationally, through an archaeological action that searches the territory for traces of historical systems and landscapes, bringing to the surface the sense of identity of places, their "seduction" (Rjkwert, 2000). This challenge appears particularly relevant in countries, such as Holland, where modernity has operated on a "tabula rasa" basis, in search of functionally perfect metabolisms. The structure of the grid is comparable to that of a rhizome: a root that develops over time, mainly horizontally. It enhances the territory, stimulating potential reactivation "from below", which can act in the microporosities of peri-urban territories, opening up to new topological continuities and uses.

In practice, the network amplifies the conditions of accessibility, building potential reconnections in the infinite fragmented mosaic of peri-urban areas, especially in metropolitan contexts.

The issue of the "civic uses" that may emerge in these areas thanks to the new conditions of accessibility is particularly important. The prefiguration of the grid should in fact be accompanied by an increase in the possibility of collective use of unused areas and buildings for sustainable purposes, including production. It would be a question of establishing "new common lands" (Everard, 2011), rediscovering and adapting principles of pre-modern law, for the proliferation of undivided territories, open to compatible productive uses, to sociality, to open-air life, to new forms of hospitality and exchange, as well as for educational programs.

8.6 Conclusions: Potential Hypercontextual Landscapes

In conclusion, two major impacts that the spatial reform strategies outlined above would have are analysed: the consequences they would have on the landscape of peri-urban areas and on the way in which urban plans and public works should be designed.

As regards the potential landscape, the concept of the materiality of places is not only to be associated with the study of the soil regime and its cadastral parceling out. This condition also deals with the physical status of each context in which the clusters of shortening flows would define local metabolisms, marked by the use and recycling of what can be produced or "extracted" in the cluster itself. The closing of short supply chains for the use and recycling of materials, also with reference to the construction cycle, would have direct consequences on the architectural character of the new arrangements: a sort of contemporary hyper-contextualism is expected in which the landscape takes on grains, colours, materiality, closely linked to the local condition in which it takes shape (Abraham, 2015; Formato, 2020). Specific urban planning rules could stimulate this transformation: the need to use in territorial regeneration processes the materials coming from the reference cluster (which, therefore, should be identified at the scale of the urban region, constituting one of the main objectives of the new territorial plans). In a recent Italian public call for tenders, launched by the Ministry of Infrastructure and aimed at the regeneration of social housing districts, a specific bonus was awarded to projects using recycled building materials from a region no wider than 50 km.

Finally, a reflection on the rationales of the territorial, landscape and architectural project is outlined. What is proposed, in fact, requires going beyond the traditional way in which the project has been conceived, looking beyond both systemic efficiency and design, conceived as a blueprint (Reed, 2006).

The character of these urban reconfiguration processes, structurally open to uncertainty, would take advantage of a programmatic choice of spatial incompleteness: a condition of "unfinished", open to the accumulation over time of functions, forms, aggregations and densifications. These new spaces are open to the process, aware of the ephemeral nature of the conformations that can be defined from time to time. The first step is to ensure public accessibility of the transformation areas, and then to stimulate and design "on the ground" the spatial conformations that the uses and functions put in place by the inhabitants will suggest. The process could take advantage of the interaction between diffuse, non-technical knowledge and expert skills in engineering, architecture, town planning, geology and botany.

This line of work opens up a critical reflection that transcends the field of this essay, aimed at deepening the relationships between soil ownership, basic infrastructure, historical palimpsest, new proximity metabolisms, in a frame that involve the need for certain strategic perspectives for the peri-urban areas of European cities.

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Chapter 9
From Wastescapes Towards Regenerative Territories. A Structural Approach for Achieving Circularity

Libera Amenta and Arjan van Timmeren

9.1 Introduction: Circular Metabolisms and the Regeneration of Wastescapes

Reporting the research developed within the European H2020 research project REPAiR, the definition of wastescapes, provided in this study, builds upon work for two main cases: the metropolitan areas of Amsterdam (The Netherlands) and Naples (Italy).

The most vulnerable spaces of urban and peri-urban areas could be found in the so-called 'wastescapes' (Amenta, 2019; Amenta & van Timmeren, 2018; REPAiR, 2017a), seen as abandoned areas, or discarded territories and, at the same time—'moving towards a regenerative perspective' (Amenta et al., 2019)—as eco-innovative resources to improve the socio-ecological value of our contemporary territories. Wastescapes could be defined as 'unresolved territories', and as: 'privileged places for the proliferation of degradation phenomena that affect the environment and human well-being' (Cerreta et al., 2020, p. 1).

The understanding of neglected areas as wastescapes, meaning as the leftover spaces, thus the conceiving of them as waste or dross of the dynamics of the 'urban metabolism', builds on the American literature on 'Drosscape' by Alan Berger (Berger, 2006a, 2006b). The sociological perspective on wastescapes, as well as on urban metabolism, as reviewed by McDonald & Patterson, 2007, is a reminder of the irrationality of societies in the face of material (including water and nutrients) and energy flows. However, one important (positive) difference is crucial to be

L. Amenta (✉)
Department of Architecture (DiARC), University of Naples Federico II, Naples, Italy
e-mail: libera.amenta@unina.it

L. Amenta · A. van Timmeren
Department Od Urbanism, Chair of Environmental Technology and Design, Delft University of Technology (TUDeflt), Delft, The Netherlands
e-mail: a.vantimmeren@tudelft.nl

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_9

mentioned here: human settlements are able to adapt to environmental conditions. In contrast to many natural entities, a human settlement has the ability to be self-aware of its actions (and the effects of those actions), and adjust behaviour if necessary (van Timmeren, 2014).

This positive approach has been applied to wastescapes in the European Horizon 2020 project 'REPAiR—*Resource Management in Peri-urban Areas: Going Beyond Urban Metabolism'*, in an attempt to understand 'wastescapes' as 'resourcescapes', meaning as potential areas to be regenerated for multidimensional socio-environmental purposes. This is founded on the awareness of the actual context of resource scarcity and of the necessity to pursue the European agenda to move towards zero waste, zero emissions and the achievement of more resilience to systemic disruptions. All of this, with the aim to achieve a more inclusive Circular Economy (Ellen MacArthur Foundation, 2015, 2017). The REPAiR project focused on the transformation of the actual (mostly) linear Urban Metabolism of six Peri-Urban European Areas towards a Circular one, by closing the loops of resource flows, and by recovering the values of the underused or unvalued wastescapes. Wastescapes can be the result of two simultaneous processes of growth (urban dispersion and fragmentation) and contraction of cities (shrinkage, abandonment) (Amenta, 2015). To illustrate, they can be the result of changes in the economy and land use, due to for instance technological innovation and resulting structural obsolescence of buildings and infrastructures, demographic change or climate-related issues. Wastescapes could also be seen as the outcome of the 'metabolism of risk' (Russo & Attademo, 2020), as the emblem of the loss of the ecological balance between citizens and landscapes.

9.2 Peri-Urban Living Labs (PULLs) as a Collaborative Methodology for the Sustainable Regeneration of Wastescapes

Wastescapes are complex territories that differ case by case, typified by site-specific features: pollution, abandonment, lack of functions for certain areas, etcetera. Their condition of wastefulness involves different social, economic, spatial and environmental aspects. Due to their complex nature, their regeneration requires systemic approaches with the involvement of all the stakeholders.

Wastescapes have been defined within the research project REPAiR (REPAiR, 2017a, 2018c) as a combination of Drosscapes (Berger, 2006a) and Operational Infrastructures of Waste (Brenner, 2014). The first category of Drosscape includes degraded and/or neglected territorial resources related to subsoil (polluted soils, bare soils, artificial soils); water (water bodies, banks, shores, tanks, plants, flooding zones); land use (abandoned spaces, vulnerable lands); buildings (vacant and underused buildings and settlements, unauthorized, confiscated buildings and informal settlements); and infrastructures (dismissed or unused infrastructures and/or facilities). The second category, namely Operational Infrastructure of Waste, includes all the still performing facilities for waste management (storage, treatment, transportation/infra, etc.) (REPAiR, 2017a, p. 29).

The presented research aims to show first of all that wastescapes go beyond brownfields, comprising the diverse aforesaid grouping, and secondly that they can be considered a spatial resource, crucial to be included in strategies of action towards a circular economy. The spatial regeneration of wastescapes—including the two abovementioned categories—involves an integrated rethinking of the structure of peri-urban areas, its relations and functionalities, as an 'in-between' territory comprises among urban and rural. Peri-urban territories could be particularly affected by the problem of wastescapes, as they are spatially fragmented territories, characterized by mixed uses, and constituted by different function spread in the areas in-between urban and rural landscapes. Again, important to note here is that, within this context, circularity is understood beyond the sole material resource management, deepening the spatial implications of a circular management of resources, investigated at the urban and territorial scale.

The regeneration of wastescapes can be addressed as an innovative approach for sustainable developments, with an ecosystems services perspective that builds on the idea to re-build on cities as cradles of encounter and shared (eco)services. On the one hand, it is necessary to focus on the existing buildings and infrastructures, by valorizing and recycling wastescapes; on the other hand, policies on urban densification, such as infilling require strategically incorporated regeneration processes of wastescapes. Densification here, is not necessarily understood as spatial densification alone. It can also be referred to densification of different kinds of use, as ecosystems services, which could support the accessibility for everyone to (re)new(ed) public (open) spaces or facilities. Due to the need to find space as a result of lower densities of use of space—based on sustainable concepts (van Timmeren, 2006)—at the same time, this process can help realize the transition towards more sustainable, liveable and just environments as well as to possible ways to finance these. Within the new reality of a (post) Covid-19 world, a clear need for a wider availability of green areas, parks and public space and facilities in general has been shown to be crucial for health and well-being. This includes proximity to nature, something that is not always as obvious in today's cities, and—even if is present—denied by the restrictions imposed to contrast the pandemic. Often, precisely as a result of (spatial) densification strategies. Therefore, in particular a smarter use of available, under-used or unused areas, like wastescapes is crucial to fill this gap.

Peri-urban areas are characterized by diffused settlements (Wandl, 2019) providing the post-pandemic resilient infrastructures at 'the right distance of the urban archipelago' (Gabellini, 2018, p. 29. Authors' translation in English from Italian). If done in the right way, they could be transformed into new infrastructures for urban sustainability and circularity: linked to green and environmental networks which could densify the dispersion and open gaps in the dense urban areas, increasing porosity and voids (Pavia, 2015).

To cope with the increasing complexity of European peri-urban areas, REPAiR implemented a 5-phases methodology based on 'Co-Creation' developed and tested in six Peri-Urban Living Labs (PULLs). This 'Co-Creation' methodology applied in these PULLs comprises the following steps: 'Co-Exploring', 'Co-Design', 'Co-Production', 'Co-Decision' and 'Co-Governance' (Amenta et al., 2019; REPAiR, 2017b, 2018c). It has been implemented and tested with the main objective to elaborate Eco-Innovative Solutions and Eco-Innovative territorial Strategies which can enable decision-makers to better deal with waste management questions, including the spatial regeneration of wastescapes. As they are based on the six models of the Geodesign Framework developed by Steinitz (2012),[1] the five steps work in an iterative and integrated way. Within this approach, wastescapes are treated in a similar way as material waste in the value chain of the metabolic flows, to achieve more circular territories.

9.3 REPAiR Peri-Urban Living Lab (PULL) Methodology and Wastescapes Characterization in the Cases of Amsterdam and Naples

The wastescapes identified in the peri-urban territories of two of the six REPAiR cases, viz. Amsterdam and Naples Metropolitan Areas, are the spaces where challenges related to waste management are intertwined to spatial (e.g. fragmentation and accessibility), environmental (e.g. nuisance zones, pollution and degradation), and functional (e.g. malfunction and ownership) problems. For these wastescapes and their regeneration, REPAiR developed an interdisciplinary and multiscale approach, based on a collaborative process, aiming to manage different challenges at the same time through the development of Eco Innovative Solutions (REPAiR, 2018a, 2018b).

Through the stated 5-phase Co-Creation process implemented in the REPAiR PULLs (Amenta et al., 2019; REPAiR, 2018c) it was possible to cope with such complexity. It also allowed the collaboration of all stakeholders, which was crucial at each stage of the development process (Amenta & van Timmeren, 2018).

The first step of the REPAiR PULL methodology was the **'Co-Exploring' phase**.[2] It aimed to develop an integrated knowledge framework and a complete description of the case study areas, which includes spatial investigations as well as all the studies

[1] For more information on the 'co-creation' PULL methodology and the relation with the Geodesign framework visit the REPAiR webpage at the following link: http://h2020repair.eu/co-creation/.

[2] For an extensive explanation of the PULL methodology, organized in 5 phases, see the two REPAiR Deliverables: "Deliverable 5.1 PULL Handbook" and "Deliverable 5.4 Handbook how to run a PULL, which could be retrieved at this link: http://h2020repair.eu/project-results/project-reports/.

related to the processes for managing material and territorial resources relevant for each area(s) of focus. Specifically, in this phase, a determined setup of stakeholder subgroups altogether were addressing the quest to identify and map the specific wastescapes in the area of subject.

This phase included an iterative process of fieldwork and meetings with local actors—differentiated case by case—e.g. representatives of the public sector and decision-makers, citizens' associations, small enterprises, and so on. The stakeholders' needs, challenges, problems and objectives also have been categorized in this phase. Overview maps were made by researchers based on the input (and finishing up of determined characterizations for the specific metropolitan area of focus), then they were verified in the PULL workshops by the local stakeholders; this activity was crucial to update the maps which were adjusted according to the stakeholders' feedback. Among the wastescapes mapped in the REPAiR case studies, and validated as a second iteration by the key local stakeholders in the PULL settings, the array of outcomes is quite rich: e.g. there are polluted and abandoned soils, but also all the infrastructures for the waste management.

This first step in the PULL methodology started in Naples Metropolitan Area, where both key resource flows as well as wastescapes were identified and mapped. In particular, the latter can be characterized by spatial and environmental issues intertwined with social problems and often with informal activities related to waste management, altogether generating complex geographies of waste.

When zooming out, it becomes clear that a large presence of wastescapes could be found in the Eastern parts of Naples, which represent the historical industrial and productive areas of the city. Here wastescapes are a result of obsolescence (mostly resulting from the industrial decline), but also due to their monofunctionality as highly specialized areas where there is no functional mix at smaller scales, and spatial fragmentation at metropolitan scales (Castigliano et al., 2020). On top of this, in East Naples, wastescapes are framed as 'un-named spots to which people do not belong anymore' (Russo, 2012).

As a next step, the mapping experiments and methodology started in Naples were further developed in REPAiR's second pilot case, viz. Amsterdam Metropolitan Area (AMA). Due to another culture of policies and land use planning (among others), in this area, wastescapes had quite different characteristics, as they were mostly observed along large infrastructures (e.g. highways, the port and airport), like for instance, wasted territories as a result of legal nuisance zones of Schiphol Airport, wind turbines and other infra, and industries in the port. In the Amsterdam Metropolitan Area, the identification and drawing up of wastescapes at all has been unexpected for involved stakeholders, showing that even in spatial contexts known to be (re)developed and planned already many times such areas exist more often, and with a larger share then imagined.

After several reiterations carried out in a series of REPAiR PULL workshops, in both the Amsterdam and Naples Metropolitan Areas, different types of wastescapes could be determined, each of which related to the specificities of the places, its use and governance. In this first phase wastescapes also were identified for their promising hidden value and possible transformability; thus, wastescapes have been confirmed to typify potential resources for urban and territorial regenerations.

In the second step of the REPAiR PULL methodology, the **Co-design phase**, local teams in the six case studies jointly developed site-specific Eco-Innovative Solutions (EIS) and strategies. This was done through academic workshops and seminars with researchers and students, over and above within PULL meetings and workshops with stakeholders. In this phase, experiments and research took place with the aim to assess the status quo of the area of focus and to further outline specific challenges and problems, in order to refine EIS and their functioning in the specific contexts. Thus, challenges and problems relevant to the local contexts were defined in order to look for the most suitable EIS supporting their regeneration. Next, the resident stakeholders helped to identify the basic characteristics that the solution/strategy aimed for must have to create lasting change in the particular context. To do so, each of the six REPAiR case studies focused on:

- Prioritizing problems and resulting objectives,
- Development and refinement of initial ideas to achieve these objectives, towards the creation of eco-innovative solutions and strategies.

An important part of this phase concerned the identification of so-called 'enabling contexts' for an easier and even faster possible implementation of the chosen solutions (e.g. publicly owned spaces). These 'enabling contexts' have been defined 'as specific locations within the focus area that are more suitable for developing the eco-innovative solutions and strategies […] system of areas in which the experimentations can be more easily applied and where the general process of regeneration can be tested and implemented as of prime importance' (REPAiR, 2018d, p. 27).

For instance, in the case of Amsterdam, main enabling contexts were classified as the areas with:

- the highest concentration of wastescapes;
- the highest index of social stress (low-income population, unemployment, low education, non-active working population);
- the highest concentration of unavoidable and avoidable (food) waste collected as residual waste, per person, per year;
- the location of companies in which the largest share of total tonnes of (food) waste are produced;
- most urban expansion and transformation areas (REPAiR, 2018d, p. 99).

In continuation, in the third phase of the REPAiR PULL methodology, **Co-production**, for each of the six case study areas local teams—in which all key stakeholder groups were represented—developed a catalogue of site-specific Eco-Innovative Solutions (EIS) for their cases.

This phase is considered crucial for the identification of suitable strategies for the transition towards sustained circularity within these peri-urban areas of focus. Crucial here is too that, at the same time, the promoting innovation processes to do so help fill in a sound economic business case.

In total, the REPAiR project developed over one hundred Eco-Innovative Solutions, connected to the cases, and being a support of circularity and for the regeneration of the pinpointed wastescapes.[3]

Focusing on wastescapes, and the two main cases, Naples and Amsterdam, inside the Metropolitan Area of Naples (MAN) wastescapes appear with quite different characteristics. For instance, one of the most challenging peri-urban areas under development is located surrounding the high-speed train station of Naples-Afragola, towards Acerra, and Pomigliano d'Arco. This area contains a number of exemplary wastescapes and was given high priority by the stakeholders present in the local PULL workshops, as wastescapes are characterized by illegal activities, often also related to waste management, to territorial 'fragmentation' and pressure on the livability of the areas in general. For this particular sample area, multiple wastescape maps and wastescape category-sheets were produced. These data subsequently were improved based on case-specific knowledge of citizens, public authorities and other stakeholders within a series of PULL workshops. The solutions identified in this phase also stressed the importance to make them available to the local communities. This, as some of them concern misused areas and even illegal settlements. Outcome of the PULLs here was that, by connecting them actively to the transition, to the regeneration of the wastescapes, they could be given potential to become new, formalized public spaces, which at the same time support circularity, inclusiveness and improve overall livability. To support this further, it resulted to be of great help that in the PULLs of Naples cultural associations also have been involved. This was done so in order to provide a potential 'problem owner', that would be apt to manage public areas, and by doing so increase citizens' sense of belonging to this territory (Amenta & van Timmeren, 2018; REPAiR, 2018b).

In the other main pilot case, Amsterdam Metropolitan Area (AMA), also wastescapes were identified in this Northern part of the larger 'Randstad' area, in the territory comprises between the two provinces of North-Holland and Flevoland and 15 municipalities. Here, more coherence was found, as most of them were related to legal restrictions for use (be it due to nuisance or pollution, of all kind). For instance, the areas around the Schiphol airport were identified as challenging wastescapes, as they are both nuisance zones subject to development restrictions as a result of noise and safety regulations, as well as areas of importance, as being part of important green, unbuilt areas supporting a positive effect on the urban heat island (UHI) of the Western parts of the city. Wastescapes identified in this case, were also related to the harbour and diminishing industrial areas. For the regeneration of these wastescapes, trust and collaboration among stakeholders 'under siege' of land use and functional change clearly resulted to be necessary. The PULLs therefore also functioned as platforms where public and private actors cooperate to respond to a common goal set, here circular area development. For this purpose, the stakeholders of the AMA PULL included researchers, local government representatives, policymakers, as well as local business representatives. Again, a series of collaborative PULL workshops

[3] For more info visit the section of the REPAiR website on the Eco-Innovative Solutions: http://h2020repair.eu/eco-innovative-solutions/.

were held with the aim to develop EIS for all kinds of circular concepts in the AMA (Amenta & van Timmeren, 2018; REPAiR, 2018b). To illustrate, for example, some of the solution paths proposed are related to the desire to overcome the problem of construction restrictions for the sake of circular material use and concepts, as well as for the regeneration of wastescapes in the (nuisance) areas around both port and Schiphol airport; they are often related to improved flexibility regarding too stringent regulations. For instance, by applying new ways of regulations based on measuring instead of calculation of noise nuisance. This, as traditionally the noise footprint of aeroplanes is computed by using models which calculate the equivalent sound pressure levels. To shorten the calculation time of such models, buildings and urban objects are neglected. The large computational overhead of diffraction points around edges, and reflections between walls, would make the calculations too time-consuming. The concept proposed in the PULLs related to these specific wastescapes builds upon so-called adaptive noise levels, as recent studies showed that the existing calculation models, which legally define them as nuisance zones, give an over-simplified image compared to reality, in which buildings yield a substantial reduction or amplification of aircraft noise. Another solution brought up in the PULLs related to these specific wastescapes was the possible increase of their ecological value, by developing a natural corridor within these airport noise contour areas. And by doing so, building upon further expansion to the previously stated function of UHI reduction in the built areas at lee side (of prevailing winds), and by doing so this could be a way to deal with the relative malfunctioning of these areas.

The fourth phase of the REPAiR PULL methodology is the **Co-decision phase** and it builds upon the results of the previous phases. In this phase, the Eco-Innovative Solutions (EIS) and elaborated strategies were shared with a wider public, also thanks to the potentialities of the GDSE tool, with the aim to feed-in to the decision-making process in general and the overall engagement of users and all other relevant stakeholders. In this phase, solutions and strategies were potentially becoming a means for reference among different actors for triggering and supporting the actual regeneration of the wastescapes in the case-study areas. In this stage, actual public programs and urban planning policies were discussed with all stakeholders within the next series of PULLs, to understand to what extent it is possible to actually implement the identified solutions and strategies. The Co-Decision phase was also useful to verify the possibility for potential implementation of the solutions/strategies, checking the existing policies and their flexibility; to this aim, existing local initiatives have been taken into consideration and discussed in the workshop sessions. In the very last phase of the project, due to the spread of the Covid-19 pandemic, the richness of the interactions possible during the initial PULL meetings was substantially reduced by the necessity to only have online meetings.

The final phase of the REPAiR PULLs methodology concerns **Co-governance**. It aims to secure and manage the actual implementation of solutions and strategies (and objectives set) related to the regeneration of the aforenamed wastescapes in the different case studies. Also, to adapt solutions to a possible transferability to different case studies elsewhere. For the transferability of solutions and strategies it is crucial to define which could be the basic principles that constitute them and how these could be applied by certain adaptions, based on different territorial realities.

Co-governance should be considered as one of the most interesting phases of a PULL, since it refers to the tangible execution of the solutions/strategies, which could be able to modify the functionality of the territorial metabolism, meaning its flows (AS MFA), its human ecology, its urban political ecology, and its landscapes ecology (Grulois et al., 2018). However, in the REPAiR project, this phase was not developed further, since it was not included in the workplan. Nevertheless, some of the case studies have been able anyway to start to apply the REPAiR developed solutions/strategies in some local initiatives and projects. Therefore it is fair to state that the whole PULL process indeed facilitated advantageous stakeholder interactions, which has led them to continue working together also beyond the REPAiR project.

9.4 Discussion and Conclusions: How to Regenerate Wastescapes in Peri-Urban Areas

The presented research, which builds on the REPAiR research project results, starts from the fact that the contemporary society is still based on unsustainable linear models of growth and consumption—involving the depletion of increasingly scarce material and territorial resources, and producing high amount of waste and wastescapes. The latter, which often concern peri-urban landscapes, are slowly metabolized by urban systems, generating pollution and overall unuse and inefficiency.

The concept of landscape—within the definition given by the European Convention on Landscape (Council of Europe, 2018)—is an important component to take into account when aiming for transformations towards a more circular society. More often than not, they can be characterized by wastefulness generated by unhealthy metabolisms, as well as spatial decline and fragmentation. Centralized infrastructure provision, a legacy of the twentieth century, facilitates linear (urban) metabolism and leads to ecological overshoot. Over-consumption is possible because of inherited resources: fossil fuel, fertile land, clean water and even oxygen in the atmosphere. Wastescapes are the result of linear urban metabolic flows and unsustainable growth which generated, for several reasons, the so-called 'peripherical areas'. The latter are urban areas that have been treated for a long time as backsides. They are defined as 'peripheries' not only for their actual distance to the urban core (which sometimes is irrelevant being in strategic positions linked to the city cores) but also for both their residual function and image, of which the latter is fixed in the common perception of citizens (Berruti, 2019, p. 21).

At the same time, gradual or sudden disruptions, such as climate change and criticalities as a consequence of pandemic or other disruptions, are worsening this disequilibrium by challenging urban settlements and the use of nature and natural areas. Altogether they are shedding light on their vulnerability and consequences to health, well-being and, in the end, even economic potentials. For instance, the complex situation as a result of the global Covid-19 pandemic is contributing to inverting the traditional point of view on the relevance of the built environment, conversely stressing—once again—the significance of open and natural areas. The open/accessible (preferably green) public spaces to be found in urban and peri-urban environments, which could be used for leisure activities, to achieve a healthier model of life, especially within this time characterized by the sanitary emergence, have regained their value which surpasses significantly that of monetary value alone. At the same time, the very being of wastescapes forms an obstruction to such values. Therefore, and in order to achieve a real transition towards a circular and sustainable future, active regeneration will be necessary to implement an approach that refuses the very concept of waste—in its wider significance—thus including wastescapes and adds new values in a multiscalar circular ecosystem. Up until now, circular economy was generally adopted by governmental policymakers with the main goal to protect the environment and reduce greenhouse gas emissions. In addition to that, a more systemic solution is needed, which puts all three dimensions of sustainability—social, economic and environmental—at the centre of societal shift. Such an integrated social inclusive approach, together with the reduction of the demand of resources and a shift to circularity—or so-called multiple value creation—could secure the sustainability of contemporary living models, functioning without overcoming the planetary boundaries and stay within the so-called 'doughnut' of a 'safe and just space for humanity' (Raworth, 2017). The doughnut consists of two concentric rings, an inner ring and an outer ring. The inner ring represents 12 social foundations, derived from the Sustainable Development Goals (SDGs), needed for a society to thrive (ibid., 2017). The outer ring represents the nine ecological planetary boundaries, developed by Rockström et al. (2009). Doughnut Economics (DE) urges us to keep challenging ourselves to take heed of the planetary system in its entirety. It reminds us of the importance of human socio-cultural development and our ability to organize. It values diversity, dynamics, scale and complexity of the interacting systems. It argues for distributive and regenerative capacity building. And although Raworth recognizes that growth is important, DE shows that there are various ways of growing that go beyond GDP growth or an increase in Gross Value Added (Raworth, 2017). In this way, other values (then monetary) are put forward too. The resulting holistic, transdisciplinary and inclusive, comprehending a bottom-up development based on a collaborative approach, can, in sum, form a robust systemic solution and highly adaptive model that allows for societal and environmental change.

The premise to be able to successfully implement an approach similar to DE, adapted to regenerate wastescapes, needs to be based on a deep understanding of the local contexts, which in this paper has been illustrated with the cases analysed in the co-exploring phase of the REPAiR PULLs. This phase is crucial for getting a deep understanding of the complex problems intrinsic in wastescapes, and by mapping of underlying processes and problems of such case study areas, within larger peri-urban territories in metropolitan regions. This forms the basis for change models.

In the presented REPAiR project, the six European cases of focus concerning metropolitan areas and in particular peri-urban territories, or so-called 'territories in between' (Wandl, 2019). These peri-urban areas contain the vast majority (in size and number) of wastescapes. At the same time, however, among the numerous potentials of these peri-urban areas, the mixed-use combined with relative lower densities and large availability of space, have also been determined as a potential starting point for further developments. In particular related to sustainability and circularity, which concepts/solutions in general can be characterized by their relative larger spatial footprints (or lower so-called performance densities). These solutions, however, also can be combined, into ecosystems services. At the same time, the concepts of sustainability and circularity are also related with the need to reinterpret the numerous infrastructural networks (and overall network geometry, or architecture). Peri-urban areas and territories-in-between are characterized by all these different kinds of infrastructures (Wandl, 2019), which—through the overlapping of new layers—often makes it difficult in (land-use) planning to establish healthy relationships with the (underlying) landscape, while generating spatial fragmentation and loss of multiscalar ecological networks supporting ecosystems and habitats (Tjallingii, 1996). Through the presented systemic and multidisciplinary approach—which implementation could be supported by the involving key stakeholders in the integrated methodology of Peri-Urban Living Labs—this research aims to find a renewed equilibrium inside these peri-urban areas and beyond, in their interrelated networks at the metropolitan scale. With the aim to regenerate and re-appropriate the different wastescapes inside these peri-urban areas as new public (open) spaces and regenerative territories, within a CE and DE approach. This approach is in line with the concepts of Industrial Ecology and Regenerative Design thinking of taking nature as a role model, where processes run on the available (usually low exergetic) resource flows. The circular or panarchy-based processes are characterized by 'low exergy design' which can strengthen the systems, methods and tools used for organizing, operating and supervising the urban environment, while minimizing the negative impacts of these urban areas on ecological cycles at all levels, creating efficient urban systems. Here, regenerative design is defined as 'human made interventions and systems (buildings, urban spaces, infrastructure etc.) that contribute to ecological, social, and cultural health in various holistic and interconnected ways […] ensuring that the functioning of the built environment leads to positive outcomes in a biological sense. One way to conceive of this is to devise ways to work towards the provision of regulating, supporting, and provisioning ecosystem services. […] Ecosystems remain the best-known example of sustainable organization of life on this planet. It is logical therefore to try to understand, and if possible, to emulate how organisms and ecosystems work and what they do in the pursuit of the creation of a regenerative human urban habitat' (Zari & Hecht, 2020, p. 3). If elaborated in this regenerative design way, wastescapes become spaces that include novel urban ecosystem services that support circular and sustainable urban systems. The regeneration of wastescapes then represents an opportunity for increasing circularity, as they take panarchy as a starting point, possibly even resilience in general, and human well-being through improved opportunities for a better quality of life, including all kinds of undervalued socio-ecological qualities, such as biodiversity and inclusiveness (DE).

At larger scale levels, well designed and interrelated regenerative territories originating from former wastescapes in this way could work as an interrelated ecological and social infrastructure.

To test and achieve this, within the EU Horizon 2020 REPAiR project, researchers, designers and local stakeholders of six peri-urban European areas have been working towards the achievement of a Circular Economy supporting methodology and tool, or Geodesign Decision support Environment (GDSE). This entailed that in dedicated Peri-Urban Living Labs (PULLs) all over Europe, a digital geodesign tool, extensive open-source data sets and eco-innovative solutions and strategies (EIS) were created and made available to support (validated) decision-making processes towards a more circular society within designated, often complex, spatial contexts.[4] To move towards regenerative territories concrete eco-innovative solutions and strategies were developed and tested with key stakeholders for the so-called 'enabling contexts' identified within the Peri-Urban Living Labs.

As a next step and scale-up, the stated solutions (and methodology) need to be tested in other contexts, as well as pilots implemented to validate the final two steps of the PULL methodology developed.

The bottom line is that technical solutions for the recovery of material resources—formerly known as waste—should be interconnected with more site-specific spatial strategies, preferably first within the many existing wastescapes.

Very often the REPAiR experiments have been slowed down due to the strict local regulations and overall complexity of area (re)development and regeneration. For this reason, an integrated and multidisciplinary approach resulted to be crucial. In this perspective, new forms of collaborative and distributed governance, based on private–public partnerships, and integrating bottom-up and inclusive actions seem to be the next step for the actual transition towards regenerative territories. In this framework, experimentations and innovations should be focusing primarily on the well-being and physical/mental health of people.

Acknowledgments Thanks to the whole REPAiR Team. In particular to UNINA and TUDelft Research Teams.

Author Contributions All the parts of this chapter have been written and approved by both the authors: L.A. and A.v.T.

Funding This research is done within the framework of the European Horizon 2020 funded research 'REPAiR: REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism'. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 688920. This work reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

[4] For more detailed information on GDSE please visit the REPAiR website at the following link: http://h2020repair.eu/gdse-software-package/.

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Chapter 10
Towards Circular Port-City Territories

Rotterdam and the Port Back to the City

Paolo De Martino

10.1 Introduction: Rotterdam Towards a Twofold Objective

Port cities in Europe cannot be properly understood as a comprehensive entity. On the contrary, they consist of peculiar aspects in relation to geography, economy, and governance. These elements play a fundamental role in shaping the identity of each port city. Space is understood here as the result of specific institutions and governance arrangements that are in fact place specific. Moreover, the presence of path dependencies—as dependence on consolidated (and therefore inertial) economies and governance processes—explain why ports, despite having similar characteristics, differ from each other (Hein & Schubert, 2020; Monios & Wilmsmeier, 2016; Notteboom et al., 2013; Ramos, 2017). Because of path dependence, port and city authorities tend to become committed to developing strategies to reinforce their historical beliefs and values (De Martino, 2020b; De Martino & Hein, 2020; Sorensen, 2018).

This chapter focuses on the case of Rotterdam where different authorities are working on breaking path dependence by developing a twofold objective: on the one hand, by improving the economic position of the port and, on the other hand, by revitalizing port-city relationship from a historical, cultural and social perspective.

P. De Martino (✉)
Department of Architecture, Faculty of Architecture and the Built Environment,
Delft University of Technology, Delft, The Netherlands
e-mail: p.demartino@tudelft.nl

Department of Architecture of Naples, University of Naples Federico II, Napoli, Italy

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_10

10.2 Approach: Path Dependence and its Implications

This chapter proposes to look at the port territory of Rotterdam and its spatial transformations as closely connected to the history of its institutions. The concept of path dependence is applied as an interpretative tool to understand the stratification of institutions, the formal and informal arrangements among authorities and how changes in the current governance setting can represent a window for new opportunities (Arrow, 2004; Arthur, 1980; David, 2007; Hein & Schubert, 2020; Mahoney, 2000; Ramos, 2017). Path dependence, whose connection with the evolution of port cities has been explored in other recent publications (De Martino, 2020a, 2020b), represent the theoretical approach to analyse what André Corboz has defined as "urban palimpsest" (Corboz, 1998), to better understand the wide variety of traces and mutations that have firstly connected and later detached the port from its city.

From this perspective, space can be better understood as institutionally constructed and therefore linked to the changes in the system of regulations and constellation of actors which have cemented over the centuries. In fact, several authors, Sorensen among others, have explained the interactions among planning authorities as something that have led historically to the creation and reinforcement of existing patterns and therefore path dependence (Sorensen, 2015). Path dependence refers to the idea that the future depends on past decisions and this reliance influences what is perceived by the authorities as a feasible outcome. The concept which has its roots in economic studies mainly focuses on the phenomena institutional inertia and the ways in which people shape political and cultural behaviour (Arthur, 1980; David, 2007; Mahoney, 2000; Sorensen, 2015, 2018). In other words, history matters and approaches built in the past define what is the range of options for the future. This resistance to change generates feedback loops that imprison actors in their ideologies, making them unable to identify alternatives.

However, change is hard but not impossible. The recent joint projects between port and city in Rotterdam show that path dependence can be interrupted. This can take place within a new awareness by the authorities of the role that the port is called to play for the territory at different scales (local and regional) and dimensions (social, spatial, economic and environmental).

10.3 A Historical Overview

The name of the city of Rotterdam originates from the presence of a dam on the Rotte river. The port overlooks the North Sea and it belongs to the so-called Hamburg-Le Havre (HLH) range which is an integrated maritime interregional network consisting of the ports of Hamburg, Bremerhaven, Amsterdam, Rotterdam, Antwerp, Zeebruges, Dunkirk and Le Havre (Plasschaert, Derudder, Dullaert, & Witlox, 2011).

The development of Rotterdam as maritime and industrial port is quite recent. The city has been eclipsed for a long time by Amsterdam where all the traffics concentrated at least until the nineteenth century. Only after the second half of the nineteenth century the economic and industrial development of Germany around the Ruhr signed the beginning of the economic and industrial power of Rotterdam and therefore also the detachment of the port from its city (Aarts et al., 2012; Camera-di-commercio-e-industria-di-Napoli, 1914; Daamen, 2007).

Oil has played a significant role in the port, defining the industrial character we still see today. Since 1862—when the first drop of oil was shipped into the port of Rotterdam—petrochemical industries became increasingly important for the port and the Dutch economy (Hein, 2009, 2013, 2018). Oil continued to play a key role also after WWII and Pernis (orange), Charlois (red) Merwehaven and Wallhaven (violet), Eemhaven (pink) Europoort and Botlek (yellow) are just the spatial impact of oil industry on the Rotterdam port landscape (Fig. 10.1).

Therefore, it can be argued that until the nineteenth century, the relation between port and city was preserved. Subsequently, the port and city developed more or less independently with the port moving away from the city towards the sea.

Due to containerization the port needed more and more space and deeper waters for ships. That is why central and local governments opted for the construction of port expansions outside the city centre. Port and city drifted apart with huge areas left behind for new urban uses. The late 1980s and 1990s were the years of waterfront regeneration projects. The area of Kop van Zuid in the South of Rotterdam is emblematic of this. Here, the city government decided to revive the city with high rise offices and apartments, which gave the city a new identity still visible today.

Fig. 10.1 Rotterdam's port development. An overview in history (*Source* Rotterdam port Authority. URL: https://www.portofrotterdam.com/en/files/history-port-of-rotterdampng)

The process of naval gigantism required the construction of the area known as Maasvlakte 2 (initiated in 2008 and to be finished by 2030) for the handling of containers, logistic and industrial activities. This expansion, which was possible thanks to a change in the governance structure that allowed the port authority to invest beyond the port perimeter, is highly controversial. On the one hand, it in fact acts as a tangible example of the need on the part of the authorities to look at the port from a regional perspective, but at the same time, it represents the concrete result of a separation between port and city. The port authority following the construction of the expansion had to introduce nature compensation to balance the damages on the environment.

Today the port–city relationship has changed a lot compared to the past and large transformations are leaving space to local renewal processes and acupunctures in the urban palimpsest. Important topics like climate change and energy transition are putting pressure on the port authority to find solutions to remain competitive in the future, not at the expense of the environment. Rotterdam represents therefore a very inspiring example because port authority and municipality are at the forefront of reinventing their relationships (Aarts et al., 2012). They aim to find each other again. Today, in fact after years of conflicts the port authorities are looking back to the city as a place to establish new collaborations with the city that can benefit both the port and the city.

10.4 Spatial Understanding and Planning Interests

The city of Rotterdam is situated in the Province of Zuid-Holland and it is part of the economic core of the Netherlands, the so-called Randstad (CityofRotterdam, 2009). This is a spatial agglomeration and complex territory constituted by different spatial, functional and administrative entities all connected to each other's (ProvinceofZuid-Holland, 2015). The Randstad is polycentric metropolitan conurbation with about 8 million people living around cities such as Amsterdam, Rotterdam, Utrecht and The Hague. The Hague is the administrative centre, Amsterdam the business city, Rotterdam, with its important port hosts the industry and Utrecht the cultural centre.

The Randstad is the scale to better analyse the port of Rotterdam whose economic impacts do not concern only the city of Rotterdam, but a broader territory. The port is the major container hub in Europe and the most important European oil hub. More than 50% of refineries in Northwest Europe are in fact supplied via Rotterdam which together with Amsterdam and Antwerp, form the so-called ARA which is an alliance for the industrial sector.

Therefore, the port represents the economic driver of the city and the region and also the main source of negative externalities, such as air and water pollution.

These are the main problems that port and city authorities are facing today in Rotterdam and these also motivate the processes of collaboration and the joint project development known as Makers District. Here, several public and private parties have decided to investigate how to develop a port in a way that can continue creating room for economic development but in a more sustainable way (PoR, 2011a). Both port and city authorities believe that the next economy will not be 100% oil-based anymore. As a result, working on new and more circular economies could help to relaunch the relationship between port, city, region and the landscape as a whole. Improving this relation is in the interests of both port and city authorities in the belief that the port will play a key role as a catalyst for new cultural integration that in the long term can generate also new economies gravitating around the port.

As for the governance, Dutch ports see an active involvement of local authorities. The Dutch government is not completely involved in the port–city relationship. On the contrary, its interest is mostly in big infrastructure developments, safety and secure shipping, but also environment and nature (OECD, 2010). The central government has in fact the ambition to make the Netherlands the most competitive, accessible, livable and safe country by 2040 (Ministry of Infrastructure & Environment, 2011).

Until 2004 the port was owned by the city (Notteboom et al., 2013). Following the port reform in 2004 the Rotterdam Port Authority detached from the Rotterdam's Municipal Port Management (RMPM) to develop a public corporation under the name of *Havenbedrijf Rotterdam NV (PoR).* As a result of this new structure, the municipality became the largest shareholder (70%) and the owner of the port land together with the Dutch Government (30%) (Brooks & Pallis, 2012; Ng & Pallis, 2010; PoR, 2018). Concretely, the port is publicly owned but commercially driven which means that the city (and the state) own the land, but the port authority has an everlasting lease contract with the city that allows to explore and develop the port on behalf of the government.

This reflects the more decentralized approach that characterizes the Dutch planning which is closer to people and users and delegates more responsibilities to local authorities. This promotes collaboration between the different levels of planning and the private sector (Ministry of Infrastructure & Environment, 2011).

The port of Rotterdam, for example, is in competition with the port of Amsterdam for the container sector. However, the two collaborate on a regional scale for the oil trade. In addition, there is even interregional cooperation between Rotterdam and Antwerp for the carbon capture and storage. From a governance perspective, there is no regional authority. Cooperation between ports happens through a bottom-up process and where authorities identify real economic benefits.

There is, instead, a metropolitan authority called the Rotterdam-The Hague metropolitan area (MRDH) which acts as an intermediate level of planning between the region, province and the municipal scale. MRDH is an alliance between 23 municipalities including Rotterdam and The Hague. It represents a recent governance authority established in 2015. Until this date, Rotterdam and The Hague focused on two different economies: Rotterdam on infrastructure and logistics due to the presence of the port and The Hague on administration and services(OECD, 2016). Today, the two cities cooperate to form a larger metropolitan region and to also integrate these two different economies (MRDH, 2016; OECD, 2016). The roadmap developed by MRDH aims in fact to look at the territory through the lens of the circular economies. These economies will have profound impacts on the society of the future, asking for significant changes in the port and logistic sector. According to the Roadmap linear versus circular, centralized versus decentralized are the dichotomies that will guide the future development of the port of Rotterdam and its region (MRDH, 2016).

On a more local scale, it seems evident that the main interest of the Rotterdam port authority goes in the direction of industrial and infrastructural developments. However, taking the lead in these two sectors in the future asks for a broader perspective. This is why since September 2011 the port authority has been cooperating with Deltalinqs, the Municipality, the Province of South Holland and the Dutch government to define an agenda for the future and more sustainable development of the port. The collaboration led to the definition of the Port Vision 2030 (PoR, 2011b). This vision acts as a strategic instrument to guide the development of the port in close dialogue with the city, the regional territory and the environment as a whole (PoR, 2011a). The main ambition of the plan is to combine the two main pillars that have guided the development of the port for years: global hub (logistics) and industrial cluster. The port authority is envisioning the port of the future as a laboratory of innovation where to experiment processes related to the circular economies (PoR, 2011a). Therefore, although the main purpose of the port is to improve the economic position and infrastructures of the Port Authority also makes efforts to offer a more vivid port environment to the employees.

Nevertheless, achieving this goal is very difficult especially if considered that the port is still quite old fashion. The Rotterdam port is an oil-based port with 30 kms occupied by storage and refineries and heavy logistics activities from all over the world. Its footprint is quite negative at the moment. While this dependence offers the port a leading position today, it also risks preventing a real change and diversification of the economy, making the existing model not resilient.

10.5 Stadshavens Strategy and the Makers District (M4H)

How to deal with a sustainable port city relationship is the main goal behind the joint Spatial Development Strategy known as “Stadshavens”. The plan identifies several areas whose development will contribute to the improvement of Rotterdam both from an economic, spatial and environmental perspective. All the areas concern specifically the relationship between port and city (City of Rotterdam, 2007).

Since the beginning of the twenty-first century, port and city needed a new narrative. On the one hand, the Port authority has become increasingly aware of the importance of investing in port–city relations on the other the municipality has also realized that there was a need to prepare young people for the next generation of port-related jobs. Stadshavens strategy therefore brings these two ambitions together (City of Rotterdam, 2007). Thus, port authority and municipality started to rethink all the port areas around the city. This area was called Stadshavens which is known as the largest port-city regeneration project in the Netherlands (Vries, 2014). This process started as a joint strategy between the two authorities to reduce the conflicts at the intersection of land and water. The strategy touches upon different areas, each one with specific dynamics and spatial qualities. The Waalhaven and Eemhaven areas are specializing as an important cluster for fruit and vegetables together with container transhipment. Rijnhaven and Maashaven are the areas closest to the city centre and also where it is possible to identify the traces of an industrial past. Merwehaven and Vierhaven will develop over the next 30 years into the Makers District (M4H), an innovative arena where houses will coexist with new start-ups and companies in the field of energy and materials.

The RDM Campus, on the opposite side of the river, was also a joint project but it is mostly owned by the Port Authority. In 2006, educational institutions, the PoR, the Municipality and Woonbron (housing corporation) signed an agreement to develop the RDM site (Daamen & Vries, 2013; Vries, 2014). The RDM, old shipyard, today focuses on the port-related manufacturing industry with related education and research. This function is in line with the location on the left bank of the Maas, where the port plays a more dominant role. Here, Techniek College Rotterdam and Rotterdam University of Applied Sciences cooperate with local companies to develop projects and education programs on port-related issues such as floating projects and 3D printing for the maritime industry (City of Rotterdam, 2017). However, the RDM had some limitations. Companies here were not able to grow further due to a lack of space. That is why the M4H came in as a place where small companies could move to continue developing their project.

When port authorities and municipality started to work on M4H was because they came to realize that the planning interests were moving towards new areas: Merehaven area. The pressure on the housing market was high and therefore mixed-use spaces were starting to become a priority and this could not be achieved around the RDM area. In M4H, companies working in the fields of logistics and maritime industry had more space to invent, test and implement new technologies, based on digitization, robotization, and smart manufacturing by coexisting with housing and knowledge institutions (City of Rotterdam, 2017). The project of M4H represents therefore an emblematic case that shows also a changing approach of the port authority. Innovation does not occur anymore behind the fences of one company. On the contrary, several companies have to cooperate. Start-ups and new businesses can influence the existing model. And these new businesses are not looking for large hectares in Massvlakte area. On the contrary, they aim to stay within the city.

Keilewerf is one of the many examples that is possible to find in the port of Rotterdam (Fig. 10.2). The project started in 2014 consisted of reusing an empty warehouse of about 1000 m^2 to host more than 80 (young) creative entrepreneurs. Here, steelworkers, artists, furniture makers and musicians have settled their new businesses.

The plan for the development of the Makers District is the result of a changing approach to port–city relationship. This highlights the spatial dimension of circularity which does not concern only the economic sphere but represents a regenerative model that touches upon different dimensions and scales. The port, with its more or less permeable areas of relevance, becomes an interesting laboratory to experiment with new possibilities of hybridism in which new forms of production can coexist with the renewed forms of living.

Fig. 10.2 Keilewerf, the place for makers in Rotterdam (*Source* Photo by Paolo De Martino)

10.6 Conclusion

In this chapter, we have analysed and discussed the case of Rotterdam which is peculiar for how city and port authority's visions intertwine when there are common values. No doubts the two authorities have different and often contrasting spatial ambitions as the developments are guided by different economic interests and needs. Nevertheless, they have made circularity a priority and a common strategy to work on. The city owns 70% of the port and this explains the active involvement of the municipality in the port planning, but this is not the only motivation. The city hosts the first European port for the handling of goods. The port, although the many efforts into the direction of clean energy, is still quite dependent on oil. Changing this model could have a profound impact on the economy of the city and region. At the same time, a possible collapse of the model would risk putting the economy of the city and the region under pressure. Authorities are therefore aware that this model should be changed and a diversification of the economy would allow for more resilience in the future. This diversification is also in the interest of the city, which in this way can prepare the next generation of workers and help to improve the environment in which they have to operate.

From a governance perspective, the analysis highlights the presence of a decentralized approach with the state not being directly involved in the port–city relationship.

On the contrary, it gives autonomy to local authorities for the management of port–city interaction spaces. This seems to be a key aspect especially in a time when uncertainties associated with global changes are asking the authorities for immediate response in order to anticipate and better adapt to the future. Decentralization also reflects in the planning tools where major territorial transformations are leaving space today to smaller and acupunctures in the city context such as the recovery of abandoned buildings with the rethinking of productive chains at the intersection of port and city. This is what circularity is about. The broader Stadshavens strategy is emblematic of this.

Thanks to this strategy, after many years of separation the port can look back to the city again. RDM Campus and Makers District are significant to show a change of perspective by municipality and port authority on the issue of port–city integration. The analysis has shown that innovation today passes through the regeneration of the territories in between. Innovation is no longer tied only to large companies, rather to small businesses and start-ups. Eventually, these micro-changes can be scaled up and change the port model at a bigger scale.

However, the risk of path dependence is always around the corner. The port in fact, with its big numbers related to container and oil traffic is challenging the sustainable relation with the city at different scales. The strong position of the port in the field of energy risks in fact to prevent a real change beyond oil. This challenge is asking authorities to engage therefore in a new relationship. To do so, it becomes crucial that all stakeholders have a keen awareness of each other's needs and interests to better develop innovative, adaptive and resilient strategies capable of looking at the port from different scales and perspectives.

The establishment of a regional authority could help to better coordinate the relationship between port and territory, improving territorial cohesion towards new forms of economies integrated with nature.

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Part III
Methodology and Representation

Chapter 11
Eliciting Information for Developing a Circular Economy in the Amsterdam Metropolitan Area

Gustavo Arciniegas, Alexander Wandl, Marcin Mazur, and Damian Mazurek

11.1 Introduction

Accomplishing circularity in metropolitan areas involves planning, co-designing, and implementing spatially explicit interventions with a multitude of stakeholders who are required to work with waste and resource management information (Arciniegas et al., 2019; Remøy et al., 2019). Waste management data is often communicated using Sankey diagrams (e.g., Clift et al., 2015; Mairie de Paris, 2017), which depict cities as black boxes where flows enter, are transformed or stored, and then either directly consumed or exported. However, what occurs in the black box remains unknown to the decision-maker. An interactive cartographic and therefore spatially precise representation of (waste) streams constitutes a way to enable stakeholders to formulate waste management strategies based on this enhanced spatial understanding of waste streams in a city or region. Furthermore, a cartographic representation of waste streams allows overlay with other data, for example, zoning and development plans of cities and regions. This overlay enriches the possibility to rethink waste management strategies, focusing more on reusing as well as establishing local synergies than seeing the waste of one activity as the resource of another activity. Therefore, this chapter addresses the following research question:

G. Arciniegas (✉) · A. Wandl
Department of Urbanism, Faculty of Architecture, Delft University of Technology, BL Delft, The Netherlands

A. Wandl
e-mail: a.wandl@tudelft.nl

M. Mazur · D. Mazurek
Department of Rural Geography and Local Development, Institute of Geography and Spatial Organization, Polish Academy of Sciences, Warsaw, Poland
e-mail: m.mazur@twarda.pan.pl

D. Mazurek
e-mail: d.mazurek@twarda.pan.pl

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_11

Can spatial planning and waste management digital information be used to portray and communicate information on streams of resources, materials and waste?

This chapter focuses on the digital representation and specific use of different types of information in a digital spatial decision support tool that aims to help decision-makers through stages of the collaborative process that begins at problem identification and status quo understanding, and finishes at the proposed circular economy (CE) strategies for a peri-urban area. The tool is called the Geodesign Decision Support Environment (GDSE) and is implemented as an interactive web application aimed to support the process of co-developing spatial strategies for quantitatively reducing waste flows, thereby promoting and advancing circularity in the Amsterdam Metropolitan Area (Arciniegas et al., 2019). The way in which information is modeled and presented in the tool is largely based on the geodesign methodology (Steinitz, 2012), and is specific to individual stages of the planning process. The GDSE presents information relevant to a study area through different mediums, namely web maps and charts to describe the study area, Sankey diagrams linked with dynamic vector flow maps to portray its resource flow streams, and the integration of the above to portray and assess the scenarios developed jointly by the stakeholders.

11.2 Circular Economy, Spatial Planning and Cartography

11.2.1 Circular Economy and Spatial Planning

In the last decade, more and more cities have recognized their crucial role in addressing the climate crisis, aiming for a "green recovery," achieving a "green deal," respecting the planetary boundaries or one of the many more "headlines" used to trigger and steer a more sustainable urban development. Cities are accounting for up to 80% of greenhouse gas emissions, two-thirds of the total energy demand, and 50% of waste generation globally; therefore, it is not surprising that circular economy strategies are recurrently part of urban and regional sustainable development policies. As cities become key players in the circular economy discourse, spatial planning is increasingly viewed as an instrument to integrate circular economy with other policy fields. Spatial planning aims to redevelop and adapt physical, sociocultural infrastructure, the economy, and the environment into its built form as well as the planning and development process (van der Leer et al., 2018). As Williams (2020) puts it, "spatial planning needs to intervene in markets to provide space for low-value, circular activities and enable the localized looping of resources within city-regions. … support infrastructure needed for circular actions and ensure urban form continues to support circular systems adopted." The often unanswered question is "where does this all need to happen?" All the plans need to land in physical locations. Both cartography and geographically informed co-creation play a crucial role in this decision process, as we will demonstrate in the remainder of this chapter.

11.2.2 Interactive Cartography for Spatial Planning

The tool presented in this chapter, the GDSE, is used for involving stakeholders in the process of active co-creation of waste management strategies, which exemplifies practical implementations of the Geodesign concept. This approach derives directly from theoretical spatial planning considerations in the era of a widespread use of Information and Communication Technologies (ICT) and Geographical Information Systems (GIS) (Geddes, 1947; McHarg, 1969). This section follows the evolution of views on the role of cartography in the creation and communication of spatial information. The onset of establishing a framework for analyzing how maps work and perceiving cartography as a science is commonly linked to Arthur Robinson's publication *The Look of Maps* (1952). The so-called "theoretical revolution" in cartography consisted of reorienting the goals from recognizing historically changing conventions to identifying mechanisms determining the functioning of a map and working out methods for increasing its effectiveness. This could be achieved through an in-depth analysis of important elements of the system, in line with the prevailing notion of scientific positivism.

Initially, the aim was to establish principles for a precise presentation of information by means of a spatial, universal manner, detached from the specific content of a map (Arnberger, 1970). Robinson (1952) introduced the concept that the function of maps is to communicate their concrete content to the people (Board, 2017). The classical transmission of information theory (Hartley, 1928) assumed that cartography should be perceived as the transmission of information concerning specific fragments of reality encoded in the form of data and then not only transcoded in relation to requirements of a specific medium such as the map (visualization stage) but also decoded by the map user (perception stage). The role of cartography is to refine the methods of encoding such information to reach the user least distorted by the information noise occurring at the stages of visualization and perception (Robinson & Petchenik, 1976). Early in these stages, the information noise can be caused not only by the map editor's inappropriate conduct but also by a deliberate generalization and symbolization of data. Consequences of these actions include generalization, simplification, and partial distortion of transmitted information. Nevertheless, benefits emerge as reducing the uncontrolled and individually determined distortion of information while perceiving the map content. At this stage, the users' thought processes as synthesizing or abstracting are rather irrelevant. Thus, informativeness and legibility of a map are closely related to each other, establishing a form of negative feedback, and should be considered cumulatively.

Following the communication paradigm, the cartographic transmission of information was considered more broadly compared to the formal approach. However, while significant impacts of receiving information from the map on the final efficiency of transmission were acknowledged, the map user was still regarded as a passive recipient of encoded information; thus, being more a map reader rather than a user. Additionally, it was assumed that the map's author possesses objective knowledge on the presented fragment of reality, and map editing consists merely of an appropriate application of specific visual graphics' principles (Bertin, 1967; Dent, 1972).

In the following years, there were significant changes concerning this view, being an aftermath of geography's abandoning the neo-positivist pursuit for one universal truth through reductionism—understanding a complex phenomenon by developing knowledge on its isolated essential elements—in favor of the postmodern paradigm. Considering the possibility of employing cartography in spatial planning, these shifts in viewpoints proved crucial. Particular models regard cartographic communication as a unidirectional linear transfer of information. Reducing the possibility of feedback was an obvious consequence of the fact that models were devised at a time when the dominant medium for maps was paper and the scope for receiving feedback from map users was considerably confined. This remark became a crucial step toward further developing cartographic theory. In the next decades, the communication paradigm was depriving such assumption, ultimately being undermined and numerous attempts for its substitution occurred. In consequence, in cartography, a slightly different, broader view on the process of cartographic transmission of information gradually developed and became prevailing over time. This notion is formed by a whole group of theoretical concepts that share a common feature of shifting attention from cartographic editing toward map users. This reorientation of approach is closely related to the increase in popularity of the term "cartographic method of research" (Salishchev, 1955). As opposed to cartographic methods of presentation, it allows the active participation of map users in cartographic information transfer (Montello, 2002). During this process, not only information noise may arise, but also some "informative added value" (MacEachren, 1995). Information obtained as a result of using the map depends on the questions posed by its user, who provides the map with desired content (Olson, 1984). It is thus individualized, embedded in the context of the map user's conceptual model. Consequently, there are no universal map editing principles that would be optimal for every user. Furthermore, the map user can acquire answers to questions that go beyond the author's initial purpose. Therefore, the map provides the possibility of obtaining information on a specific matter rather than a particular message (Keates, 1996).

The role of the map's author in the process of cartographic information transfer has been perceived more broadly than in the assumption of cartographic method of presentation. Evidently, the cartographer's knowledge on the map's subject cannot be complete nor presented objectively (Perkins, 2017). Therefore, it has become reasonable that the map's author may also act as its user—who, by means of implementing cartographic methods of research—may obtain new information or adjust prior perception of the surrounding reality. The trend of increasing appreciation associated with the role of map users was rooted in the cognitive approach (Aslanikashvili, 1974; Salishchev, 1975). This research was characterized by a holistic view upon potentials of obtaining information based on a map, regarded as a coherent system of signs. The stage of map perception was in this case treated much more broadly than in the communication paradigm. It not only included psychophysical determinants attributed to reception of visual stimuli, but also a number of thought processes enabling interpretation of received information in the context of individual experience, conceptual models and map user's imagination. The consequence of accepting the individualized character of using a map was the rejection of reductionism in research, which was aimed at optimizing individual signs to produce one universal map. The map began to be compared to other sources of learning about the surrounding reality. It has thus been treated as a model depicting reality in a formalized, logical, simplified, and purposeful manner, considering only the attributes relevant to a particular objective. By means of the above-mentioned characteristics, one becomes acquainted with a certain aspect of reality's structure, which in the case of maps is mostly the spatial aspect (Czerny, 1993). The cognitive approach also embraces the semiotic concept (Freitag, 1971), in which cartography is compared to a language (Pravda, 1994). Semantic principles in this case define the meaning of individual cartographic signs (words), which can be expressed by means of a legend (dictionary). Rules of syntactics describe how these signs are constructed using elementary graphic variables (alphabet) (Bertin, 1967), and relations between them (grammar). The principles of pragmatics define the purpose and function of a map, i.e., the conceptualization and expression of reality by the map's author, features of a potential group of its end users along with anticipated circumstances and purposes of use (non-verbal context of a language communicate).

During the 1990s, the process of convergence of communication and cognitive approach was triggered, which is natural as each cognition requires flow of information (Berlant, 1992). The crucial difference relies on emphasis as principle. These basic, apparently contradictory, viewpoints are simply stressing syntactic (in communication approach) or semantic and pragmatic (in cognitive approach) relationships. While the Internet with a widespread use of the World Wide Web became a major medium for cartography since the mid-1990s (Peterson, 2007), another wave of attempts to develop cartographic theory occurred and convergence of communication and cognitive approach even accelerated, which is also strictly linked to ICT and GIS tools development. A smooth transition between transmission of spatial information and its visualization takes place in three dimensions of map using: the purpose of use (from reading a known to discovering unknown spatial information), the target group of users (from general public to the individual needs of the author) and the flexibility of use (from traditional maps to *interactive dynamic maps*).

Being in use since the 1990s, mapping means made it more feasible for anyone than ever to be a cartographer for his own purpose (Muehlenhaus, 2014). Simultaneously, maps are ideal for dissemination and consumption of spatial aspects of information because their graphical format of complex spatial patterns provides an immediate visual summary that can inform (or misinform) (Kent, 2017). Also, a map-maker receives from a map user immediate feedback concerning information disseminated via a map, even if it is not the same person. Thus, a constant evolution of maps triggers cartographic creativity and diversity as cartographic communication can nowadays simply become a "cartographic dialogue." This is reflected in the theory of cartography as well, where map using became to be perceived as another, equivalent ending of the same continuous axis.

Some cartographers go even further. Attracted by the epistemological break introduced by Harley (1989) as critical cartography, they claim that currently the entire purpose of designing maps is to provide quick visual delight and nothing more (Field, 2014). While the medium of web mapping is designed to be ephemeral, there is a diminishing return on the time spent on their aesthetics and a good design of maps is disappearing in a current age (Muehlenhaus, 2014). Nevertheless, even if the map user is the same person as the map-maker, successful map using requires providing a meaningful product.

Perceiving cartography as a science has evolved gradually. The last decades have seen the development of a broad view of its subject. As an aftermath, today's maps, which are not preserved on any solid medium (hard copy) by the author and its impact on undertaking concrete actions for spatial planning, perfectly fit into the existing concepts. In turn, the development of a cartographic methodology allows the map user to obtain increasingly accurate and precise answers to the questions raised. However, it was only the dynamic development of ICT and GIS that facilitated, accelerated, and disseminated this process in practice, granting the aforementioned theoretical concepts and progress in the methodological field a strictly applicative dimension. The following sections describe map use within the GDSE for the inclusion and activation of stakeholders in the spatial planning process, which is one of the numerous examples of possibilities to widely benefit from achievements in the field of "interactive" cartography for practical purposes.

11.2.3 Representing Waste Management Information

This chapter deals with the representation of waste management information, particularly flows of materials and waste between actors, and spatially explicit strategies that aim to reduce quantities of waste generated in these flows. Information on flows of resources is typically represented by Sankey diagrams. A Sankey diagram is a well-known type of flow diagram in which the width of the arrows is proportional to the flow rate, and emphasizes the major transfers or flows within a system. Sankey diagrams are often used to represent inputs, useful output, and wasted output, but do not give an indication of the spatial component, or detailed spatial patterns, of these flows. Figure 11.1 exemplifies how Sankey diagrams are currently used to visualize waste streams for three European cities: Paris, London, and Amsterdam.

The Paris Circular Economy Plan 2017–2020 describes the city's commitment to implement a circular economy, and the targets set targets to advance toward developing it (Mairie de Paris, 2017). To describe the current flows of materials entering and leaving Paris in 2015, the report utilizes aggregated Sankey diagrams that show the major flows of materials and waste (see Fig. 11.1a). This study also provided a "first portrait of emerging forms of economy," which were mapped using an interactive map of services provided by these "new forms of economy" and available online on the website of the Paris Urban Planning Agency (APUR, 2020). This map shows a point cloud portraying the potential services these economies produce and

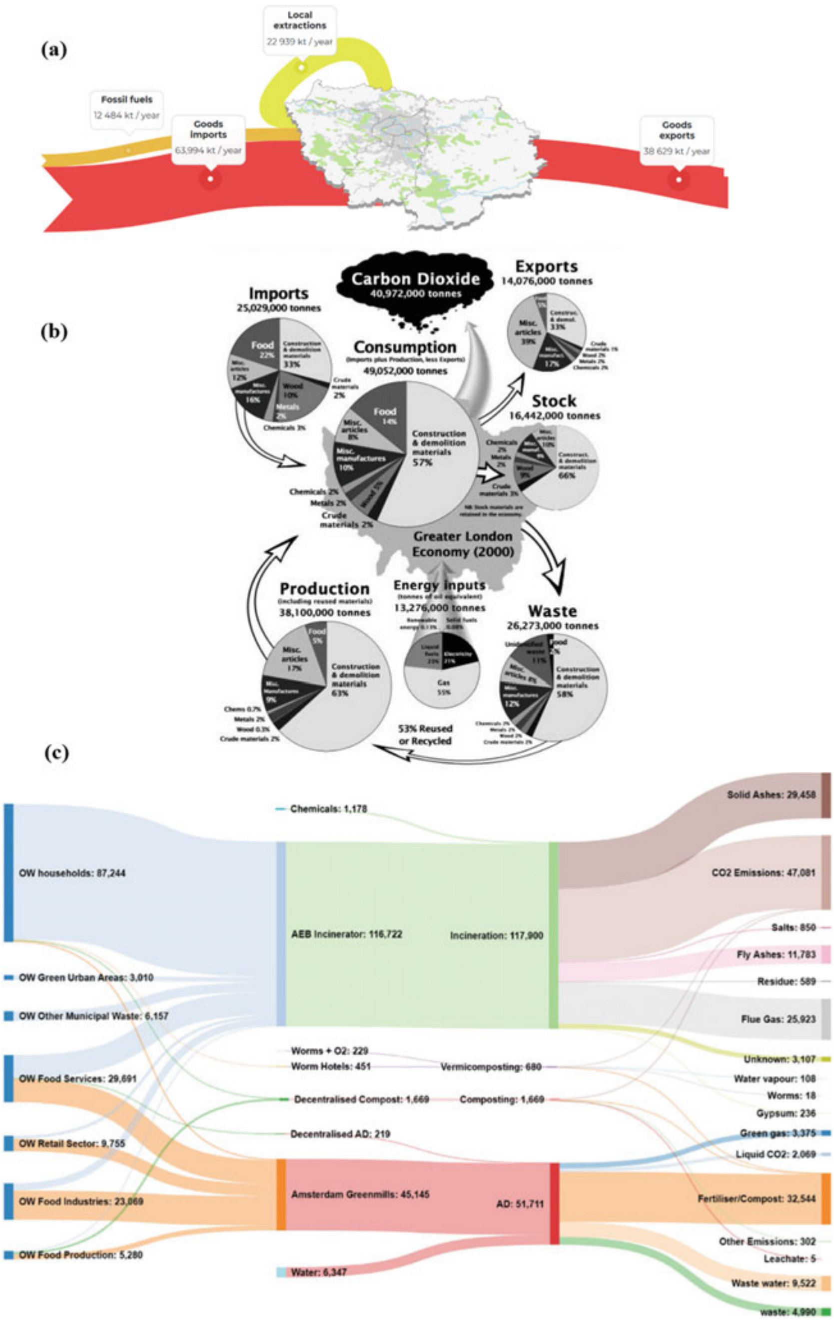

Fig. 11.1 Examples of resource flow visualizations using Sankey diagrams: (a) total amounts of waste flowing in and out of the Metropolis of Greater Paris (Urban Metabolism of Paris, 2019). (b) Urban metabolism of London in 2000. (c) MFA for organic waste (t/year) in Amsterdam visualized through a Sankey diagram

classifies them into categories, such as food, mobility, coworking, fablabs, resource centers, recycling centers, and accorderies.

As a second example, the city of London has set the circular economy goal to generate by 2036 net benefits of at least £7 billion every year. To address this goal, the London Waste and Recycling board (LWARB) published in 2017 the Circular Economy Route Map as the main plan of action to accelerate the circular economy across London. This plan reports total aggregated amounts of waste generated for waste themes, such as built environment, food, textiles, electricals, and plastics; and provides guidance for the acceleration of London's transition to become a circular city and it recommends actions for stakeholders (LWARB, 2017). In 2018, the Greater London Authority (GLA) published its London Environment Strategy, covering, among several environmental themes, energy, waste, and the transition to a low carbon circular economy (GLA, 2018). The total amount of municipal waste produced in London is reported and its major waste stream contributors identified as green garden waste and common dry recyclables (paper, card, plastics, glass and metal), food waste, and plastic packing. In a broader context, a working paper prepared by the Government Office for Science discusses urban metabolism and its implication for environmental sustainability for, among other UK cities, London. In this working paper, urban metabolism is understood as the inflows of material and energy resources, the outflows of wastes and emissions, and the retention of materials as stock in the built environment and infrastructure (Clift et al., 2015). This study uses results from an earlier analysis of urban metabolism in London by Best Foot Forward (2002), which delivered aggregated non-spatial results for material flows (construction and demolition, miscellaneous articles, food, and miscellaneous manufacturers, wood, gas, liquid fuels, unidentified waste, crude materials, metals, chemicals, electricity) in the Greater London Area in terms of imports, exports, consumption, production, energy inputs, waste, and stock (see Fig. 11.1b).

The city of Amsterdam implemented a "City Circle Scan" to identify areas in which the city can make progress toward realizing a circular economy. This scan helped identify construction and organic waste value chains as key streams to target and accelerate this transition (Circle Economy, 2015). The scan also shows how these resources move through the city, and highlights what is not circular in the current economy to target areas that can be further addressed. These aggregated flows are visualized in a 2.5D Sankey diagram overlaid on a landscape sheet. A study by Viva et al. (2020) performed a Material Flow Analysis (MFA) for organic waste in the city of Amsterdam and delivered classic Sankey diagrams for these flows (see Fig. 11.1c).

These examples show aggregated values for flows of energy, materials and waste, but disregard actual locations of all the individual actors involved in the flows. The next section describes a method to represent and visualize information on flows of waste and materials between involved actors, and the solutions to reduce waste quantities in these flows.

11.3 Presentation of Information for Co-Developing CE Economy Strategies

11.3.1 Geodesign Decision Support Environment

There are numerous ways to present and generate information to support spatial decision-making. Maps and charts are obvious and preferred means (Janssen & Uran, 2003). Maps and interactive charts are common means, and more recently implemented ICT tools, such as IoT and dashboards (e.g., Jagtap et al., 2019), virtual environments, multi-touch tables, and planning support theaters (e.g., Punt et al., 2020). This section shows how waste management information can be presented in a digital tool, which is used at living lab workshop settings by stakeholders of the Amsterdam Metropolitan Area to co-develop spatial waste management strategies that contribute to developing a circular economy. The tool is called the GDSE, and was developed as part of an EU-funded research project called REPAiR (http://h2020repair.eu/).

The GDSE features an open-source prototype web application that has been implemented in living labs in six European peri-urban areas with the purpose to support the process of developing place-based eco-innovative spatial development strategies that aims to have a quantitative reduction of waste flows (Arciniegas et al., 2019). Within REPAiR, a GDSE-related eco-innovative strategy is understood as: "*An alternative course of actions aimed at addressing the objectives identified within a Peri-Urban Living Lab (PULL) for developing a more CE in peri-urban areas, which can be composed of a systemic integration of two or more elementary actions, namely eco innovative solutions (EIS)* (Amenta et al., 2019)." The GDSE is meant to be used collaboratively by multiple stakeholders and is structured in five main steps, namely Study Area, Status Quo, Targets, Strategy, and Conclusions. Each step addresses one or more of the design questions proposed in Steinitz's Geodesign framework (Steinitz, 2012), and presents specific information to stakeholders. Table 11.1 describes the purpose of each step, and the information that is presented, generated, and used.

This chapter focuses on the steps Study, Area, Status Quo, and Strategy, and utilizes the example of the Amsterdam Metropolitan Area Peri-Urban Living Lab (AMA PULL) to demonstrate how information is presented and used, to support spatial decision making for developing a circular economy. A pilot case study of REPAiR, the Amsterdam peri-urban area includes the city of Amsterdam, the provinces North Holland and Flevoland, which amount to a total of 32 municipalities containing over 2.4 million inhabitants. The CBS, the Statistics Netherland's database, provided waste datasets for companies, which included supply, composition, and processing of company/industrial waste in the Netherlands, for the year 2016. More specifically, this data contains information on the type of waste (Eural code), waste generator (i.e., name and geo-location of the company), and waste collector (name and location of waste treatment), and the type of waste treatment.

Table 11.1 Purpose and information presented for all five GDSE Steps (adapted from Arciniegas et al., 2019)

GDSE step	Purpose of step	Information presented, processed, and used
Study area	Describe and explore the peri-urban area	Maps: spatial planning and MFA Charts: CE objectives as charts Stakeholders: as text Key resource flows: text and images
Status quo	Describe the current status of circularity of the peri-urban area Present results of MFA Present and rank CE objectives relevant in the peri-urban area	Flows: as Sankey diagrams and maps Flow Assessment: as charts and maps Wastescapes: as maps Sustainability indicators: as numbers, tables and charts Objectives: text and images
Targets	Match flow indicators targets with CE objectives Rank CE objectives	Flow indicators as interactive text boxes that can be linked with CE objectives CE objectives as interactive text boxes that can be ranked
Strategy	Present available solutions Present actors involved in solutions Choose solutions and their locations as combined strategies Explore how strategies affect flows Control if targets have been achieved and to what extent	Solutions as Images and charts Actors as Maps Strategies as maps Flows as Sankey diagrams and maps Charts
Conclusions	Present generated a comparative summary of the entire geodesign process	Text, tables, charts, and maps

The five steps of the GDSE are used in the phases of a peri-urban living lab, as defined in the REPAiR project by Amenta et al. (2019).

11.3.2 Presenting Information on Waste Flows in Spatial Planning

The first GDSE step “Study Area” presents the study area (i.e., the peri-urban Amsterdam Metropolitan area) to stakeholders using maps, charts, stakeholders, and key flows. Particularly, maps include external web mapping services (e.g., topographic or satellite photo from OpenLayers, Google maps, Leaflet, OpenStreetMaps), as well as individual thematic maps that were generated for the living lab’s study area (e.g., environmental and socio-economic maps, waste management maps, and maps resulting from material flow analyses). These maps are available at all times at later stages of the collaborative process, and can be utilized, for example, as background maps, on which waste flows can be overlaid. The GDSE organizes and presents map information for the AMA PULL, and also stores and presents information about stakeholders of the decision process and their specific objectives as tables and charts.

The second step "Status Quo" presents stakeholders with the key flows of materials and waste relevant to the study area, and allows stakeholders to define flow assessment indicators relevant to the key flows and specific administrative locations. Flows or resources are modeled as follows: yearly household and industrial waste data is gathered, geocoded, and coupled with European activity data. The result is a georeferenced point cloud of actors in vector format with attributes for type of waste, waste generator, (e.g., name and location of the company), and waste collector (name and location of waste treatment), and the type of waste treatment. Activity-based Material Flow Analysis is used to analyze and visualize this point data up to the level of individual materials (Geldermans et al., 2019). Figure 11.2a shows flows visualized into two interlinked views: (1) as a Sankey diagram showing activities, materials involved, and flow rates. Flow direction is visualized mostly from left to right; and (2) as an animated flow line between actors in vector format on the map. The thickness of flow lines indicates relative flow ratios. The views are interactive and also interlinked, which means if a flow is selected on the Sankey diagram, it will be displayed on top of a background map, and color-coded accordingly on the flow map. The flow map shows the actual directions of the flows, which are determined based on whether the actor is categorized as the start (origin) or end (destination) of a flow. By hovering the mouse on a flow on the left, flow characteristics (such as start actor, end actor, material composition, treatment type) are displayed. Mouse hovering can also be done on Sankey flows on the flow map.

Figure 11.2b shows an example of a flow map used in an Amsterdam PULL workshop that focused on food waste. The participants wanted to visualize food waste flows for oils and fats at the material level in order to achieve an understanding of the individual material flows for this type of waste, and see which flows needed to be addressed in later steps to contribute to a CE. The GDSE evaluates the status quo in terms of flow indicators based on the MFA data. Flow indicators are first identified using existing literature and then are selected through a collaborative process by the stakeholders during a co-design workshop. REPAiR defines an initial list of flow indicators, which includes flow amounts (for each material or their combination, e.g., vegetal waste vs. separate vegetables and fruits), flow structure (e.g., percentage of renewable material in each flow), flow intensity (e.g., amount of flow consumed/conducted per person), flow efficiency (relationship between economic factors and each material flow), and flow density (material consumption/conduction to sustain urban development) (Arciniegas et al., 2019). For the case of the flow in Fig. 11.2b, stakeholders were interested in assessing the oils and fats flows per inhabitant for the entire city of Amsterdam.

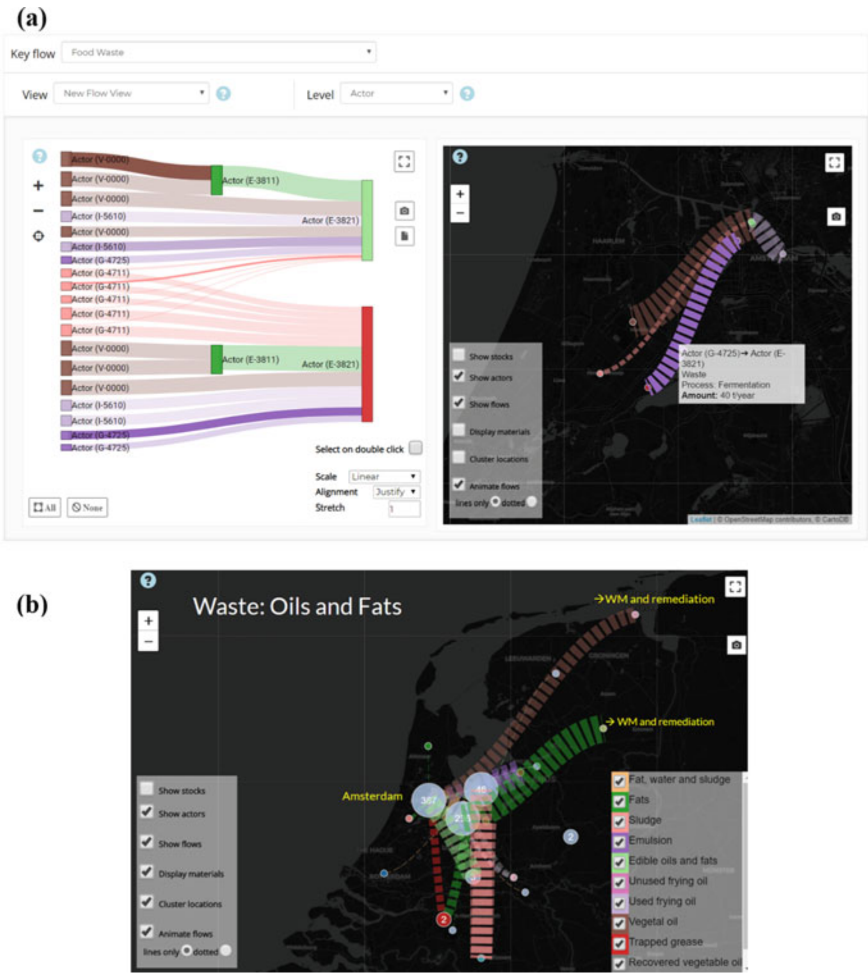

Fig. 11.2 Visualizing flows of food waste between actors in Amsterdam. (a) The Sankey diagram (left) shows individual flows color-coded for activity. A selection of flows is visualized on the flow map, while an animation shows the actual flow direction and flow attributes are retrieved via mouse hovering (right). (b) Aggregated flows visualized and color-coded at the material level

11.3.3 Presenting Circular Economy Strategies

The fourth step Strategy helps stakeholders co-develop eco-innovative strategies for their city. A Strategy is a proposed combination of solutions implemented in specific areas by specific stakeholders. The GDSE stores all the solutions available for the case study, which were developed by researchers of the living lab, based on the circular economy goals of the city. Stakeholders use the GDSE to select from these existing solutions and draw implementations (i.e., polygons in vector format) of these solutions at desired spots or locations in the study area. After choosing one solution, members of the small group indicate which stakeholders should be involved in the development of the solutions for their metropolitan area. Within the REPAiR project, an *eco-innovative strategy* consists of:

- One or more *eco-innovative solutions*
- Implementation Locations (areas) of these specific solutions
- One or more Stakeholders to be involved in these implementations
- A number of Actors (companies, households) affected by the value chains of the solutions in the strategies

A REPAiR solution can be viewed as creative and smart ideas aimed to improve a specific and fixed process in relation to the management of waste as a resource. For example, a REPAiR local solution called BIO-BEAN can transform coffee grounds into renewable energy, and was implemented for the city of Amsterdam. The solution is intended to alter the current linear process of generating coffee grounds (which normally would finish at a landfill or incineration plant), through a process, more circular, proposed in the solution, in which the coffee grounds are collected, transported, processed, and turned into renewable energy. At the PULL workshops, stakeholders used the GDSE to propose implementations of Eco-innovative solutions. These implementations are locations where the solutions are relevant and can be operationalized. Within the GDSE system, an implementation of a solution is a polygon drawn by a stakeholder using a touch-enabled screen. One or more polygons for the same solution can be drawn by the stakeholders. Figure 11.3a illustrates a GDSE-implementation of the BIO-BEAN solution in peri-urban Amsterdam.

The map of Fig. 11.3a shows all actors that generate coffee grounds in the city center of Amsterdam, and outside: restaurants, hotels, catering. This is the basis for drawing implementations. Next, participants set a desired percentage that could be used for the solution. This will have an effect on the impact of the strategies. Using the GDSE and the information on the key flows presented earlier together with the map of relevant actors, participants can draw multiple implementations of the same solution, and also of other solutions that are part of their integrated strategy to develop the circular economy of their city. Multiple solutions can be selected and locations of implementation can be drawn using the GDSE (see Fig. 11.3b).

Once the small group finishes drawing implementations of solutions (i.e., their strategy), the next step is to press the *Calculate* button (Fig. 11.3b), which will start assessing the impact of their strategy on the waste and material flows of the status quo. The GDSE selects those actors and activities that produce the specific waste flow and assesses all the strategies that were drawn by all the groups, both in terms of sustainability and circularity. Flows and actors inside a drawn polygon are incorporated in the calculations to modify the flow situation and thereby reduce quantities of waste (Fig. 11.3c).

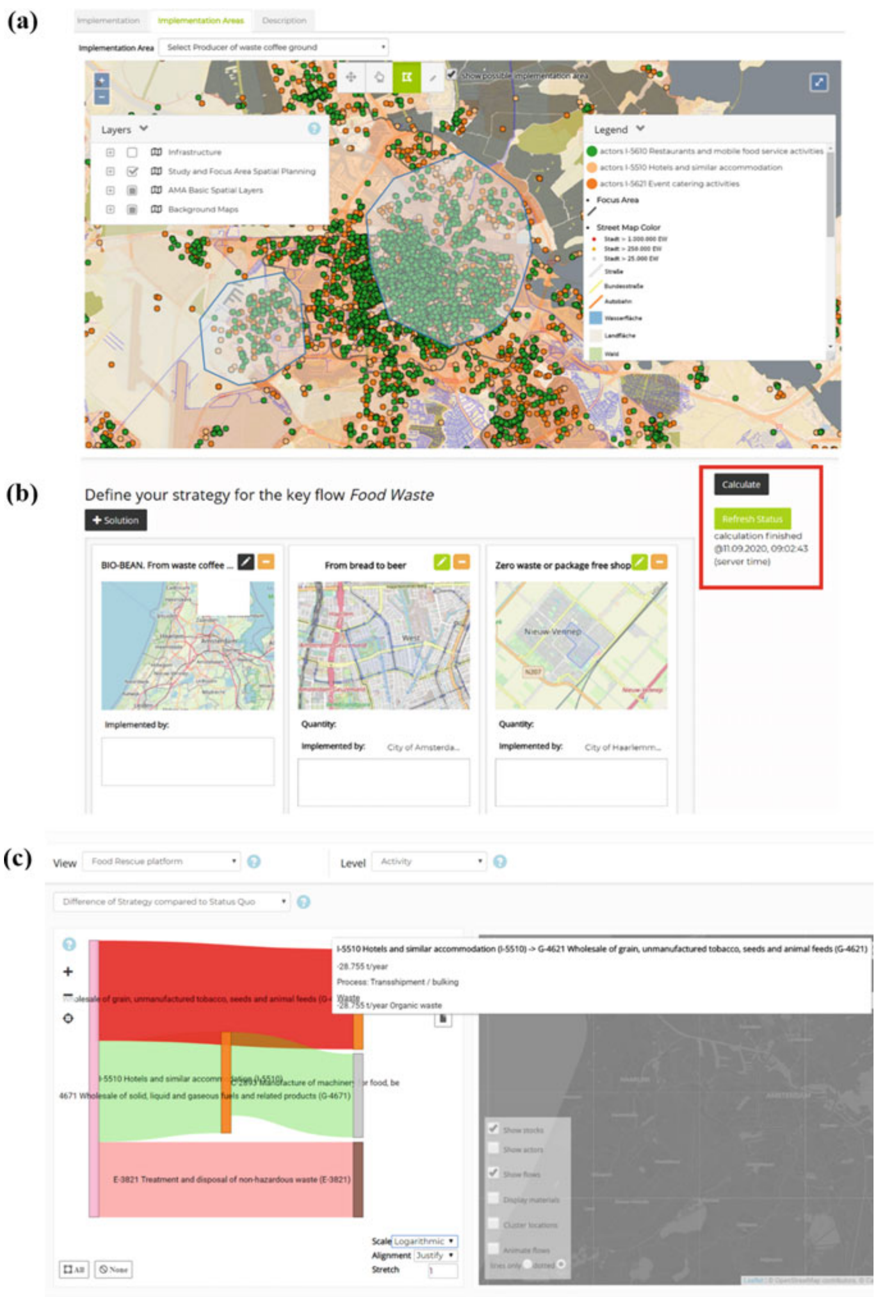

Fig. 11.3 Visualizing solutions and strategies, and their impact. (a) Drawn polygons represent spatial implementations of BIO-BEAN solution at workshop, overlaid with a map of actors that generate coffee grounds. (b) Combining implementations of BIO-BEAN with other two solutions into one strategy. (c) Sankey diagram showing color-coded impacts, and new attributes of the flow on mouse hovering

11.3.4 Presenting Flow Assessment of Circular Economy Strategies

To assess the impacts of one strategy (i.e., a bundle of solution implementations) on the flows, all solutions must be modeled and operationalized involving a consistent flow modeling. Thus, REPAiR solutions are modeled as a collection of *solution parts*, where one solution part describes a proposed process looking to affect a current process (this is, status quo flows between economic activities). A solution part is defined as six schemes for six processes, namely flow modification, shift of flow origin, shift of flow destination, new flow creation, flow prepending, and flow appending.

Assessing flow changes is done by comparing the status quo flow indicators set earlier with the anticipated changes introduced by the strategies. Once a combination of solutions and their implementation areas were chosen by the workshop participants, the GDSE calculated the impact in three steps; (1) actors within the drawn implementation areas are captured and selected. (2) A flow calculation algorithm redistributes the flows in between the economic activities, keeping overall mass balance of the affected flows consistent and also distributing total surplus or shortfalls within an economic activity in between all actors inside the drawn implementation area. (3) Flow changes are reflected in the chosen flow indicators and their values can be compared with the targets that were defined earlier. Figure 11.3c shows this visualized in the GDSE. The flow in red denotes a reduction of food waste at the level of activity “Wholesale of grain, unmanufactured tobacco, seed and animal feeds” by 28.8 tons/year, while green flows show increased quantities of materials or waste demonstrating a positive impact of the drawn strategy on the circular economy of Amsterdam.

11.4 Conclusions

This chapter demonstrated how information on flows of resources can be portrayed and used to improve the circularity of waste flows in a peri-urban area. The REPAiR project’s main support tool, the GDSE, is a tool that attests to the reported shift of cartography, in line with the development of ICT and GIS, from static maps and charts to *interactive dynamic maps* that prompt the inclusion and activation of stakeholders in the spatial planning process, and includes a cartographic representation of flows of resources and materials to create enhanced spatial strategic scenarios. The GDSE was used in workshops as part of the Amsterdam PULL, playing the role of the main tool for the creation and communication of both spatial information and strategic scenarios that decrease waste quantities. Flows of resources were successfully presented to stakeholders at the level of commercial activity, individual actors, and specific materials in order to provide more insight into the waste flows coming in and out of Amsterdam. Beyond applying sound cartographic principles when preparing informative interactive dynamic flow maps, it is important to note that the success of the GDSE-implementation also, and quite strongly, depends on the availability, quality, and detail level of the data necessary for mapping and processing flows of resources. Data on yearly household and industrial waste is not always easy to find, and very often is confidential, and in some countries not detailed enough (to allow analysis at the level of specific materials) or just absent. The GDSE is meant to be used in workshops and by teams of stakeholders, following a stepwise structure that allows them to (1) attain a common understanding of their study area both in geographical and waste management terms, (2) explore and understand the spatial dimensions, actors involved, and material-specific compositions of the various flows of resources flowing into and out of their city, and (3) use this information identify actors, neighborhoods, city areas where solutions can be optimally implemented in order to reduce waste quantities in their peri-urban area, thereby making progress toward developing a circular economy.

Acknowledgements This research has received funding from the European Union's Horizon 2020 research and innovation program. We want to thank Christoph Franke (GGR) for their vital contributions to the software development of the GDSE.

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Chapter 12
Collaborative Decision-Making Processes for Local Innovation: The CoULL Methodology in Living Labs Approach

Maria Cerreta and Simona Panaro

12.1 Introduction

The recent European Union programs and activities, oriented to promote an integrated vision of innovative urban planning and design, involving citizens as "city makers" to innovate and participate in governance and policy-making, identify cities as nodes able to bring together global networks of skills, knowledge, capital, public and private value (European Commission, 2019a, 2019b, 2020). The different existing and new research and innovation activities focused on urban issues contribute to enabling a sustainable and systemic approach to innovation through promoting co-creation, co-development and co-implementation processes, supported by new business and governance models, mobilising new partnerships and types of investments, and informing policy-making, planning and land use management.

The multiple initiatives support cities in developing a people-centred approach, putting open innovation into practice and spreading multi-stakeholder solutions across cities, accelerating the transition to sustainable, climate-neutral, inclusive, resilient, safe, healthy, smart, prosperous and socially innovative cities.

A human-centred city needs strategic research and innovation agenda focusing on eco-innovative solutions, where eco-innovation, according to European Commission (Decision N° 1639/2006/EC) and the Eco-Innovation Action Plan (EcoAP) (European Commission, 2011), can be defined as "any innovation that makes progress towards the goal of sustainable development by reducing impacts on the environment, increasing resilience to environmental pressures or using natural resources more efficiently and responsibly". EcoAP identifies the need to promote a constructive interaction among different stakeholders, including policy-makers on various

M. Cerreta (✉)
Department of Architecture (DiARC), University of Naples "Federico II", Naples, Italy
e-mail: maria.cerreta@unina.it

S. Panaro
Faculty of Business and Law, University of Portsmouth, Portsmouth, UK

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_12

governance levels, Member State representatives, the business sector, researchers and civil society, underling the opportunity of designing and proposing an interdisciplinary and transdisciplinary framework that ties together knowledge, innovation and the environment.

Indeed, the elaboration and implementation of eco-innovation processes and actions can be supported by the Quintuple Helix model (Carayannis & Campbell, 2010), which integrates the Triple Helix and the Quadruple Helix models. Whereas Triple Helix focuses on knowledge production and uses in a context where university, industry and government interact (Etzkowitz & Leydesdorff, 2000), the Quadruple Helix adds the helix of the media-based and culture-based public (Campbell & Carayannis, 2017; Carayannis & Campbell, 2009) (Fig. 12.1).

The Quintuple Helix introduces the helix of the "environment" with attention to natural environments, including social ecology features, and considering society–nature interactions and symbiosis between human activity and the environment (Rapport, 2007). The Quintuple Helix can be considered an analytical framework for sustainable development and social ecology, where societal ecosystem (actors, institutions, structures and processes) interrelates with social and natural environments, enabling the integration between knowledge and innovation, and making operative the eco-innovation defining a context of "innovation ecosystem". Knowledge and learning represent, respectively, a resource and a process able to generate new ideas and opportunities, leveraging innovation and creativity, and able to develop "creative knowledge environments" (Concilio & Celino, 2012; Dougherty, 2004; Ellström, 2010; Hemlin et al., 2004; Wallin & Horelli, 2010; Zobel et al., 2017).

In crisis conditions, it is essential to understand how cities build, convert and modify the relationships proper to urban contexts through endogenous development processes based on knowledge and learning (Campbell, 2012). The interaction between knowledge and the learning process determines the opportunity to build new relationships among communities, where trust becomes an essential component for elaborating shared collaborative development strategies.

According to the above perspective, Living Lab's concept constitutes an approach that structures the possible interactions between knowledge and learning, identifying a user-centred ecosystem, open to different kinds of innovation, understood as a process model of collaborative behaviour and active democracy, to implement self-sustainable development practices (Concilio, 2016; Dutilleul et al., 2010; Følstad, 2008; Leminen et al., 2012; Marsh, 2008). The competitive advantage of the territories and their economic actors no longer depends solely on technological innovation and the territorial system's capacity to understand the social demand for innovation and direct it towards a better quality of life.

The Living Labs approach can be implemented to design, explore, and experiment with policies, programs and projects and evaluate potential impacts, using methods and tools capable of integrating technical assessments with those of a political nature. These approaches allow analysing the changes in the relationship between the natural and built environment and the settled community, stimulating reflections oriented on the collaborative aspects of the decision-making process. A crucial role is played by co-evaluation techniques (Garnsey & McGlade, 2006; Guba & Lincoln, 1989;

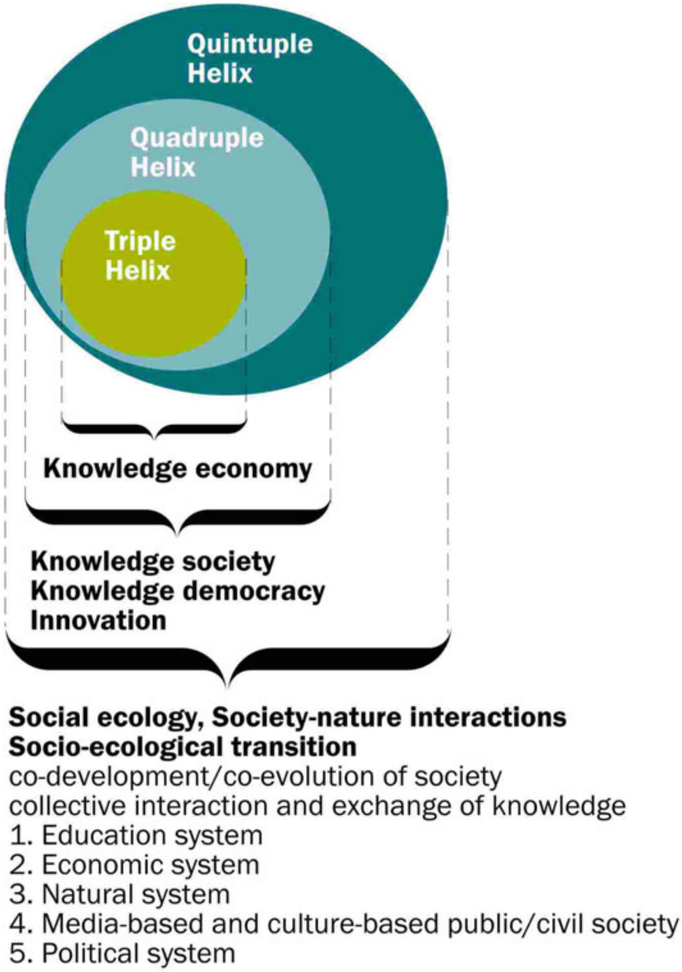

Fig. 12.1 From Triple Helix model to Quintuple Helix model (*Source* Carayannis & Campbell, 2017, *elaboration of authors*)

Patton, 2011), experimenting with adaptive and synergistic evaluation models to support collaborative and incremental decision-making processes. Co-evaluation is open to the interaction among knowledge, new digital technologies and innovative methodologies, such as gamification processes, useful to support the creation and strengthening of existing bonds and solve real-life problems (Cerreta et al., 2020; Panaro, 2015).

The implementation of collaborative evaluation processes integrates Multi-Criteria Analysis (MCA) and Multi-Group Analysis (MGA), Social Mapping Analysis, Social Network Analysis, Participatory Appraisal and GIS, Soft System Methodology, and Network Analysis, combining approaches and tools focused on enabling dialogue and cooperation among different interests, skills and knowledge. The interaction among different groups of actors allows us to understand and identify the possible Public–Private-People-Partnerships (PPPPs) (Marana et al., 2018), outlining a context-aware strategy, consisting of micro-actions, co-created and co-designed, shared and achievable.

In these processes, the web and platforms allow activating networks among services and people, taking into account the Internet of Things, Internet of Services, and Internet of People (Simmers & Anandarajan, 2018).

The paper is organised as follows. Section 12.2 presents the Living Lab approach; Sect. 12.3 describes the CoULL methodology oriented to develop an integrated approach of Urban Living Lab, an evolution of FormIT methodology combined with the 4Co Model; Sect. 12.4 explicates the framework of CoULL methodology implemented in some research projects; Sect. 12.5 provides some recommendations and highlights the conclusions.

12.2 The Living Lab Approach: A Transformative Process

The concept of Living Lab (LL) (Marsh, 2008, European Commission, 2009; Leminen et al., 2020; ENoLL, 2021) is closely connected to the priorities of the Europe 2020 strategy and of the Digital Agenda for Europe and is the subject of numerous user-centric open innovation programs (Framework Program for Competitiveness and Innovation—CIP, ICT Program of the Seventh Framework Program), and of European projects (SMARTiP, EPIC, PERIPHÈRIA, City SDK, CIVITAS, LIVERUR, AgriLink, etc.), supported by the European ENoLL Network, today composed of more than 440 accredited Living Labs.

There are many definitions that, over time, have tried to clarify the concept of LL, related to its fundamental principles: openness, influence, realism, value, sustainability (Bergvall-Kåreborn et al., 2009).

Openness refers to the collaboration between people of different backgrounds, perspectives, knowledge and experiences. Influence is related to users' active role, who, like other partners, have decision-making power; for this reason in the LLs there are often correlated concepts such as participation, involvement and commitment (Barki & Hartwick, 1989; Baroudi et al., 1986). Realism refers to the need to test innovation and user behaviour in a real-life context, thus obtaining valid results for the market. Value is related to the economic value for the actors involved, to the "business value" (the value for the employee, for the customer, of the suppliers, the managerial and social value). Sustainability means responsibility for the broader community in which we operate. The following aspects are highlighted: lifelong learning, development over time, partnerships and networks, satisfaction of personal and social desires, environmental responsibility and economic effects (Bergvall-Kåreborn et al., 2009; Hossain et al., 2019; Liedtke et al., 2012). Precisely the capacity of LL to produce innovation in a broader community has determined that they assume stronger links with urban policies ever. Therefore, the LL approach has found new application fields (work environments, district areas, urban planning) and took different forms. Today the trend in Europe is to adapt the LL concept and approach and use them as a tool to foster ITC innovation, inclusion, utility and usability and their applications in society (Eriksson et al., 2005; Voytenko et al., 2016).

In recent years, many European research strategies have promoted new social innovation paths for urban development (for example, Horizon 2020, Urbact and JPI Urban Europe). In particular, the JPI Urban Europe program seeks to create the conditions for which solutions can be developed and tested in real-life environments thanks to the collaboration between interested parties and citizens, paving the way for experimentation with Urban Living Lab (ULL).

ULLs distinguish from LLs for the find of locally sustainable solutions to city problems. Indeed, in ULL, the real-life context of innovation is a territory or a space-bound place, and the answers are found involving citizens and local stakeholders. The ULLs have been implemented to support cities to speed up the sustainable transition (such as climate change and energy transition), promoting the development and operationalisation of innovation, experimentation, and knowledge in real-life urban settings while emphasising the important role of participation, engagement and co-creation (Bulkeley et al., 2016). Indeed, it is becoming increasingly evident that none of the challenges facing contemporary cities (economic and digital disparities; ageing populations; migration; environmental and health crisis) can be solved by governments if they act alone.

The search for innovative solutions to current urban problems also requires new models of cooperation among entities (central, regional, local government), civil society associations, businesses and other interested parties. The traditional relationships between the citizen and the public administration are therefore evolving towards "pluralist" models (Peters & Savoie, 2000), in which the interested parties participate in some way in the realisation of sustainable solutions and services (Pollitt et al., 2006). ULLs become tools for triggering local innovation processes that affect public goods and collective services in this decision context.

Generally, in ULLs, the innovation process is assured thanks to co-creation activities (Steen & van Bueren, 2017). By co-creation, unusual and new ideas can be developed thanks to the presence and the co-working of several stakeholders at the same time and in the same place. They can help identify problems and challenges, desired trajectories that are seen as feasible solutions and can be followed to deal with complex systems. At the same time, ULLs rely on Public–Private-People-Partnerships (PPPs) (Innovation Alcotra, 2013), as citizens and local associations are considered an essential source for the innovation process.

However, integrating the LL approach with the territory development policies is a complex operation that requires the need to identify necessary initiatives and structure a network of participating and potentially interested local actors. In this way, the demand for innovation is prepared for actual experimentation, in which participatory strategic planning and territorial self-government take on particular importance. Research on how to shape and steer ULLs has been conducted through the literature review on LLs and participatory governance models. The study has developed a methodology framework, called Collaborative Urban Living Lab (CoULL)

(Panaro, 2015), an evolution of FormIT methodology (Ståhlbröst & Holst, 2012), combined with the 4Co Model (Pollitt et al., 2006) to implement ULL in the local Co-Governance processes.

12.3 The CoULL Methodology

The CoULL methodology aims to rationalise local Co-Governance processes through the articulation of a ULL. These processes aimed at engaging and involving citizens in every phase of public and collective services development (4CO Model): design (Co-Design), production (Co-Production), decision-making (Co-Decision), and evaluation (Co-Evaluate) (Pollitt et al., 2006). The 4CO model highlights how cooperative solutions are necessary for cooperation between governments and between bodies and institutions, civil society associations, businesses, stakeholders and citizens. Participation and active involvement are a prerequisite for development creation of sustainable solutions. This consideration implies that public bodies evolve from a closed system towards the organisation of an open network, which builds dialogue and a relationship of trust with society through transparency and the activation of awareness and responsibility processes. Therefore, the traditional model of "design-decision-production-evaluation" is reinterpreted according to a cooperative approach that involves stakeholders and citizens at every stage of the process.

The "co-design-co-decision-co-production-co-evaluation" model develops dynamically, including continuous feedback among the different phases, recognising that a production experience can lead to design changes, evaluation results can influence the other stages, and different decisions are made at all stages, not just at one point in the process cycle.

The four different models of relations among public institutions and citizens/users (Fig. 12.2) allow for highlighting how decision-making processes can progressively evolve.

The Traditional Model (quadrant I) highlights a predominance of internal activities oriented to providing services and focused on inputs and procedures. Citizens as consumers do not intervene in the process; the focus is on the quality of resource allocation and the related processes and activities. Compliance with the rules and legality are the essential prerequisites.

The Implementation Participation Model (quadrant II) includes citizens intended as co-producers. Public sector administrations are recognised as open to the outside world, but the focus remains on internal inputs and procedures. Voluntary collaboration is only considered to reduce costs and provide additional services.

The Enlightened Ruler's Model (quadrant III) provides for the citizens' participation only in the evaluation phase concerning the quality of the services offered.

The Co-Governing Model (quadrant IV) integrates the phases of co-production and co-evaluation and adds co-design and co-decision. The model is open to the outside world and provides for the active participation of multiple stakeholders, involved both in the services offered and in the expected results, outlining a form of

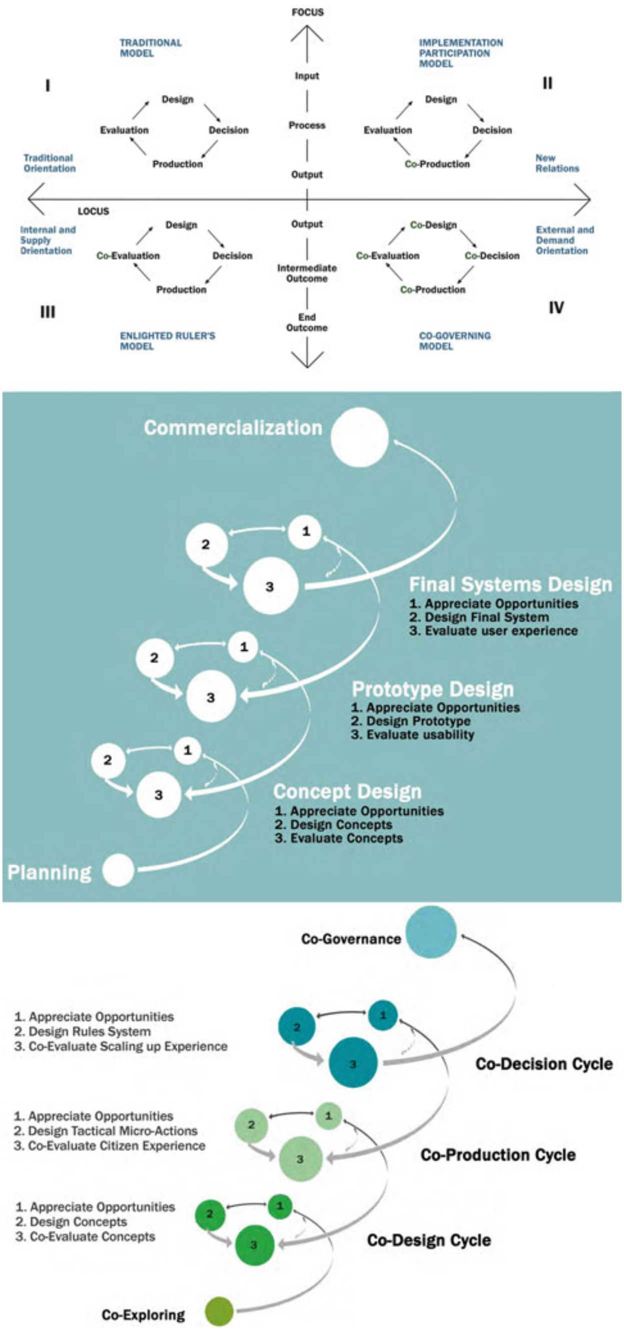

Fig. 12.2 The 4CO model (*Source* Pollitt et al., 2006, *elaboration of authors*); The FormIT model (*Source* Almirall et al., 2012, Ståhlbröst, 2008 *elaboration of authors*); The CoULL methodology (*Source* Panaro, 2015)

co-management in which the measure of citizen satisfaction can be transformed into satisfaction management (Van Dooren et al., 2004).

The 4CO model introduces an innovative process in the decision context, including cooperation among the different stakeholders to improve the quality of the process and results.

At the same time, the FormIT model (Fig. 12.2), developed by the Luleå University of Technology in cooperation with CDT and different IT enterprises with the aim to support the involvement and engagement of users in LL (Bergvall-Kåreborn & Ståhlbröst, 2009; Bergvall-Kåreborn et al., 2009; Ståhlbröst, 2008), integrates the approaches of Soft Systems Thinking (SST) (Checkland, 1981; Checkland & Scholes, 1999), which recognises plural points of view crucial to bring about change; Appreciative Inquiry (AI) (Cooperrider & Whitney, 2005), which considers the development opportunities arising from positive experiences as a basis for innovation; and NeedFinding (NF) (Patnaik & Becker, 1999), which focuses on the needs and interests of users throughout the entire process of developing innovation, keeping multiple fields of investigation open and looking beyond the immediate problem to be solved. The FormIT methodology articulates an interactive process between users and the development team. The innovation occurs in three iterative cycles: Concept Design, Prototype design, and Final Systems Design. Each cycle, in turn, is developed in three phases: Appreciate Opportunities, Design, and Evaluate. The evaluation phase is present in each cycle to expand the focus from aspects related exclusively to usability towards a system's holistic vision. In each cycle, the individual phases take on specific objectives and lead to different results.

According to the FormIT model, the CoULL framework has articulated a ULL into incremental and progressive development cycles, drawing a spiral process. Each cycle represents a phase of the 4CO Model: Co-Design (Cycle 1), Co-Production (Cycle 2), Co-Decision (Cycle 3). At the same time, each cycle has further divided into additional steps that assume a diverse nomenclature and meaning in the different cycles. A Co-Evaluation phase has been added in each development cycle, while the Co-Governance model is placed at the spiral's apex.

The methodological structure also provides for a preliminary Co-Exploring phase. The conditions for developing and concrete experimentation of innovative solutions for the supply and co-management of public or collective services, spaces and goods are investigated with local actors (Fig. 12.2).

The proposed methodology aims to include in the different development cycles: citizens and social innovators; enterprises (profit, low profit and non-profit); cognitive institutions (schools, universities, research centres, academies and cultural institutes); organised civil society (social partners and third sector subjects); public institutions (Iaione, 2015).

In the Co-Design Cycle, the goal is to identify the values recognised by local communities and define concepts with the citizens to enhance the territory. The cycle develops by considering the following steps:

- Identification of a reliable sample of citizens/users and selection of involvement and engagement tools and techniques (Appreciate Opportunities);

- Elaboration of intervention concepts with the participants (Design Concepts);
- Identification and representation of local values shared by the involved community (Co-Evaluate Concepts).

The Co-Design Cycle works to recognise the identity components on which to base transformation micro-actions of the context. Indeed, the specific context is the privileged place where the behaviours, actions, ways of living and perceiving of users and citizens that change over time are manifested. All these components give each context-specific meanings, making it an identity for a community in a given period.

Therefore, representing the perceived reality is equivalent to investigating the spatial and temporal relationships of local values, developing an internal knowledge of the territory, starting from acquiring the meanings attributed to physical characteristics. Therefore, the aim is not to represent reality as it is but as it is lived. The specific context does not have a value in itself; it depends on the social relations that give meaning to the different goods and places.

Indeed, contexts with similar characteristics can assume different meanings, roles, protection systems because there is a relational nature between goods and places that requires interpretative analyses. Therefore, the role and type of relationships that contribute to the formation of values are investigated, starting from the perceptions of users and citizens' points of view, thus also exploring the lesser-known aspects and the potentials that emerge in the comparison between specific groups of involved actors.

In the Co-Production Cycle, the goal is to implement micro-actions to enhance the specific context with a selected group of citizens and partners. It is, therefore, configured as a cycle that includes the definition and testing of regeneration models. The cycle develops considering:

- Identification of citizens and users to be actively involved in the testing process, identifying specific needs and requirements (Appreciate Opportunities);
- Elaboration of an intervention program, defining the conditions, methods and types of collaboration among partners, also through the drafting of specific agreements (Design Tactical Micro-Actions);
- Monitoring of the experience of citizens, users and partners to detect perceptions, changes in behaviour, and any corrective actions and new relationships (Co-Evaluate Citizen Experience).

This cycle is taking into account the practices of tactical urban planning (Pfeifer, 2013), which recognises the needs and methods to be included in the processes of gradual transformation in everyday experiences. The main purposes are: actively involve the beneficiaries to bring about the change; collect the ideas that come from the context to face the challenges of local transformation; satisfy real needs with low costs and short times; reduce the chances of risk; develop the different forms of social capital among the different actors involved in the decision-making process. To give and answer to the social and economic changes of a local context, an active commitment of citizens is therefore experienced in the transformation process through the implementation of temporary interventions, considered as a bottom-up approach that can help to recognise shared goods and trigger innovative processes of revitalisation of local resources.

In the Co-Decision Cycle, the goal is to define a co-management system of goods and/or places shared among citizens, local administration and users.

This process happens when a community recognises itself around a common good (Ostrom, 1990) and claims its management capacity. By participating actively and directly, an individual activates a mechanism of sharing with others but recognises a common good when he/she begins to feel responsible for actions, affect transformations and contribute to related choices. Only in this case, it is possible to start a Co-Decision process, defining: needs and opportunities (Appreciate Opportunities); a system of rules for the co-management of common goods (Design Rules System); the conditions of process scalability (Co-Evaluate Scaling up Experience).

According to Ostrom (1990), commons are spaces or collective resources, managed by a limited group of people (local community), based on rules known, accepted and shared by community members. The commons' recognition depends on social conventions and institutions: indeed, a good becomes legally common only if a community undertakes to manage it as such. Through experimentation by trial and error, communities can consolidate mutual trust relationships, self-regulate and develop high skills. Community and shared management of commons, when applicable, can lead to more significant benefits than state or private management, because it actively involves individuals for whom that resource is conceived as a vital good.

The Co-Evaluation phase, internal to all development cycles, allows for the transition and implementation from one cycle to other thanks to the recognition of: values shared by a specific community (Co-Evaluate Concepts); actions that favour the recognition of common goods (Co-Evaluate Citizen Experience); local conditions that can enable the development of new models of co-management of common goods (Co-Evaluate Scaling up Experience).

Co-Evaluation, integrating adaptive and synergistic approaches, identifies cyclical decision-making paths that from knowledge lead to the identification of relationships and, therefore, to the construction of new values (Zeleny, 2005). In this phase, the potential of the spontaneous transmission of knowledge and the availability to interactive, mutual and collaborative learning among the different involved actors, useful for supporting social and territorial innovation processes, are investigated.

12.4 The CoULL Implementation in Different Decision Contexts

The CoULL methodology has been elaborated and tested in the CilentoLabscape project (Cerreta & Fusco Girard, 2016; Cerreta & Panaro, 2017), revised in the GardeNet project (Cerreta, Panaro, et al., 2018) and the SSMOLL project (Cerreta et al., 2020). Besides, it represents the conceptual reference of the methodological

Fig. 12.3 The CoULL methodology and the test projects

framework developed and implemented in the REPAiR project (Amenta et al., 2019; Cerreta, Inglese, et al., 2018) (Fig. 12.3).

In the CilentoLabscape project, the Living Lab, activated in the National Park of Cilento, Vallo di Diano and Alburni, focuses on the concept of "human smart landscape", in which the smart and human dimensions are integrated and uses technologies as an enabling factor to connect and involve institutions and citizens. The aim is oriented to rebuilding, recreating and motivating communities, stimulating and supporting their collaborative activities to achieve a condition of shared social well-being. In this direction, the CilentoLabscape LL represented a Co-Promotion and Co-Production process of the unknown, abandoned, or underused places of the Park.

The CoULL methodology has allowed to Co-Explore with local actors the more suitable topics and places to activate specific thematic arenas, Co-Design experimental actions, and Co-Produce them with local groups. Where possible, has also been implemented the Co-Decision Cycle to support local Co-Governance processes.

More in dept, thanks to the cooperation with local actors, three different thematic arenas have been activated:

- Ri.Vivo arena for identifying new ways to reuse the abandoned village of Castel Ruggero in the municipality of Torre Orsaia;
- Ci.Resto/Ci.Vado/Ci.Torno arena for re-discovering value places of the Park and identifying new itineraries suitable for more sustainable tourism;
- Ri.Uso arena for bottom-up regenerating of unused public spaces in the municipality of Sapri.

From a methodological point of view, the Ri.Vivo arena was developed up to the first cycle of Co-Design that was carried out a new narrative of the Castel Ruggero village by mapping its significant elements, collecting stories, surveying the buildings and spaces, elaborating visions, identifying interests and needs. The Co-Evaluation step was worked to bring out a new interpretation of the landscape values and identify possible enhancement tactics.

The Ci.Resto/Ci.Vado/Ci.Torno arena was a travelling workshop in the National Park of Cilento, Vallo di Diano and Alburni and was developed in the Co-Design and Co-Production cycles. In the Co-Design Cycle, a survey was elaborated on the "places of value" of the Park aimed at building maps of identity values. In the Co-Production Cycle, a gamification process was activated to test an alternative way of cultural promotion of the Vallo di Diano territory. Attention was focused on the spatial experience of people and communities and its representation in the geographical space to trace the identities of the territory and develop a multidimensional interpretation of the landscape qualities.

The Ri.Uso arena has developed the three cycles of Co-Design, Co-Production and Co-Decision. In particular, in the Co-Design Cycle a survey was focused on the public space in the municipality of Sapri to identify an area in which to experiment bottom-up urban regeneration. In the Co-Production Cycle, micro-actions were developed for the transformation of the test area. The Co-Evaluate Citizen Experience phase has had a key role and was aimed at assessing citizens' engagement and experience throughout the process activated in the Co-Production cycle. The Co-Decision cycle has been activated when the neighbourhood inhabitants have started a process of co-management of the common spaces by agreeing on a uses regulation and related maintenance, then approved by the local administration.

The incremental process has activated new social interactions over time, resulting in a change of intended use (from parking to square) of the test area, recognised as a common good and supporting the cooperation for shared results. In this cycle, the Co-Evaluate Scaling up Experience phase was aimed at monitoring the process of co-management of urban spaces, the local community's level of participation, the dissemination of results in the urban context and institutional and social spaces.

In the GardeNet project, an Urban Living Lab has been activated in the city of Naples, developing a co-learning process to favour the involvement of the young generation in urban green care. Indeed, the GardeNet ULL has represented a safe test environment for new collaborations among public and private actors, non-profit organisations, young people, and active citizenship to increase young people's participation in green care.

The collaboration with different organisations has permitted to explore the potential of shared gardens as socialising public places in problematic urban areas characterised by a high density of population and young, a high unemployment rate, a low level of education and a lack of safe public spaces.

The CoULL methodology has facilitated the activation of a Public–Private-People Partnership (PPPP) and to exchange among different actors developing their ability to direct services at citizen's and young's needs. The GardeNet project has worked in three problematic districts of the city, and the related activities have been implemented according to all the cycles and steps of the CoULL methodology.

In particular, in the Co-Design Cycle, it has been activated collaboration with high schools, universities, and local associations to share experiences and co-design ways to involve different target groups of young (teenager, students, parents, unemployed) in the various neighbourhoods of the city. In the Co-Production Cycle, have been tested different activities (practical workshops, open-air lectures, training activities and public events), monitoring all participants' engagement and their progressive interest to cooperate to improve spaces and the definition of new activities for the post-project phase.

In the Co-Decision Cycle, a process of communication, information and dissemination of the results was activated. During all process, the Co-evaluation of elaborations (Co-Evaluate Concepts), actions and services (Co-Evaluate Citizen Experience) has permitted to analyse the conditions for the replicability of the experiments in the same or other areas of the city (Co-Evaluate Scaling up Experience), promoting shared gardens as a model for increasing civic participation, the sense of belonging of the younger generations and responding to the demand for urban well-being.

The GardeNet project has allowed developing a collaborative and inclusive learning space for the new generations, using new technologies and gamification processes as tools for interaction, expanding the languages and methods of exchange, and stimulating formal and informal cognitive processes.

In the SSMOLL project the CoULL approach has been explored and tested in the case study of the San Sebastiano del Monte dei Morti Living Lab, in the municipality of Salerno, activating a Collaborative Decision-Making Process Living Lab (CDMP-LL) for the adaptive reuse of cultural heritage and the implementation of a Creative Living Lab (CLL).

In this decision context, the three main phases have been reinterpreted to identify the enabling conditions for the galvanisation of a culture-led regeneration process for the San Sebastiano del Monte dei Morti church, unused since the 1980s. A central role has been developed by the Co-explore and Co-Design phases. The Co-explore phase has had the purpose of activating the CLL and included the structured decision-making process before reopening the church. It aimed to understand the potential and critical issues and, above all, at building the enabling conditions that would allow the reopening of the church and the activation of a culture-led regeneration process. The results obtained in the Co-explore phase have been oriented to identifying the main characteristics of the CLL and the selection of actions able to build a shared collective awareness. The Co-Design phase started with the church's reopening and has been followed by the Co-Production phase, including the two cycles of activities that made it possible to develop and test the CLL process.

In the SSMOLL project, the Co-evaluation phase has been conceived as a transversal action, present during every phase of the process but also including the three main phases of Co-explore, Co-Design and Co-Production. Indeed, in each phase, it was possible to assess and share the results with the other actors involved in the decision-making process, analyse their multidimensional components, and express quantitative and qualitative indicators generated by the community's active collaboration. The methodological process activated for the CLL of the former Morticelli church is still in progress, allowing redefining and testing an adaptive collaborative decision-making process and generating new values during the path of reuse, with relevant impacts for the entire urban context. At the same time, the CLL implementation was essential to develop and experiment with techniques and modalities of co-evaluation to support adaptive community-based reuse processes.

In the REPAiR project, the CoULL methodology has been the basis for the Co-creation process implemented in Peri-Urban Living Labs (PULLs), based on five iterative phases: Co-Exploring; Co-Design; Co-Production; Co-Decision; Co-Governance. The main innovative aspects introduced by the REPAiR project concern both the context in which the methodological path of LL is developed, oriented towards the regeneration of the peri-urban areas interpreted as wastescapes, and the interaction with the approaches of Geodesign and Life Cycle Assessment (REPAiR, 2017, 2018).

The PULLs have been organised in six metropolitan areas across Europe: Amsterdam and Naples, as pilot cases, and Ghent, Hamburg, Pécs, Łódź as follow-up case studies. In these physical and virtual environments, different key actors and stakeholders (representatives of regions, municipalities, corporations, people, citizens and individuals, design professionals, information technologists, scientists, and students) collaboratively generate new ideas, creative innovation and strategies for the development of circular economy thought the elaboration of eco-innovative solutions, in co-creation sessions.

In the methodological process, the Co-Exploring phase assumes a crucial role. It deals with two relevant phases of the Geodesign model: the Representation Model, dealing with the definition of a common understanding of the territory, developed with the collaboration and cooperation of all the researchers, stakeholders and experts identified and involved in the project, and identifying the main challenges and objectives; the Process Model, investigating key resource flows, and mapping material flows and waste management system in the selected focus areas.

The Co-Design phase interacts with two other significant phases of the Geodesign process: the Evaluation Model and the Change Model. In these two phases, the research team with local stakeholders and experts developed a phase of assessing the status quo and identifying specific challenges to elaborate situated Eco-Innovative Solutions (EIS) and their functioning.

The Co-Production phase is related to the Change Model of Geodesign, focused on developing EIS and Eco-Innovative strategies to promote and activate innovation processes oriented to the transition to more circular models in peri-urban areas, managing agreements and conflicts among different interests and groups of decision-makers.

The Co-Decision phase supports the Impact Model's structuring, assessing EIS efficiency, analysing the multidimensional impacts and their effects on the selected peri-urban areas.

The Co-Governance phase is related to the Decision Model, and it is about delivering decision-making models based on co-creation and scaling up to other similar cases, promoting collaborative governance processes.

In the REPAiR project, the co-creation builds on multidimensional and multi-contextual strengths of PULLs and interacts with the co-evaluation of physical and socio-economical impacts of eco-innovative solutions and building a process of awareness and collaborative learning among all the engaged stakeholders to stress out the main issues of each phase.

12.5 Conclusions

In conditions of crisis, it has been highlighted that it is essential to understand how cities build, convert and modify the relationships typical of urban contexts through endogenous development processes (Campbell, 2012). The interaction between knowledge and the learning process determines the opportunity to build new relationships between communities, in which trust becomes the essential component for building shared collaborative development strategies.

The LL concept and the CoULL methodology allow structuring an approach that enables the possible interactions between knowledge and learning, identifying an innovation, user-centred and people-based ecosystem, interpreted as a process model of collaborative behaviour and active democracy, applied to carry out self-sustainable development practices.

Integrating the LL approach to the development policies of an urban context and territory is a complex challenge that requires the need to identify priority interests and structure a network of participating and potentially interested local actors. In this way, the demand for innovation enables effective experimentation, in which participatory strategic co-planning, territorial self-government and social cohesion take on particular relevance.

The LLs, in different interpretations, can be used for the design, exploration, experimentation of policies, programs and projects and for the assessment of potential impacts, using approaches and tools capable of integrating technical and political evaluations. These approaches allow analysing the changes in the relationship between the natural environment, the built environment and the settled community. They stimulate reflections on the collaborative aspects of the decision-making process and the co-evaluation techniques, experimenting with adaptive and synergistic evaluation models to support incremental decision-making processes, open to the interaction between different knowledge,

In general terms, the CoULL methodology implemented in different LLs experiences develops a site-specific approach, depending on the purposes and the various stakeholders involved in the decision-making process and how they can contribute.

The application of the CoULL approach in the four identified projects highlights how it was possible to pursue specific objectives at different territorial scales (landscape, city and neighbourhood), in which collaborative governance represents a common component. In the CilentoLabscape project, a Co-Promotion and Co-Production process of places for enhancing the National Park of Cilento, Vallo di Diano and Alburni was activated, focusing on collective awareness, sustainable tourism and adaptive reuse. The GardeNet project was developed by activating a Co-learning process for young generations inclusion in the shared urban gardens practices, where the green and young city is a crucial component. The SSMOLL project implemented a culture-led regeneration process for the adaptive reuse of religious cultural heritage, contributing to a diffused collective awareness. The REPAiR project promoted a Co-Creation process to develop eco-innovative solutions and strategies for transition to circular economy models in peri-urban areas. The topic of wastescapes and their implications on urban metabolism is essential to need a hybrid approach, where Geodesign and Life Cycle Assessment interplay.

The CoULL methodology aimed at assuring more extensive participation and cooperation of local stakeholders who are actively involved in the decision-making process for the regeneration of the selected contexts. It follows that the outcomes of the co-creation workshops implemented in the different experiences of the described research projects are the result of the actors' engagement since the first phase of the idea development, sharing the ownership of the project/solution ideas and assuring conscious management of their implementation. Furthermore, local communities' involvement has shown to positively influence citizens by having them struggle together to identify solutions and strategies for operationalising sustainability principles, resulting in increased trust in their institutions and among the new communities' actors. The implementation of co-creation processes has been supported to overcome institutional lock-in situations, promoting collaborative and cooperative processes to identify strategies and actions that integrate roles and points of view, overcome the limits of sectoral approaches and make local innovation operational.

Acknowledgements The authors want to acknowledge the projects, opportunities to test and implement the CoULL methodological approach and its elaborations: "Cilento Labscape: An integrated model for the activation of a Living Lab in the National Park of Cilento, Vallo di Diano and Alburni", funded by FARO Program 2012–2014 "Funding for the Start of Original Research", University of Naples Federico II; "GardeNet. Una rete di giardini condivisi", MeetYoungCities Program, Associazione Nazionale Comuni Italiani (ANCI) and Comune di Napoli, co-funded by Presidenza del Consiglio dei Ministri, Dipartimento della Gioventù e del Servizio Civile Nazionale; "San Sebastiano del Monte dei Morti Living Lab—SSMOLL", Blam collective, Department of Architecture (DiARC), University Federico II of Naples, Municipality of Salerno; "REPAiR—REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism", funded by the European Union's Horizon 2020 research and innovation programme under grant agreement no. 688920.

Authors Contribution The authors jointly conceived and developed the approach and decided on the overall objective and structure of the paper: Conceptualisation, MC, SP; methodology SP; validation, MC, SP; formal analysis, MC, SP; investigation, MC, SP; resources, MC, SP; data curation, SP; writing-original draft preparation, MC, SP; writing-review and editing, MC, SP; visualisation, MC, SP; supervision, MC; funding acquisition, MC, S.P.

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Chapter 13
Urban Metabolism Evaluation Methods: Life Cycle Assessment and Territorial Regeneration

Pasquale De Toro and Silvia Iodice

13.1 Introduction: The City as an Urban Ecosystem and the Concept of Life Cycle

The co-evolution of human and natural systems results in the interpretation of cities as hybrid ecosystems, that are unstable and unpredictable, but also capable of innovating (Alberti, 2015). A city, if treated as an ecosystem, can be better evaluated (Collins et al., 2000). In the present work, a shift is proposed from the 'ecology in cities' approach to the 'ecology of cities' approach. The first approach links ecological approaches in urban areas (Grimm et al., 2008; Sukopp, 2008), whereas the second incorporates the first approach and expands it by considering the city itself as an ecosystem (McPhearson et al., 2016).

What primarily characterises ecosystems is the search for consistency and coordination between the components. From this perspective, cities are ecosystems, living organisms that are defined by a high level of complexity and in continuous transformation, produced by the union of cultural and natural events, and that are composed of places endowed with identity, history, character and long-term structures (Magnaghi, 2010). Another main feature of urban ecosystems is the presence of dynamic boundaries and a high dependence on their fringe environments. Three main components of urban ecosystems have been identified (Chen et al., 2014):

- Structures, which are based on the distribution of organisms, including humans, as well as landscape patches, and soil, atmospheric and hydrologic patterns;

P. De Toro (✉)
Department of Architecture (DiARC, UNINA), University of Naples Federico II, Naples, Italy
e-mail: pasquale.detoro@unina.it

S. Iodice
European Commission, Joint Research Centre (EC, JRC), Ispra, Italy
e-mail: silvia.iodice@ec.europa.eu

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_13

- Processes, which are based on various forms of communications as well as political and cultural activities, together with economic and ecological processes in the built environment;
- Functions, such as resource consumptions and ecosystem services.

Urban ecosystems are defined as: 'dynamic, three-dimensional combinations of natural, social and built features, and their functions, associated with an urban area' (Brown, 2017, p. 10). They are mostly influenced by human actions, but are not totally dependent on them (Hobbs et al., 2006), and they are the result of human and ecological processes occurring simultaneously in time and space (Alberti, 2008).

Urban ecosystems face many difficulties because of rapid and major urbanisation phenomena, leading to dramatic environmental changes at different scales, from local to global (Buhaug & Urdal, 2013; Pataki et al., 2006). Moreover, because they are a concentration of people and human activities, urban ecosystems are also energy-intensive, determining their being more unbalanced than many other ecosystems, and characterised by a heterotrophic nature, because of their strong dependence on external energy sources (Collins et al., 2000).

Urban ecosystems are also part of the wider territory: they are complex and open systems that interact with other territories, such as the ecosphere and biosphere, and that are transformed, used and managed by a system of actors who relate to each other in socially organised forms. Loiseau et al. (2018) propose identifying three main dimensions of a territory: a material dimension defined by its physical components, an organisational dimension defined by the presence of social and institutional actors, and an identity dimension defined by the way social and institutional stakeholders interact with the territorial system.

Another important distinction must be made between urban and peri-urban areas; the latter are portions of territory in transition, that are characterised by a juxtaposition of activities and by the possibility of alterations and modifications of their features due to human activities (Douglas, 2012). These complex systems are crossed by economic, ecological and social flows whose quality and quantity is strongly influenced by human activities (Rotmans et al., 2000).

Urban ecosystems are characterised by the interaction of environmental, economic and social dynamics and they are areas in which a high rate of production of negative externalities is concentrated. From this perspective, cities are less balanced than human-free ecosystems and 'the feedback control of ecological consequences to social policy is relatively weak' (Collins et al., 2000, p. 140).

As ecosystems, cities have to face many challenges, such as population growth, pollution, changes in climate and water systems and soil consumption (McPhearson et al., 2016). Consequently, the amount of built infrastructures is increasing (Ahern et al., 2014), with negative consequences for natural resources at different scales. Urban ecosystems have not yet been appropriately incorporated into the various forms of urban governance and planning approaches aimed at increasing resilience, despite the strong need for such integration (McPhearson et al., 2016).

These ecosystems are also crossed by metabolic processes that define the interconnections of different life cycles (Russo, 2017, 2018). The concept of the life cycle of urban ecosystems is related to the evolution of the territory as a heritage and as a system of environmental, social and economic resources and services, whose transformation is linked to the governance of that particular territory. The territorial life cycle is formed in subsequent phases that are influenced by the systems of resources and performances of that territory, which follow a predefined plan scenario (Torricelli, 2015a).

According to Zucchetti (2008), in a systemic conception, a certain portion of the territory does not have the possibility of growing indefinitely. It can undergo an involution phase, that manifests itself with an increasing degree of entropy and a reduction of the value of the ecosystem. This process will continue until the creation of a new system with a different structure and a new life cycle is started.

In general, there are many different drivers that can determine the evolution of the territorial life cycle—not only economic factors, but also social and environmental ones—and each case has its own specificity.

Carta (2013) identifies three categories of life cycles:

- Completed or never born life cycles: These are spaces of abandonment and waste, closed workspaces, and unfinished or no-longer-used structures. In these areas, it is possible to adopt an up-cycle process and activate transformations capable of giving life to multiple functions, with a view to hyper-cycling;
- Seasonal life cycles: These are linked to the system of second homes and tourism in crisis because they are on sale or subject to a real estate crisis. Additionally, in this case, the hyper cycle, acting on the causes of territorial decline, allows the activation of new life cycles and thus promotes the regeneration of new connection networks;
- Productive life cycles in 'border landscapes': These are production areas that generate wasted landscapes, requiring a linear production cycle's transformation into a circular production cycle. Here, it is possible to apply the concept of sub-cycles and the 'from cradle to cradle' approach, creating new, resilient and adaptive processes.

The speed that distinguishes the succession of different life cycles and the consequent consumption of resources determines the unavoidable formation of residual spaces, or *wastescapes* (Amenta & Attademo, 2016). At the end of their life cycle, *wastescapes* await the start of regeneration actions.

If the city is like a living organism, the start of a new life cycle in a *wastescape*—through proliferation and hybridisation of the surrounding tissues—can transform a group of undifferentiated cells, giving rise to new organs. Areas subject to recycling actions are like sprouts that generate new connective tissues (Carta, 2013). The concept of a life cycle can be compared to that of change and it is also closely linked to the analogy of ecosystems and the urban environment, which forms the basis of the idea of a city as an organism in constant transformation (McDonough & Braungart, 2002). In this sense, cities, in their making and unmaking, are seen as renewable resources. Recycling the city is a fundamental strategy that touches upon scales and themes of contemporary urban challenges (Ciavatta, 2016).

This recycling action, from the perspective of the circular economy, strongly needs the help of decision-making tools and quantification methodologies that are based on the environmental impact assessment principles.

13.2 Environmental Assessment: Agendas, Methods and Tools

The general concept of environmental assessment was introduced in the 1970s, with the aim of integrating the environmental component into decision-making processes as well as analysing the state of the environment and increasing citizens' awareness of environmental issues (Lerond et al., 2003).

There are no standardised methodologies for territorial environmental assessment, despite the existence of a wide number of tools and methods with this purpose (Loiseau et al., 2012).

From this perspective, environmental assessment is an instrument of considerable importance because the high concentration of people in urban ecosystems puts massive environmental pressure on not only ecosystems and natural resources, but also on the well-being and quality of life of the ecosystem's inhabitants. As soon as the concept of sustainable development was introduced (Brundtland, 1987), a variety of methods for environmental assessment was proposed and developed to enhance territorial sustainability. Environmental assessment can be defined as an instrument that aims to support land planning and management decision-making processes and provide environmental information using a global approach (Torricelli & Gargari, 2015a).

Ness et al. (2007) subdivide these methods into three categories:

- Methods based on the use of indices and indicators. Whereas an indicator, using observed or estimated data, describes one characteristic of the state of the environment (Dizdaroglu, 2015), while an index represents a quantitative aggregation of many indicators, thus providing a simplified view on the state of the environment (Mayer, 2008). Many indices of sustainability on an urban scale have been developed by different organisations and from different perspectives (Albertí et al., 2017). For example, consider the City Sustainability Index (Mori & Christodoulou, 2012) and the Environmental Performance Index (EPI) (Esty et al., 2005);
- Integrated assessment methods, which are used to investigate policy changes or project implementation statuses using development scenarios. In this category, some examples are Multi-Criteria Decision Analysis (MCDA), Cost-Benefit Analysis (CBA) and impact assessment (such as the Environmental Impact Assessment [EIA] and the Strategic Environmental Assessment [SEA]) (Dizdaroglu, 2015);
- Methods that assess sustainability on the scale of a single product and that focus on the material and energy flows of a product or service by adopting a life cycle

perspective (Dizdaroglu, 2015). Noteworthy examples are the Ecological Footprint (EF) (Wackernage & Rees, 1997), which is sometimes based on the concept of 'carrying capacity' (Rees, 2017), Material Flow Analysis (MFA), Substance Flow Analysis (SFA), Physical Input–Output Tables (PIOT), Ecological Network Analysis (ENA), Emergy, Exergy and Life Cycle Assessment (LCA).

Dizdaroglu (2015) proposes that the so-called 'indicator-based sustainability assessment' be added to this list. This assessment uses urban ecosystem indicators in order to achieve urban sustainability. Moreover, Albertí et al. (2017) propose a detailed description and classification of some sustainability indices developed for cities.

Urban ecosystems are increasingly becoming a part of the various agendas for sustainable development (Albertí et al., 2017); these agendas aim to improve their economic growth management and avoid social instability and environmental degradation (Rotmans et al., 2000). For example, the 2030 Agenda for Sustainable Development[1] was developed to integrate the Millennium Development Goals and balance the three dimensions of sustainable development. The Agenda consists of 17 objectives, known as Sustainable Development Goals (SDGs), and 169 targets. One of the most significant goals in relation to urban ecosystems is Goal no.11: to make cities and human settlements inclusive, safe, resilient and sustainable.

Another important example is the New Urban Agenda, adopted during the United Nations Conference on Housing and Sustainable Urban Development (Habitat III),[2] which promotes urban development that is respectful of the environment and that provides guidance for the achievement of SDGs.

In light of this overview, the aim of this chapter is to bring greater clarity to the environmental assessment methods—particularly those related to Urban Metabolism (UM), which is introduced in the next sub-chapter. A specific area of focus is the LCA method, which, in recent years, has shown promise in relation to its possible use on a territorial scale, to support the decision-making phase linked to urban governance and territorial regeneration processes.

13.3 Cities of Flows: The Concept of UM and Its Evaluation Methods

Comparing urban ecosystems to organisms crossed by metabolic flows shows the necessity of introducing in this sub-chapter the concept of UM. Metabolism in general refers to the biochemical reactions of synthesis and degradation that occur in every living organism in order to sustain its growth, renewal and maintenance.

UM is a scientific phenomenon comprising individual processes that take place in all cities at different spatial and temporal scales (Kennedy et al., 2014) and that are based on the principle of conserving mass and energy. Urban ecosystems are powered

[1] http://www.2030agenda.undp.org/content/2030agenda/en/home.html.

[2] http://habitat3.org/the-new-urban-agenda/.

by incoming flows that allow the processes of the use and consumption of resources to be carried out, generating outgoing flows in the form of waste and emissions. The territory as an organism is characterised by a sequence of vital phases, which, while influencing its metabolism, also have an impact on the functioning and the shape of the territory and of its networks (Russo, 2015).

Analysing the metabolism of a city makes it possible to understand the impacts of urban development (Mostafavi et al., 2014), taking into account the flows of energy, water, nutrients and waste, and of the materials in general that circulate within a city, and allowing a multidimensional assessment of sustainability (Beloin-Saint-Pierre et al., 2017). This phenomenon can be analysed according to four fundamental flows: water, materials, energy and nutrients (in the input and output of the system). It is currently mainly characterised by a linear development model. The metabolic functioning of an urban area affects not only its flows but also the anthropogenic stocks that transform the input flows into the so-called 'grey infrastructure', which shapes the physical environment of urban areas and determines their development models.

UM is not an isolated phenomenon, but it is strictly connected to the functioning of urban areas. Minx et al. (2011) underline the necessity of associating metabolic flows with some characteristic aspects of cities, such as land use-intensity, urban form and size and population density, as well as other kinds of phenomena, such as land use planning and citizens' lifestyles, described as urban drivers, urban patterns and urban lifestyles (Fig 13.1).

In general, given the growing interest in environmental issues, UM has become a key concept in quantifying the level of urban sustainability and consumption of resources (Qi et al., 2017), as well as in assessing environmental impacts and opening the way to innovative systemic approaches. The same flows that pass through cities and that can lead to an exhaustion of their life cycles if carefully quantified, can instead represent the potential to guarantee a sustainable urban life.

In general, many approaches and applications are used to compare, from a quantitative point of view, the environmental sustainability of different scenarios of urban consumption/production (Beloin-Saint-Pierre et al., 2017). Furthermore, as Li and Kwan (2018) state, UM can be examined at different spatial scales: global UM studies analyse the global anthroposphere, whereas other studies analyse the national or regional scale as well as the urban and local dimensions. UM determines the necessity to adopt a flow perspective of urban ecosystems (Dijst et al., 2018).

Many authors have explored the phenomenon of UM and experimented with indices and evaluation methods, but there is still no consensus on the assessment methods to use; there are, indeed, many different experimental approaches.

For example, Kennedy et al. (2014) propose a complex indicator to evaluate the UM of some large cities (megacities), with the aim of collecting information related to multiple aspects, such as the biophysical characteristics of the climate and population, the metabolic flows of water, waste, materials and energy linked to spatial boundaries and constituent urban elements.

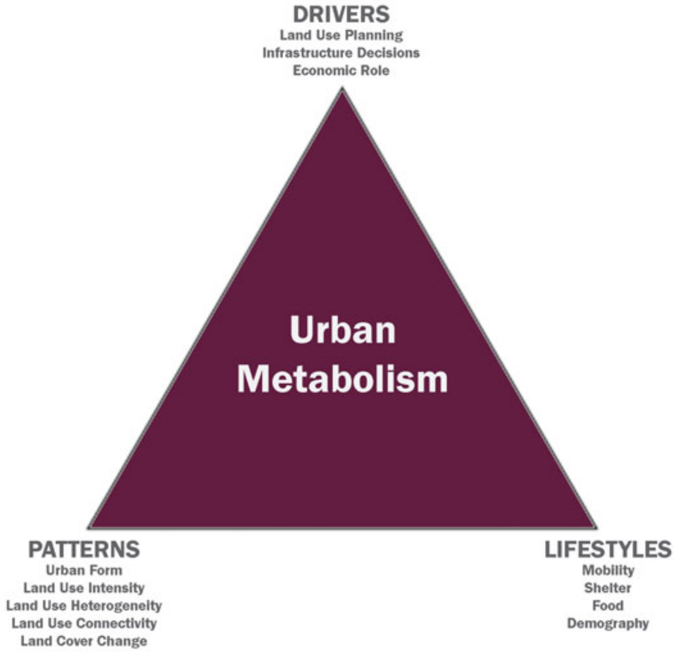

Fig. 13.1 UM drivers, patterns and lifestyles (Adapted from Minx et al., 2010)

In their study, Kennedy et al. (2015) subsequently demonstrate that megacities are responsible for consuming 9% of the world's electricity, generating 13% of its solid waste and housing 7% of its global population.

Conke and Ferreira (2015) evaluate the changes in matter and energy that took place in a city in Brazil in the period between 2000 and 2010, aiming to monitor urban transformations and the contribution of cities to sustainable development. Further, Mostafavi et al. (2014) propose an integrated analysis framework called Integrated Urban Metabolism Analysis Tool (IUMAT), based on the quantification and aggregation of human, social and environmental capital linked to urban activity. Giampietro et al. (2009) propose the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) approach, which is based on the analysis of the patterns of metabolism of socio-economic systems at different levels and scales—especially those linked to socio-economic activities and ecological constraints.

Despite the development of many evaluation tools, there is still a lack of consensus on the most suitable evaluation methods and techniques for evaluating UM.
At the European level, the important approaches and research projects are as follows:

- The REPAiR project[3] (REsource Management in Peri-Urban AReas: Going Beyond Urban Metabolism), which investigates the link between UM, waste

[3] http://h2020repair.eu/.

management and wasted landscapes. UM is deeply examined with reference to some specific waste flows (Organic Waste and Construction and Demolition Waste), and their spatial implications verified through the MFA and LCA.

- SUME project[4] (Sustainable Urban Metabolism for Europe), which links the evaluation of UM to the spatial component and, in particular, to urban planning. The project assesses development scenarios for six different cities (Athens, Oporto, Monaco, Newcastle, Stockholm and Vienna) up to 2050 in relation to three layers: soil consumption, energy consumption and materials consumption. UM is investigated according to the main flows crossing these territories, with special emphasis on the flows' impact on the urban form.
- UrbanWINS[5] (Urban Metabolism Accounts for Building Waste Management Innovative Networks and Strategies), in which UM is again focused on waste flows with the aim of identifying innovative and sustainable strategic plans for waste prevention and management.
- UrBAN-WASTE[6] (Urban Strategies for Waste Management in Tourist Cities), which is aimed at developing strategies able to reduce the amount of municipal waste production and to reintroduce waste as a resource into UM flows.
- BRIDGE project[7] (Sustainable Urban Planning Decision Support Accounting), which uses a bottom-up approach to quantitatively assess UM on the local scale, connecting biophysical sciences to urban planning.[8] In this case, the metabolic flows represented by energy, water, carbon and pollutants are quantitatively assessed on the local scale.

According to Beloin-Saint-Pierre et al. (2017), who review the main UM studies, more than 150 of those studies use different UM assessment methodologies and analyse more than 60 cities.

The authors propose three main typologies of system modelling:

- The Black-Box (BB) approach, which is based on the description of flows in the input and output of the system;
- The Grey-Box (GB) approach, which disaggregates the flows in the input and output according to the different components (e.g. buildings, roads);
- The Network (NE) approach, which is similar to the GB approach, but also describes the environmental impacts of specific components of the assessed life cycle.

Furthermore, Li and Kwan (2017) state that UM assessment methods can be divided into two main categories: 'material-based analysis', which includes MFA, LCA, Ecological Footprint Analysis (EFA), SFA, Input-Output Tables (IOTs), and ENA and

[4] https://www.sume.at/.

[5] https://www.urbanwins.eu/.

[6] http://www.urban-waste.eu/.

[7] http://www.bridge-fp7.eu/.

[8] Other initiatives can be found at: https://metabolismofcities.org/; https://www.thenatureofcities.com/2018/07/24/urban-metabolism-real-world-model-visualizing-co-creating-healthy-cities/; http://www.urban-waste.eu/urban-metabolism/; https://www.metabolic.nl/.

'energy-based analysis', which studies the energy flows within an urban ecosystem and involves the development of various emergy index systems.

MFA can be used to establish the material and energy balances of a system, whereas the EFA can be used to determine the theoretical area used by people to consume bio-resources and to assimilate waste (Loiseau et al., 2012). MFA distinguishes between 'stocks', which refer to materials accumulating in the system, and 'flows', which refer to elements going in and out of the system (Dijst et al., 2018). Flows and stocks are influenced by the activities that are happening inside the urban ecosystem and that depend on the needs of individuals and communities (Dijst, 2013). Flows can be material (such as energy, water, materials, etc.) or immaterial (such as social capital, culture, etc.) (Dijst et al., 2018). Chen et al. (2014) further subdivide flows into two types: flows of small volume with a high environmental impact (e.g. heavy metals); and flows of large volume with a low environmental impact (e.g. water).

Chen et al. (2014) also present many references of applications of MFA in global cities. In these applications, MFA is used to model the metabolic intensity in relation to urbanisation processes (Douglas, 2012; Hendriks et al., 2000). Meanwhile, SFA instead is used to evaluate the flows of substance in a given area over a given time. IOTs are more focused on monetary flows, whereas PIOT is more focused on physical flows. ENA focuses on system modelling, linking material flows to the ecosystem structure. Last, exergy analysis identifies 'technical improvements or protection measures which should be implemented in order to improve energy performance and to maintain resource availability' (Loiseau et al., 2012, p. 218); emergy analysis provides information on territorial functioning using four indicators that 'reveal the degree of independence of anthropised territories in terms of resource use and of their interaction with their surrounding environments' (Loiseau et al., 2012, p. 218).

Other typologies of UM assessment methods and indicators are: urban ecology models (Chen et al., 2014; Zhang et al., 2006), ecosystem services and land use models (Haase et al., 2014; Kroll et al., 2012), urban transport and accessibility models (Wegener, 2011), and finally urban energy models (Keirstead et al., 2012).

Environmental analysis of UM can also be carried out using another kind of modelling approach: the 'life cycle perspective', which takes into consideration the entire supply chain, from the raw materials extraction to the waste treatment (Beloin-Saint-Pierre et al., 2017). Indeed, some authors (Beloin-Saint-Pierre et al., 2017; Loiseau et al., 2013) suggest adopting a life cycle and multi-criteria approach, highlighting at the same time the difficulties in the practical application of this methodology at the territorial level because of the absence of a standardised methodology.

An important study in this regard is Goldstein et al. (2013), which proposes a hybrid approach based on the integration between UM and LCA (UM-LCA) to quantify environmental impacts by modelling both upstream (i.e. incoming) flows, and downstream, (i.e. outgoing) flows, and introducing a set of appropriate indicators.

Definitely, there is a clear need to evaluate the environmental loads connected to the upstream and downstream processes related to the metabolic flows of a city and to select the best approach in order to guarantee an efficient environmental assessment. The LCA approach has proven to be a very promising tool to support territorial regeneration actions and in the next section a small in-depth analysis is presented.

13.4 LCA and Territorial Regeneration: Is There any Correlation?

The present section focuses on the LCA method, which is used to evaluate the environmental impacts related to the life cycles of single products and services. The first examples of LCA applications appeared around the 1970s, in conjunction with the evolution of the concept of sustainable development and with the increase in the amount of attention being paid to identifying strategies aimed at reducing environmental impacts.

LCA is an objective procedure for evaluating energy and environmental loads related to a process or activity. It is performed by identifying the energy and materials used and the waste products and emissions released into the environment. The assessment includes the whole life cycle of the process or activity, from the extraction and processing of raw materials to transportation, manufacturing, distribution, use, reuse, recycling and final disposal (Society of Environmental Toxicology & Chemistry, 1993).

During an LCA application, impact indicators are divided into two categories: midpoint, expressed in the form of impact categories and subject to a characterisation process and endpoint, representing damage categories obtained by submitting midpoint indicators to normalisation (Fig. 13.2). This kind of analysis, which has to take into consideration the entire life cycle of a product or service, starts from the production of raw materials to their disposal; from the life cycle thinking perspective, these macro phases are referred to as ‘from cradle to grave’.

Over the years, there has been an increase of LCA application, with the introduction of variations of scale and therefore a distinction between LCA at the single product level and LCA at the meso (e.g. municipal) and macro levels (European Commission et al., 2010). The LCA approach could prove to be a valid tool for assessing the sustainability of a territory by adopting appropriate methodological modifications and hybridisations (Torricelli & Gargari, 2015b). The LCA approach is evolving from the single product scale; applications and hypotheses at scales that are different from the micro one are becoming well recognised (Hellweg & Milà i Canals, 2014; Saner et al., 2013), such as those supporting decision-making in land management.

Loiseau et al. (2012) propose an approach called ‘Territorial LCA’, which establishes a comparison between different methods for implementing the European Directive (2001/42/EC) on SEA. After the lack of success of MFA and ENA, it is demonstrated that the LCA approach can provide a complete framework for the assessment of territorial sustainability. The framework the authors propose starts from the ‘goal

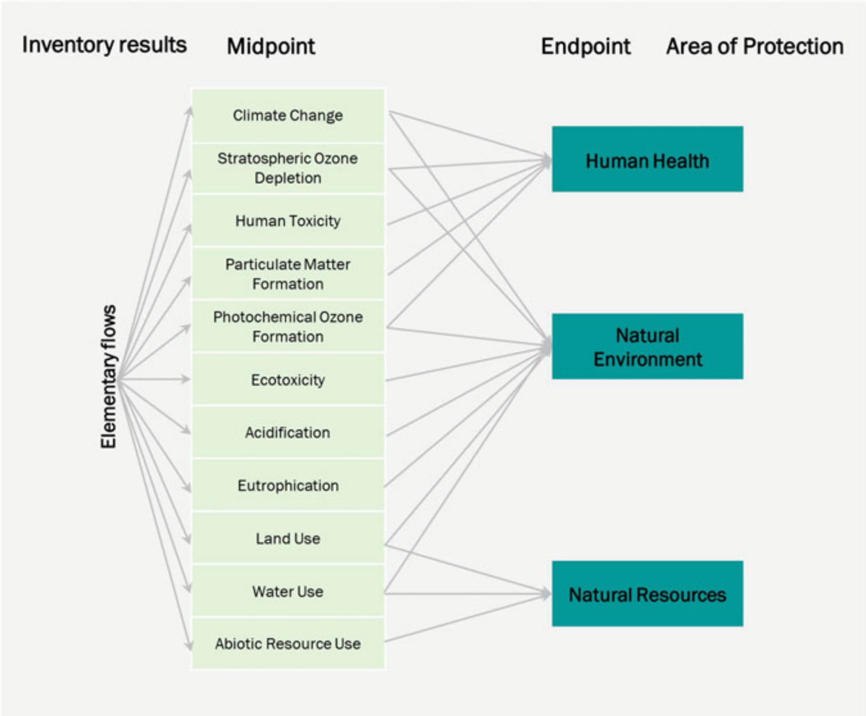

Fig. 13.2 Impact categories (Adapted from Hauschild & Huijbregts, 2015)

and scope definition', that from a territorial point of view is formed by the studied territory, compared to a system of flows defined by a set of Land Use Functions (LUF), representing the goods and services that the use of land is able to provide. Subsequently, the method is based on the 'activity inventory', which comprises all the consumption and production activities of the given territory. The last phase is the 'indicator evaluation' for the assessment of the territorial environmental impacts (Loiseau et al., 2014).

Through this approach the usefulness of the LCA method is demonstrated for evaluating the sustainability of a territorial system. The applicability of the 'Territorial LCA' is tested through experimentation in a French Mediterranean case study (Loiseau et al., 2014).

The starting point of this approach is indicated by the presence of a geographical area associated with a territorial planning scenario. The objective is to evaluate the eco-efficiency of this area, identifiable as a system of flows. The inventory phase considers all the production and consumption activities, including upstream processes linked to these activities in a defined temporal scenario. The outputs are a vector of environmental impacts and a vector of LUF.

Production activities include agriculture, aquaculture, fisheries, quarrying, manufacturing, shops and services, and consumption activities are those performed by inhabitants and tourists. Societal, economic and environmental LUF are considered and are assessed through performance indicators. Precise data about the activities are collected, including the types and amounts of goods and services consumed or produced. The results show that the human health and ecosystem quality impact categories witness a higher impact from production activities than from consumption activities. A distinction is made between in-site impacts, which are caused by environmental flows that occur in the territory and off-site impacts, which are caused by environmental flows happening outside the territorial border. A baseline scenario is developed for future comparisons and for supporting SEA.

Later on, Loiseau et al. (2018) propose a further clarification, dividing territorial LCA into two main approaches (p. 474):

- 'Type A, which focuses on the assessment of a specific activity or supply chain anchored in a given territory';
- 'Type B, which attempt to assess all production and consumption activities located in a territory, including all environmental pressures embodied in trade flows with other territories'.

Another important approach linked to the application of LCA to a territory is the 'Regionalised LCA' approach. It involves the use of regionalised impact assessment methods to compare the environmental impacts between different locations of resource extraction or emission through the Geographic Information System (GIS) support (Hellweg & Milà i Canals, 2014). Nitschelm et al. (2016) underline the necessity of expanding the potentiality of territorial LCA by using spatially explicit data and by considering the territorial nature of urban planning decisions, as well as taking into account the locations of activities in a spatially explicit manner. Therefore, they propose a spatialised LCA (STLCA) with reference to agricultural territories, which considers the locations of the emissions and uses spatially explicit databases and GIS to geolocalise the various territorial processes. Gargari (2015) conducts an environmental impact assessment based on the life cycle methodology of the LUF 'river boat service' in a protected natural area. Finally, as already previously specified, many authors propose to integrate LCA and SEA to develop a life cycle and multi-criteria approach in the field of urban planning (Beloin-Saint-Pierre et al., 2017; Bidstrup et al., 2015; Björklund, 2012; Loiseau et al., 2012, 2013).

In conclusion, there are many significant emerging approaches that aim to identify environmental hotspots and to support decision-making for the improvement of future policies' environmental performances (Loiseau et al., 2018).

13.5 Conclusions

Urban ecosystems are complex and, like living organisms, have their own metabolism. This metabolism's functioning is linked to the presence of input and output streams. The territory is commonly considered a geographical space managed by local stakeholders and characterised by a regional identity. The inclusion of this concept in the application of LCA is still being debated (Mazzi et al., 2017). New definitions and experimental applications are required to facilitate this inclusion. The use of spatially explicit data is necessary to evaluate the environmental impacts of a territory. Although LCA was born as an approach that was independent of spatial characteristics, it is necessary to remember that environmental and administrative decisions take place in a territory. The activities' locations should be examined in a spatially explicit way, starting from the assumption that emissions and impacts take place in different locations (Nitschelm et al., 2016).

Urban ecosystems are endowed with a high potential to reduce the input and output flows of resources through a more efficient territorial management. Such management is based on a better spatial organisation and implements circular practices in all the life cycle phases, in order to reduce resource consumption.

To achieve an urban management style that can be defined as resource-efficient, it is advisable to have a detailed knowledge of the territory and the urban metabolic flows (European Environment Agency, 2015). This would make it possible to guide decision-makers in defining sustainable planning choices. Further, to stem the negative externalities, it is also necessary to create a territorial government system that prioritises a sustainable environmental protection and considers the territory as a complex dynamic system.

The need to protect the environment and its resources, as well as achieve the sustainable valorisation of urban and peri-urban spaces, is an unavoidable reality (Scarmellini, 2015). Urban and peri-urban areas are sources of environmental pressures that go even beyond their own territorial borders. This makes clear the need to quantify the metabolic flows going in and out of urban ecosystems through appropriate methodologies that include the territorial component. In conclusion, it is only when we start with a detailed cognitive overview of the urban environment and of its most important matrices, is it possible to offer support to the decision-makers involved in the territorial regeneration. One of the prerogatives to go in this direction is that it allows one to evaluate urban metabolic flows and their spatial implications in order to support urban governance. One needs to select appropriate methods to support this form of governance, such as LCA, which has already shown that it can offer a detailed metabolic characterisation of a territory.

Authors' Contributions The present work has been developed through a strict collaboration between the authors. In particular Pasquale De Toro wrote the second chapter, providing as well a general overview of the entire structure, while Silvia Iodice wrote all the other chapters. Both the authors contributed to the conclusions.

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Part IV
Sustainable Strategies and Solutions for Circular and Healthy Metabolisms

Chapter 14
Planning Wastescapes Through Collaborative Processes

Anna Attademo and Gilda Berruti

14.1 Introduction: In the Public Field

Contemporary metropolitan areas are affected by serious phenomena of urban decay and functional retraction, especially in the area in-between the city and the countryside (Piorr et al., 2011). The impacts of the current model of urban growth challenges fragile environments, where spatial fragmentation is interlinked to socio-economic inequalities, in a generalized lack of accessibility to public use and spatial capital (Secchi, 2013). In Bernardo Secchi's words, it is urgent to address "the new urban question" considering spatial injustice and unequal access to services, combining actions to address environmental, social and economic threats.

This chapter focuses on collaborative processes through which accessibility and spatial hierarchies of public use areas can be redesigned in order to address socio-spatial inequalities in sustainable development.

The field of action is twofold: on the one hand, it regards urban metabolism; on the other hand, collaborative processes. The first is used to interpret the impacts of metabolic processes (Ferrão & Fernández, 2013) and the expiration of territorial life cycles (Loiseau et al., 2018), resulting in the production of *wastescapes* (Amenta & Attademo, 2016; Amenta & Van Timmeren, 2018). The latter are aimed at defining the opportunities of co-creating place-based services (Evans et al., 2017), in order to reassess shared usage and wide access to spatial potential.

The chapter has been written and revised together by the authors. Anna Attademo wrote sections 14.1, 14.3.1. Gilda Berruti wrote sections 14.2, 14.3.2. They both wrote sections 14.3 and 14.4.

A. Attademo (✉) · G. Berruti
Department of Architecture, University of Naples "Federico II", Naples, Italy
e-mail: anna.attademo@unina.it

G. Berruti
e-mail: gberruti@unina.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_14

This research moves from the analysis of places born for public use, but abandoned over time or never actually completed; places in disuse, waiting to reenter territorial life cycles (Grulois et al., 2018). Industrial ecology defines these life cycles that feed the urban-territorial environment, with incoming and outgoing flows of matter and energy, as the "urban metabolism" of a city (Allen et al., 2012).

Urban metabolism describes the deployment of processes that, on the one hand, interact with space—urban form, density, morphology, biodiversity, ecological integrity (Kennedy et al., 2011)—on the other, are influenced by intangible factors of different nature: economic and social. The metabolic processes that regulate cities, cannot be evaluated only according to linear life cycle models. Extending the ecosystem perspective, with the concept of an ecological field intertwining human, physical, cultural, biological and socio-ecological aspects (Swyngedouw, 2006), the city can be interpreted as an open and complex system of interactions between natural, artificial, socio-economic, and cultural processes (Pincetl et al., 2012).

Urbanization, particularly in metropolitan areas, has profoundly modified the landscape, alternating historical values and everyday demands, density and dispersion, natural, and rural spaces with settlements and infrastructures, that consume the integrity of agricultural landscapes. This urban blight that affects territories, buildings, parts of cities, is particularly relevant in peri-urban areas. Although peri-urban areas are crossed by large infrastructures, polarized by tertiary and large-scale distribution and low-density settlements, they still represent a resource that can be reintroduced in urban lifecycles, defining places and functions for urban, functional and social rebalancing. Here sustainable (re)development means acting directly on the metabolism, through a project capable of managing resource flows—to minimize waste, support recycling policies, and regenerate the territory, against the background of circular economy concepts (Russo, 2014).

Within the wide literature on degraded landscapes (in the different acceptations of *terrain vagues* de Solà Morales, 1996; drosscapes Berger, 2006; wasted landscapes, and then wastescapes, H2020 REPAiR project; wastelands Berruti, 2018; Berruti & Palestino, 2020a), there is always a specific look on the hybrid combination of both natural and man-made ecosystems. This is especially true in reference to damaged ecosystems, when their natural value is low and/or when the ecological balance is broken due to the contemporaneous presence of man-made components, altering the relationship with nature: as in the case of unauthorized, confiscated, neglected, vacant buildings and/or settlements.

In particular, neglected and vacant buildings and areas can be the direct consequences of urban decline. Sub-categories range from empty buildings to underutilized, abandoned or obsolete buildings, to informal and unauthorized settlements, to urban plots in transformation, never completed, to confiscated assets, but also to abandoned infrastructures and their interstitial spaces. Public equipment no longer used, or legally born with a public destination and never used, can be included in the taxonomy. Among those, there are also Italian "planning standards," publicly designed in compliance with the quantities defined by law, and often partially used or not properly managed.

Here spatial degradation often coincides with socio-economic segregation. In general, wasted landscapes present high levels of unemployment and lack of public facilities, but also temporary inhabitants (Roma populations, non-permanent migrants), activators of commons (associations who manage, informal groups who occupy and revitalize abandoned spaces, etc.), together with public institutions and researchers, who can interpret and prefigure opportunities for the future of places.

These areas can become the place for innovative partnerships between public and private-social sectors, within collaborative methods that build on the fruitful participation of public–private–people, in a process of reconstruction of local identity (Amenta et al., 2019). Cities as complex socio-ecological systems, require processes of co-creation of demand to support the construction of flexible and contextual functions and services. These processes should be place-based and follow a procedural decision-making model, through forms of co-planning and co-management of discarded assets to be reactivated. These new decision-making practices imply a change of paradigm for the public actor's role in the perspective of a strategic relaunch of the discarded resources of the landscape, starting from uses and services collectively elaborated.

This contribution reflects on the new role for the public actor through the activities developed in two collaborative planning processes experimented in the city of Naples and in its Metropolitan Areas. These specific cases are relevant because they represent conditions of spatial and functional inequalities that have been overcome through a collective and strategic definition of a framework of practices and services provision, prefiguring the actual change of physical components.

The proposal of new uses and services within the investigated contexts is based on criteria of flexibility, not fixed once and for all, not predetermined in time, but in progress in order to overcome the limits of the implementation of policies and programs that often halted development and designs in the past.

The methodology used reflects a case study approach (Flyvbjerg, 2006), based on the testing of public actor's new role in two real-life environments. Thus, the chapter explores the role of the enabling State in supporting the redistribution of accessibilities and values; then investigates the two aforementioned collaborative processes, focusing specifically on how they both redesigned the concept of public facilities as co-created and place-based services. Finally, the lessons learned from both case studies on institutional and social innovation, aimed to plan wastescapes through collaborative processes, are outlined.

14.2 Method and Approach: The Enabling State—Inequalities and Roles

The research aims to face spatial inequalities in access to spaces and services, in a wider redefinition of welfare (and welfare spaces), as an effect of global economic and financial crisis. The point of departure for this in-depth exploration is given by the renewed attention in contemporary planning literature for the issue of collective housing and services, with a different meaning compared to the past. This meaning is related to both a push towards sharing (Bauman, 2001; Sampieri, 2011) and the claim to discarded places by groups of citizens and associations (Cellamare, 2019; Paba, 2004). On the one hand, inhabitants are increasing their skills in activating forms of welfare and new welfare spaces (Munarin & Tosi, 2014); on the other, the public actor is shifting his role from "provider" of public facilities to "supporter" of design capabilities coming from local contexts, prefiguring an "enabling State" (Gilbert & Gilbert, 1989; Marchigiani, 2011).

More and more frequently, public housing and public facilities are regenerated or managed by institutions and social actors' mixed partnerships (Allen et al., 2004; Padovani, 2011). State-sponsored care is not the same as in the past, due to the economic crisis and the lack of human and technical resources in the public sector. For this reason, the delivery of public services can be partly privatized. A transformation of welfare is ongoing, that promotes work and responsibility over protection and strengthens the role of civil society by diluting the pervasive role of government (Gilbert, 2002). This role of "enabler" performed by the State (Gilbert & Gilbert, 1989) is summed up by the aim of offering "public support for private responsibility," where "private" includes individuals, the market, and voluntary organizations, thus demonstrating the shift from an emphasis on citizenship rights to communities' civic duties.

Starting from these assumptions some questions emerge, related to the ambiguity of this change and the trend referred to as "from welfare to workfare," from a passive to an active role of communities, mainly concerning work for recovering and reappropriating places. The rise of the enabling State might be interpreted as the outcome of a market-driven drift aiming at dismantling welfare policies, or, on the contrary, as the responsible for a moral obligation for local communities to exert an active role (Bifulco, 2011). In this framework, where empowerment risks to be seen as a way to charge local inhabitants with the management of public services, thus going beyond the need of active work-oriented policies, inequalities become harsher and harsher, both in peri-urban and urban areas.

Especially in Southern Europe, spaces designed as public facilities or services (the so-called "planning standards"[1]) are often abandoned or never used, for different reasons, going from the lack of flexibility, or fixed uses, to the power of inaction by institutions. These wastescapes seem to be almost waiting to be part of urban metabolism again. In addition, especially in peri-urban areas around the most important cities, the provision of public facilities and services is inadequate and scant (Colavitti et al., 2020; Urbani, 2011), enhancing inequalities among citizens.

Inequalities need to be balanced through non-sectoral responses, which take into account environmental, social and spatial issues in an integrated way. Fair and

[1] Planning standards are threshold values of areas per inhabitants assigned to public facilities or services, based on a quantitative approach, that 'the public' had to ensure by means of planning instruments. In Italy, they are regulated according to the Ministerial Decree n.1444 issued in 1968. See Renzoni (2018); Laboratorio Standard (2021).

adequate public services can be realized by recapitalizing discarded wastescapes, working on networks of spaces and services, through the recovery of degraded local contexts, pointing to their "looseness" (Franck & Stevens, 2007). Such an approach requires triggering integrated processes involving a profitable dialogue among public institutions, private actors, social private actors, social organizations and local groups. In these processes, public institutions give up part of their predictive role and knowledge, working as mediators among different actors, and coming up with new formulas of management, although they are often not completely prepared for ongoing innovations.

14.3 Experiments

The chapter is focused on two experiments of wastescape regeneration in the Metropolitan Area of Naples, dealing with urban and peri-urban areas. The first case is the former NATO area in Naples (in Bagnoli neighborhood) which is the subject of a Plan for urban renewal, recently adopted by the Municipality of Naples. The area, actually owned by a public company whose purpose is the assistance of disadvantaged children (Fondazione Campania Welfare), has been redesigned as a public facility at a metropolitan scale within a public consultation process between owners, the Municipality of Naples and local stakeholders. The second case is related to peri-urban wastelands in the Metropolitan area of Naples, investigated in the Horizon2020 research "REPAiR", where public abandoned areas have been redesigned through collaborative laboratories, aimed at their recovery and reappropriation, also through the rationalization of resource and waste flows.

14.3.1 Wastescape #1: The Collaborative Definition of Uses of a Public Facility on a Metropolitan Scale

The case of the Urban Plan of the former NATO area in Naples represents—by size, location and nature—an example of "research by design" (Roggema, 2017) through the project of public facilities within dense urban settlements.

The area is owned by a Foundation (Fondazione Campania Welfare): a sort of "social enterprise," a non-profit company aimed at providing childcare in the disadvantaged bracket. The Foundation has carried out its mission for decades thanks to the generous rent paid by the NATO forces.

Historically designed and built as a college for disadvantaged children, the area has always been functionally self-sufficient, equipped with sports and education facilities, ateliers, a church and a theater, two gyms, as well as large open spaces, also for production purposes (cultivated terraces on the Hill of San Laise).

Since 1941, the "Collegio" was confiscated by military authorities and the International Refugee Organization. But its real story begins in 1952, with the assignment for "higher political and military needs" and lease to the NATO Command—Headquarters of the Allied Forces of Southern Europe. Up to 2013, the Foundation used this lease to perform its main scope and finance social welfare activities all over the city, but outside the area and its facilities.

Thus, for almost 60 years the city has been *dispossessed* of the place, due to its role of extraterritorial national security, losing its public usability, and its role in urban life. But when the NATO Command left the place, the entire area stood neglected and abandoned, with big buildings and open spaces in need of further uses and meanings, beyond actual care and maintenance. Therefore, the municipal administration signed a Protocol with the ownership, aimed at defining the area as a public use facility and gathered citizens' demands to reuse it through a collaborative process (Piscopo, 2019).

During 2016, in compliance with the Western Variant of the Municipal Urban Plan (1998), the Municipality of Naples promoted and approved in consultation with the ownership, a preliminary Development Plan ("Masterplan") which allocates half of the cubic capacity of the area to public use, even beyond the quantity of planning standards defined by law (public spaces and park, education, and sports facilities, etc.). The collaborative process involved several categories of stakeholders, under the leadership of a group of local urban planners: third sector organizations, cultural associations, local institutions, and citizens. Together they achieved the scope of identifying planning standards tailored to the context, overcoming the quantitative perspective defined by law and eventually opening the chance to co-management opportunities of social and cultural activities.

The Masterplan was the first step in a strategy that is becoming increasingly more adaptive in recent years, aimed at the long-term recovery of the site, but in search of possible triggers in the short time (Fig. 14.1), through the search for temporary uses of public space and buildings. Thus, the majority of social uses (childcare activities, cultural, and sports events, etc.) started immediately after the closure of the collaborative process, partially managed by the Foundation itself, even before the final adoption of the Urban Plan that occurred in December 2020.

The mix of the technicality of the blueprint of the Urban Plan together with the disruptive anticipation of immediate changes, through access and use of public spaces, created hybrid and original "alliances," between actors interested in the site use and enhancement (Attademo & Formato, 2019).

Therefore, the "strange case" of the former NATO military area (Attademo et al., 2017) is a story in which the allocation of spaces for public functions becomes a complex process of co-creation of public services, where public, private and mixed public–private actors reactivate a wastescape for public purposes.

It is also relevant to state that the process of public use prefiguration has been generally accelerated by a political phase in the history of the city of Naples in which other places of civic significance have been legally identified as "commons" (Rodotà, 2018). The Municipality of Naples guaranteed the restitution of neglected and degraded urban areas to the collectivity, in the full recognition of uses and

Fig. 14.1 Vision (on the top) for the recovery of the area from the Municipal Urban Plan (*Source* https://www.comune.napoli.it) and temporary uses in former NATO area (in the bottom-Ph. Marilù Vaccaro/2019)

functions that communities were already expressing in them (Piscopo, 2019) with two Regulations (in 2015 and 2016, matured over a long period of time). Eventually, in 2017, the Municipality regulated the temporary use of discarded public equipment, without modifying the urban destination, aimed at the enhancement of the unused or abandoned public assets.

14.3.2 Wastescape #2: Co-Creating Public Services in Peri-Urban Areas

In the framework of the EU H2020 research "REPAiR: REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism," interpreting waste and wastescapes as resources for sustainable regeneration, a co-creation process was carried out based on the methodological approach of Living Lab (ENoLL & ENoLL Members, 2016; Evans et al., 2017). From April 2017 to May 2018 in the Metropolitan area of Naples, Federico II University of Naples scholars and local stakeholders took part in peri-urban living labs (PULLs, Amenta et al., 2019) on the critical issues of the waste management cycle and wastescapes regeneration. In particular, five municipalities (Acerra, Casoria, Casalnuovo, Afragola, and Caivano) have been involved, belonging to the same rule for waste management.

Living Lab participants worked in three groups, each one focused on a project to carry out together, responding to wastescape regeneration. Each group consisted of a mixed environment, involving the research team and students, Campania Region and municipal officials, associations, groups, practitioners, and entrepreneurs.

One of the groups focused on the design of a "Homogeneous Recycling Centre" (REPAiR, 2018), responding to the primary objective of solving the issue of abandonment and illegal dumping of waste along peri-urban roads. Both agricultural and construction and demolition waste, in fact, are abandoned in disused areas along infrastructures (Fig. 14.2).

In addition, overcoming the suspicion on the correct reuse of construction and demolition waste was also considered a challenge, due to the frequent involvement of criminal organizations in Southern Italy waste management (Berruti & Palestino, 2020b; Palestino, 2015).

Stemming from this original idea, the Homogeneous Recycling Centre has been conceived as a hybrid place, where the free disposal of durable goods and inert waste is allowed, and a warehouse to keep them is provided together with a selling place. A fab lab focused on the arrangement of open upcycle workshops, spreading circular economy principles, is also part of the project.

Such project has the added value of contrasting the informal disposal of construction and demolition waste and durable goods by privates and small companies in unauthorized landfills and at the same time putting aside a reserve of materials, to be reused in the future. Confiscated properties, formerly belonging to organized crime, waiting for a new destination by municipalities, or disused areas have been selected

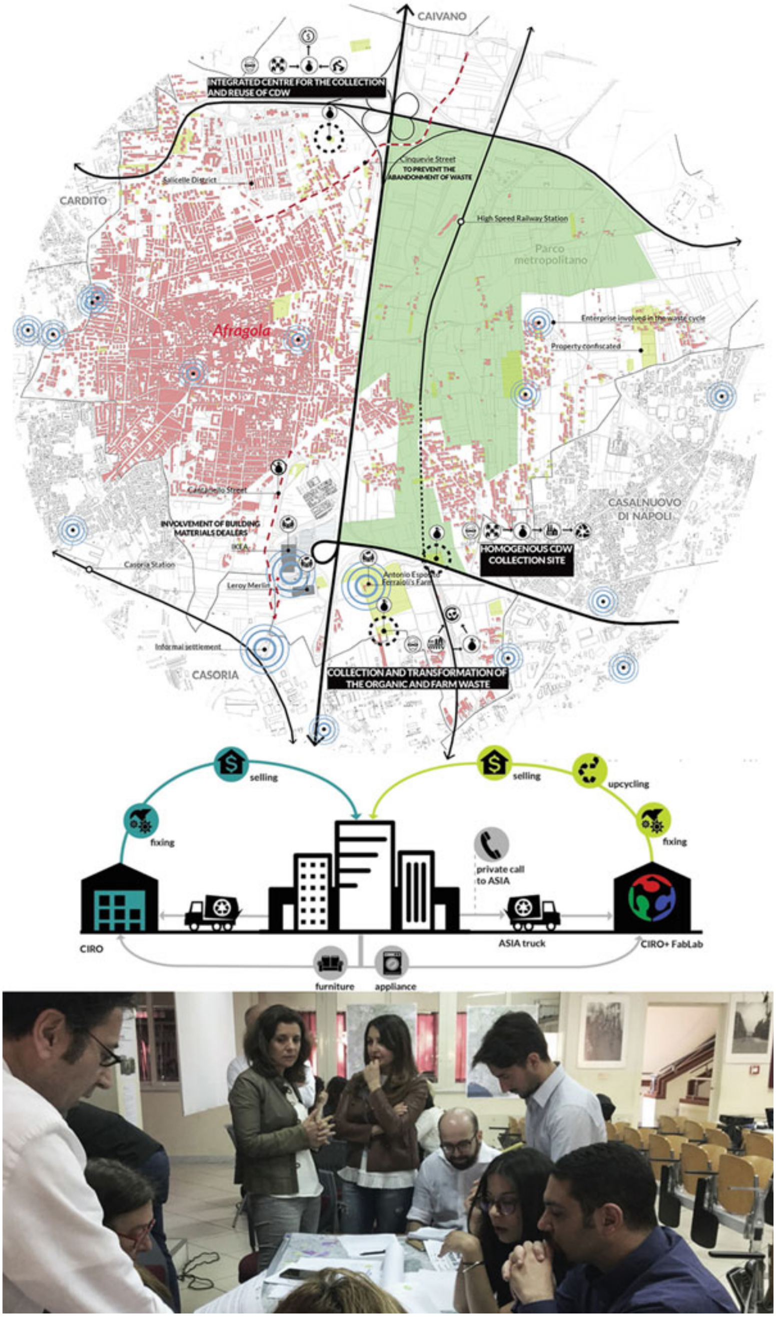

Fig. 14.2 Masterplan and systemic section of CIRO eco-innovative solution (REPAiR, 2018) and photo of the co-creation process in the living lab (Ph. University of Naples team)

as proper places for Homogeneous Recycling Centers, changing their nature from discarded to reclaimed places.

By reducing illegal dumping and decreasing wastescapes production, recycling centers should affect the health of the urban region of Naples, also impacting citizens' awareness of environmental issues. These plots of land, from 2000 to 5000 square meters, are figured out as planted with trees and surrounded by green infrastructures, so as to increase the natural surveillance of places.

Debate in the group opened on the opportunity of allowing to drop off materials without requiring legal recognition, at the beginning of the project, also with the objective to raise the question on the territorial impacts of unauthorized building. Managing knowledge disparity among participants was also an issue at stake. Supporting stakeholders' proposals, their creative process of design, eventually avoiding the rise of conflicts or helping to treat conflicts were tasks of the research team.

In addition, this project partly resumed a strategy foreseen in 2013 by the Campania Region in the Plan of waste prevention, responding to the waste management hierarchy defined by the Directive 2008/98/EC. The strategy concerned the implementation of Integrated Centres for the optimal reuse of durable goods (in Italian, *Centri integrati per il riutilizzo ottimale dei beni durevoli*, acronym CIRO) in order to intercept some objects or products in good conditions before they become waste, thus allowing to sell them as second-hand goods, after small repairs. This strategy was originally excluded by the Regional Waste Law (n. 14/2016), but, thanks to the current process, in 2018 was regained and defined by the Regional Law n. 29/18.

In the perspective of REPAiR research, these Centres for the optimal reuse of durable goods should be conceived not as waste plants but as public services, contemporary "planning standards," strongly affecting environmental perceptions and inhabitants' quality of life. Designing a public service, instead of building a waste plant, has the added value of simplifying the bureaucracy in the selection and availability of areas. This option is available only because the treated objects have not become waste yet, otherwise strict rules and authorization should be adopted.

The described co-creation process worked as a driver for ongoing environmental policies, allowing a fruitful alignment of the outputs of living labs with public measures. An in-depth exploration of the possible forms of management and a call for private or social subjects available to be in charge of recycling centers is needed.

On the other hand, as for the reserve of inert waste, a separate further study will be useful in order to define the role of the centers for the reuse, because inerts are included in special waste.

14.4 Discussion and Conclusions

This research applies the metabolic perspective to the reconstruction of identity and public use in neglected areas. Through a case study approach, social and spatial inequalities associated with current urbanization phenomena are investigated, against a wider reflection on the changing role of public actors in urban regeneration processes.

In both cases, among the most interesting issues characterizing the co-creation process, there is the fertile interaction among different actors, with their competences and knowledge, that came to reinforce the value of social issues in the spatial analysis and to test what research team learned on impacts of inclusive decision-making on urban changes.

In the first case, local practices and uses of the former NATO area acted as a catalyst, going beyond the Urban Plan itself, and restituting a horizon of *efficacy* of changes through temporary uses and prefigurative actions (Tutino, 1986 in Russo, 2020), in anticipation of longer term designs.

In the case of REPAiR Homogeneous Recycling Centre, the process was effective also in triggering a collaboration among separate regional departments, in order to plan integrated measures and promoting inter-institutional work, especially thanks to the suggestions by regional representatives to municipalities about funding or programs concerning wastescape regeneration. This was an experiment of multilevel governance that is necessary for effective planning, but is out of the ordinary in actual processes (Obersteg et al., 2019).

Planning in itself can still be strictly anchored to obsolete legal devices and over-regulations, while rapid urbanization phenomena leave behind a landscape of neglect and vacant spaces. Efficient urban planning must work in the space between long-term regulations and tactical interventions, exploiting strategies of reactivation of places as catalysts to improve the social-economic attractiveness of places, while physical transformations are still on the way. The traditional model of planning has to be redefined in consideration of the redefinition of welfare policies as effects of the global crisis. As discussed before, taking inspiration from the studies on American welfare, "social welfare arrangements are increasingly designed to enable people to work and to enable the market and the voluntary sector to assume an expanded role in providing social protection" (Gilbert, 2002, p. 16).

All social welfare policies must address the questions of *who* gets *what* social benefits, *how* these benefits are delivered, and *how* they are financed. This also includes a wider understanding of the role of public and private actors, their weakness and loopholes, their strength, and potential.

This implies an increasing relevance of the ability to activate a dialogue between institutions, citizens, and stakeholders, in order to build effective paths of participation and inclusion, combining policies and planning, in a committed process open to adaptive uses and temporariness.

Stakeholders should be actively involved in the development of services and strategies, promoting actions also in the implementation process and co-management of activities. Thus, contemporary "planning standards" should not be based on quantitative demands, but should build an operative response-able to stimulate social awareness and common responsibility in the use and care of public, and open services.

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Chapter 15
Manufactured in the Peri-Urban: Regenerative Strategies for Critical Lands

Giuseppe Guida

15.1 Productive Peri-Urban

The adoption of a regenerative approach to the development of the contemporary city (Cole, 2012; Girardet, 2010; Newmann et al., 2017) leads to assign a determining role to the peri-urban territories. These “intermediate lands” are characterized by complex uses, often at the service of denser urban systems, but with which they are not compatible. A condition that generates operational landscapes (Brenner, 2016), wastescapes (Amenta & van Timmeren, 2018; REPAiR, 2020), abandoned infrastructures, underused areas, rural fringes, etc. The term peri-urban, as understood in this chapter, therefore, identifies places that cannot be thematized only as the infiltration of urban functions in the rural environment, but that present spatial and functional peculiarities such as to define an original nature (Wandl et al., 2014). However, although peri-urban territories are characterized by some common characteristics, Europe, the United States and the large and fluid “peri-urban interfaces” of the large African and Asian agglomerations have substantially different spatial and functional forms (McGregor et al., 2006). In this chapter, although within a more general background, reference is made to the peri-urban territories typical of the European and, more specifically, Italian context. In such contexts, the peri-urban—apparently external to urban contexts and often considered as an unresolved “hybridization” area—presents, both from a spatial and functional point of view, similar characteristics to what is traditionally classified as an urban context (Brenner, 2014). More specifically, in these areas urban, natural and rural components interact (Forman, 2008) creating more complex forms than those of the traditional metropolitan model. In the latter, in fact, the peri-urban territories coincided with the margin areas, geographically peripheral compared to the extension of the settlement system, and hierarchically

G. Guida (✉)
Department of Architecture and Industrial Design,
University of Campania “Luigi Vanvitelli”, Aversa, Italy
e-mail: giuseppeguida@unicampania.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_15

dependent on the center, characterized by high settlement densities and the presence of valuable functions. On the other hand, within the contemporary peri-urban territories, margins and boundaries appear rearticulated, the urban centers multiplied and deconstructed, settlement systems fragmented and permeated by shreds of countryside and nature (Formato & Guida, 2018). Therefore, they are an integral part of what Soja defines as "post-metropolis" (2000), an agglomeration in which urbanization takes on a regional dimension and in which density is no longer an exclusive feature of the central cities (Balducci et al., 2017). Precisely because of the changing scale of contemporary urbanization processes, the metropolitan dimension appears today to be the most suitable to capture the forms and characteristics of peri-urban territories. In fact, it is at this scale that the complex assembly of "territorial issues" emerges clearly—linked to the multiple infrastructural and settlement needs, to the widespread informal and unregulated phenomena (Guida, 2015) and the equally widespread disposal processes—which determines the hybrid and composite nature of the peri-urban territories. The widespread presence of "latent" risks also contributes to increasing the complexity of peri-urban territories (Guida, 2020) and that is, often devoid of immediate evidence but that significantly affects the quality and requires the triggering of regenerative processes: the combination of industrial activities, illegal waste deposits, landfills, sometimes even long-used, intensive agricultural activities, generates, in fact, multiple forms of pollution and/or alteration of environmental matrices (soil, water, air, etc.). However, the heterogeneous elements that structure these territories can be recombined (Shane, 2005), to generate new urban forms and, at the same time, increase the potential, available natural and social capital of metropolitan territories through regeneration processes of "waste." In this sense, the peri-urban territories can be understood as articulated places for the purposes of a wider regenerative strategy of the contemporary metropolis. On the one hand, waste processes specific to urban areas with higher density land in the peri-urban fringes, often generating crisis conditions, on the other hand, it is precisely these fringes that offer potential and space for the activation of regenerative processes to encourage regulation of the metabolic flows of the wider urban areas of which they are part (Galderisi & Guida, 2020).

Thus, proposing for these territories "visions" strictly connected with the circular economy model. A model, as it is known, fundamentally different from the "linear economy," based on a simple, linear process; extract, produce, consume and trash, with little or no attention to the pollution generated at each step (EC, 2020; Sauvè et al., 2016).

This chapter aims to discuss a particular type of peri-urban, where the aforementioned issues interact with industrial clusters "landed" in many regions of southern Italy with the aim of encouraging the industrialization process and economic development, but also conflicting with the rural and urban identity of the territories, proposing for them "visions" strictly connected with the circular economy model.

P.U.R.E. (Productive and Urban metabolism Resources. Eco-solutions for new lands) research in this complex context, where the urban and economic planning tools alone have proved ineffective and unable to adequately read the mosaic of this "plural" territory. The research, first of all, both through cartographic and socio-economic analyses of data (elaborated by a Geographic Information System—GIS), and then, also through educational laboratories, elaborating strategies of regeneration and spatial planning, and ecosystem reconfiguration of this urban-industrial-rural with a focus on the area of the province of Caserta in Campania Region. An important part of this area is also known with the ancient Roman name of Campania Felix, but today unfortunately known as Terra dei Fuochi (Land of Fires), due to air pollution following the continuous illegal burning of waste materials, in turn the result of partly illegal manufacturing activities. In this peri-urban magma, the research focuses on the role that industrial platforms, now enveloped in the urban fabric in constant growth up to a decade ago, can have in relation to the still existing cities and rural areas.

15.2 Productive/Urban: Caserta Case Study

The focus area of the research is the province of Caserta, and in particular the industrial/urban contexts, large areas where industrial settlements, cities and agricultural areas compete for the territory.

The large plain which consists of this patchwork has been affected by locations of large industrial settlements, plants, logistics, landfills and territorial large infrastructures that clash with residential, agricultural or residual areas and in-between natural ones and a mainly polluted hydrographic network (the Regi Lagni, the Volturno River, the Agnena canal, etc.).

Essentially, this mosaic of different urban and territorial facts (Russo, 2011) is the result of the industrial development planning activated by the Cassa per il Mezzogiorno (a public body that promoted and financed development policies for the South of Italy until the 1980s) and regulated by Law n. 634 of 1957 and subsequent decrees and circulars. Legislation provided for the possibility of forming consortiums between Municipalities, Provinces, Chambers of Commerce, banks, and so on, with the aim of promoting industrial initiatives to be concentrated in specific areas, called Industrial Development Areas (ASI) (in Italian, Aree di Sviluppo Industriale—ASI). The implementation of these policies was preceded by a so-called phase of "pre-industrialization," in which the action of the Cassa was dictated by the cogency of the agrarian issue and unfolded through a first transformation and infrastructuring of the South (Adorno, 2015). The interventions were implemented following the approval of specific plans, drawn up by the consortiums, which have the value of Territorial Coordination Plans (provided for by the Italian Law n. 1150/42), with respect to which the municipalities are required to standardize their urban planning tools. The plans of the ASI areas were extended to the entire territory of the municipalities included in the consortium and, in addition to providing for the works to be carried out by the consortiums, could include indications on the needs of general infrastructure, public works and services. In summary, it was a sui generis urban planning that, between the 1960–1970s, surrogate the regional and provincial and filled a void of municipal planning determining, as in the case of the territory of

Caserta, a particular type of peri-urban, with clear agricultural, urban, and industrial components. The coordination between the plans of the ASI and the municipal plans almost never happened, creating "fractures" in the territories, contributing to separate the industrial plates from the urban and rural contexts, creating industrial enclaves, also from an administrative point of view. A condition that has gradually worsened with the crisis and the closure of many activities since the 1990s.

The ASI are made up of "industrial agglomerations," where factories are concentrated. The localization of the agglomerations took place in such a way as to allow industrial investors to find, in addition to the proximity to the main mobility infrastructures and urban centers, a network of small industrial settlements already active, so as to take advantage of the supply chain system and the interrelations between the different stages of the production process.

In general, the implementation timing of agglomerations did not always coincide with the changes in Fordist and post-Fordist industrial economic processes. For this reason, the actual realization of the ambitious program of the heavy industrialization of the South was delayed, when the metamorphoses of the productive system, the delocalizations in areas with low-cost labor and disposal processes had already been activated. Over the decades, this partial failure was associated with spontaneous or planned urban transformations (both residential and other productive ones, for example, the areas of the Productive Settlement Plans—PIP acronym in Italian) induced precisely thanks to the infrastructure built by and for the ASI, which have contributed to the territorial disorder and urban quality in terms of services and equipment.

15.3 The Path of P.U.R.E. Research

The aims of P.U.R.E. research are to provide a methodology for the analysis, classification and mapping of abandoned or underutilized areas; to define a catalogue of eco-solutions for their regeneration and guidelines to improve the integration of industrial clusters in the urban territories. In this sense, the eco-innovation of design solutions for "new lands" is crucial. Eco-innovation, as defined by the European Commission (EC), is a form of innovation designed to promote development opportunities and environmental safeguard, optimizing the use of resources. The EC has also defined an Eco-Innovation Action Plan (EcoAP) (EC, 2011). The above concepts will have as the field of investigation the Industrial Development Area (ASI) in the District of Caserta (Fig. 15.1). The attempt to integrate these areas with the urban, rural, and natural surrounding areas has never been made and today these areas are only partially active and have left thousands of hectares of brownfield areas. The research will work on the quality of single areas but also on their relationship with neighbor urban and/or rural contexts, transforming each area into a spatial/functional element of an articulated network of open spaces for technological, ecological-environmental, and social needs. The analysis, classification and mapping of disused areas, internal and close to ASI, in addition to returning an unpublished soil map, will bring out

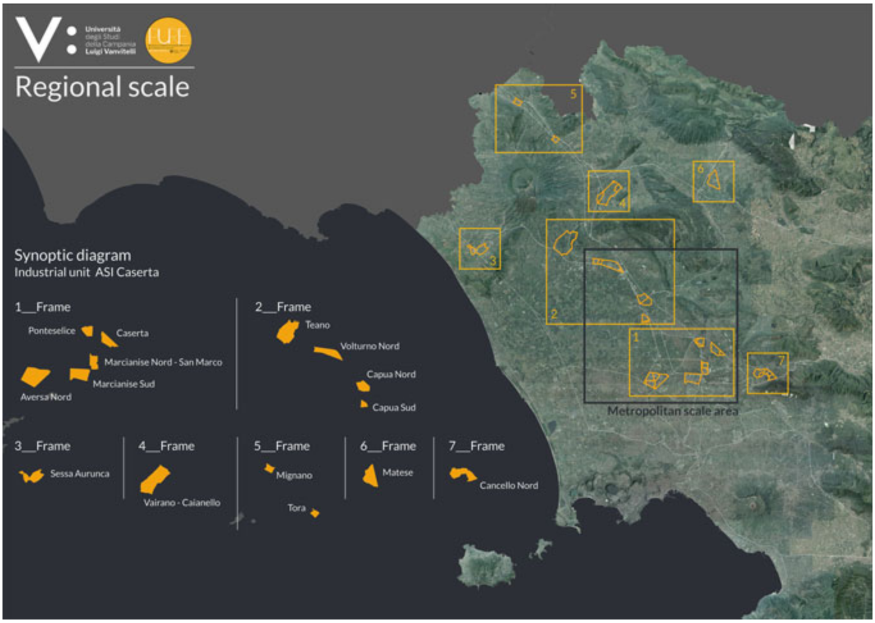

Fig. 15.1 The agglomerations of Industrial Development Area of Caserta (Italy) (*Source* PURE Laboratory of Department of Architecture and Industrial Design of University of Campania—Giovanni Bello)

some paradigmatic areas where design exemplifications will allow to test possible eco-innovative solutions. The methodology of P.U.R.E. project is structured into three phases. The first includes both the preliminary collection of data and maps from the ASI, Caserta District, Campania Region, Cassa del Mezzogiorno and the selection of a set of criteria for analyzing, classifying, and mapping brownfields or underused areas. The second phase involves the editing of a catalogue of already tested eco-solutions at an international level, with a focus on soil restoration, reuse of waste materials (in particular CDWs), ecological techniques suitable for brownfields areas. These activities will end with the elaboration of thematic GIS maps. These two phases are underway and have been implemented through the Urban Planning Educational Laboratory, both in the analytical phase and in the proposal of strategies and visions, at an intermediate scale, called "Focus scale." The third phase is aimed at applying the outcomes of the previous ones to the pilot area of the ASI, at "Sample scale." The outlined criteria will allow to carry out, within the pilot area, analytical maps of the brownfield areas and the identification of the residual natural, semi-natural, agricultural or green areas. To date, the data is being entered into a GIS platform intended as an innovative knowledge framework, nowadays not available, able to support regeneration actions. The use of open-source maps will integrate the database with information about the quality of the soils, the physical condition of the buildings and infrastructures and the function they contain. In particular, the use

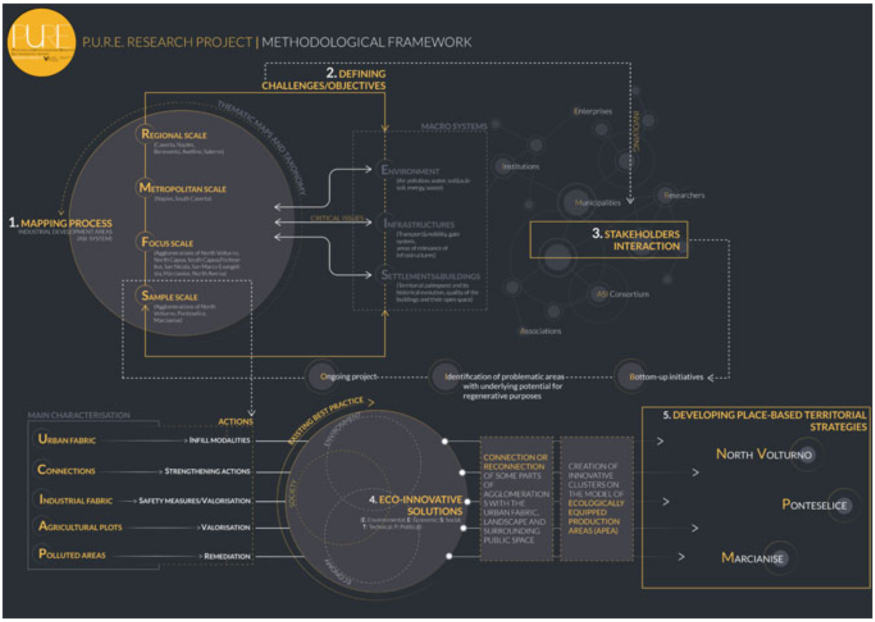

Fig. 15.2 The PURE research methodological framework (*Source* PURE Laboratory of Department of Architecture and Industrial Design of University of Campania—Valentina Vittiglio)

of multitemporal satellite images will allow for the analysis of the electromagnetic response of the territory in order to acquire information that is not visible. Then, some targeted design tests will be carried out, in order to define alternative place-based strategies on three selected sample areas. The outlined path is in Fig. 15.2.

15.4 First Steps, Expected Results and Future Research Paths

The P.U.R.E. research project, which will end in 2021, aims for some specific and complementary results. The first outcome is an implementable GIS mapping model, replicable at different scales, able to represent the state of the soil, its uses, the dimensions of abandonment and degradation of the 14 agglomerations (covering about 4000 hectares) and the urban and rural areas adjacent to them. The second result is specifically connected to the territorial and industrial nature of this research call. Soil reuse practices are conceived both in a dimension of the urban and territorial project (able to coordinate the needs of the production with the priorities of the cities), and specific intervention techniques. Starting from a circular and regenerative approach, the results of the project suggest replicable methods and models aimed at reducing waste and soil consumption, while also promoting recovery and regeneration. In the three focus project areas, the possible reuse of waste materials, such as CDWs, will also be tested. All this in order to be able to configure these territories as ecosystems, assessing the interrelationships between the anthropic and natural phenomena. Considerable importance will be given to the evolution of the research methodology, proposing it for the entire South, reconstructing cartographically the history of the industrialization of the South of Italy and returning the current state of affairs, with elaborations in GIS, statistical data, economic indicators, spatial and functional relationship with the neighboring urban organisms. The final outcome may be an interpretative model to be proposed as a fundamental support to decisions and to the definition of specific national intervention policies.

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Chapter 16
Urban Regeneration: An "Incremental Circularity" Perspective

Paolo Cottino, Dario Domante, and Alice Franchina

Urban Regeneration (UR) is an approach to urban development contrasting soil consumption by catalyzing social energies to reuse urban existing heritage (brownfields and dismissed buildings). The authors of this chapter are professionals within KCity Ltd., a bespoke consultancy specialized in UR design strategies adopting an interdisciplinary approach, derived in particular from policy analysis and urban planning. The aim of this chapter is to investigate the potential of UR practices to give a contribution to the scientific debate about Circular Economy and its application into urban development.

16.1 Circular Economy Vision of Urban Development

Circular Economy (CE)—intended as a regenerative approach in contrast to the traditional "linear" economy—has been widely discussed over the last decades and it is now a very popular and accepted concept within scientific, business and political debate. Cities have been recently at the center of such a debate as they are places where large flows of people, goods, services, materials and energy are concentrated, so here the negative effects of the traditional linear economy based on consumption are more evident. Cities are also places of large social concentration, hosting more than half of the world's population: for all these reasons, conceiving and implementing sustainable solutions toward CE is strongly urgent in urban contexts.

P. Cottino (✉) · D. Domante · A. Franchina
KCity Ltd, Milano, Italy
e-mail: paolo.cottino@kcity.it

D. Domante
e-mail: dario.domante@kcity.it

A. Franchina
e-mail: alice.franchina@kcity.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_16

During the last decade the Ellen MacArthur Foundation has been engaged in a deep reflection on how to stimulate and realize CE, and has recently set out a model for implementing it in cities, based on three guiding principles: (1) design out waste and pollution; (2) keep products in use and maintain their value; (3) regenerate natural systems in and around cities (Ellen MacArthur Foundation, 2019). Within this model, the absence of waste and the complete optimization of resources' use are key to trigger a new economic development for city and citizens (World Economic Forum, 2018).

Looking at the political level, both the UN New Urban Agenda (2016) and the Urban Agenda for the EU (2016), clearly promote a shift for urban policies to embrace the CE perspective; one of the partnerships established for delivering the EU agenda is explicitly dedicated to Circular Economy, and it recently published different documents on how to implement CE principles at the urban scale, focusing on resource management (Circular Economy EU Partnership, 2018, 2020), and on building and land reuse strategies (Circular Economy EU Partnership and Sustainable Land Use EU Partnership, 2019).

Within this consensual framework, policymakers are asked to drive the transition to CE implementation by defining strategies, approaches and actions to trigger a new economic development for city and citizens (Bulkeley et al., 2010; Prendeville et al., 2018; World Economic Forum, 2018). While in a way CE is a cross-cutting and fecund concept especially for changing the global ecological footprint of cities, its implementation is not free from criticisms. From the policy point of view, some scholars have noticed that there is generally a gap between how CE is conceptualized in policies and how it should be translated into concrete actions, pointing out that very often CE tends to fuse with the larger concept of sustainability (Prendeville et al., 2018). Moreover, in urban strategies, there is generally a big emphasis on the role of businesses in driving transition toward CE (Farnè Fratini et al., 2019), which refers to the idea that CE depends mainly on production and flows of goods. It clearly appears indeed that political guidelines, business engagement and part of the academic production on CE in cities has been strongly influenced by an approach centered on the physical component of the urban body, whether it is the built environment, or the material and resources flows, or the land itself. Some scholars have highlighted this point, criticizing the dominance of techno-centric views on "circular cities" and a lack of reflections on social aspects and impacts (Pomponi & Moncaster, 2016; Prendeville et al., 2018).

16.2 Urban Metabolism and Urban Regeneration

The concept of Urban Metabolism (UM) has recently spread in urban studies to coping with some of the abovementioned issues: it calls for looking at the heterogeneous processes, networks and flows going through contemporary cities as an integrated, interdependent and bio-physical system (Broto et al., 2012; Kennedy et al., 2011). Even if UM concept also originates from a scientific landscape dominated by the material or energy flow analysis, it recently saw a rejuvenation of studies (Dijst et al., 2018; Rosales Carreón & Worrell, 2018); some scholars and practitioners also tried to mix UM and CE concepts, some called for an explicit “circular urban metabolism framework” (Lucertini & Musco, 2020); some others imagined a “recycle city” that should reactivate its economic loops looking at its endogenous cultural and social resources (Carta et al., 2016). The interest of UM debate is that it progressively opens a perspective putting attention on the human and social component within the urban realm (Dijst et al., 2018). In particular, we believe the metabolism concept itself contains the idea of *dynamic process* which risks getting lost into the “closed loop” typical of CE discourse.

It is from this perspective that we want to consider assonances with some innovations the discourse on Urban Regeneration (UR) has recently brought to the debate on city development. UR has seen a huge spread in literature, practices, and policies within the last decades at the global level, as a concept going beyond the urban renewal, encompassing physical, economic and social aspects into a long-term transformation process (Leary & McCarthy, 2013). UR is very often associated with the reuse of brownfields or former industrial buildings, which are intended as the main asset for the city to develop in order to stop soil consumption. However, in UR strategies the reuse is not the ultimate goal: in our view, UR is rather about catching abandoned buildings and unused spaces as an opportunity to trigger new and alternative mechanisms of city-making, for improving urban quality, promoting social inclusion and public participation, and boosting economic development. In fact, UR draws on the reflection about the urban body as composed by *hardware* and *software* (Landry, 2006): the first one is made by infrastructure, buildings, spaces; the second one is made by human relationships, cultures, social dynamics, economic processes. While the traditional approach to city planning has focused primarily on the hardware, UR assumes that the city is an intertwined organism, then it is not possible imagining urban transformation without taking into account the software component. In particular, our approach to UR builds its specificity on two main aspects: a focus on *process* and *time* in progressively imagining and realizing transformation; stress on *social resources* and values in driving the process.

Starting from this perspective it becomes clear that spreading CE within the urban realm is not only a matter of changing the material flows and cycles into the cities but also asking how CE principles might change to embrace city’s complexity.

16.3 Incremental Circularity

Framing UR into CE debate, we might say that UR is not just a matter of avoiding waste of physical resources by reentering them in the same process: UR is about generating new and unprecedented (material and immaterial) value through the combination of existing resources, and triggering a process that will go on over time. This is why UR cannot be defined as a way of merely applying UM or CE principles in cities, also because the main CE principle of "closing the loop" is not easily transferable within the urban realm: rather than "closing," UR aims at "opening" new transformative development paths. Incorporating time dimension and focusing on reactivation of heterogeneous types of resources, UR design process pursues longer-term transformations, also taking into account the possibility of "adjusting the target" over time; this approach is similar to the one proposed by Mallach and Brachman (2013), who advocate a step-by-step "strategic incrementalism." This is what we can call "incremental circularity": a perspective combining the value of material and immaterial resources reuse, with the exploration of new (and more adequate) models of their integration, that goes on over time by cycles progressively advancing the reflection and creating the condition for the generation of new values.

Such an approach asks for an active engagement of the community in the co-design of the project for neglected areas, in a process that some scholars have defined as circular metabolism (Amenta et al., 2019).

As UR practitioners, our design strategies aim at enabling physical reuse opportunities to generate social relationships and partnerships that will be the starting point for new local development paths over time. In particular, KCity has set up a specific participatory planning format called "Building communities," aiming at promoting an innovative way to approach regeneration based on releasing and catalyzing local energies, strengths and resources and introducing them along the city making process (Cottino & Domante, 2017). "Building communities" is a methodological framework that incorporates the idea of "incremental circularity" in its subsequent phases. However, if the traditional symbol of CE is a circle, we conceived a different scheme for the "incremental circularity" (Fig. 16.1) which should embrace and make

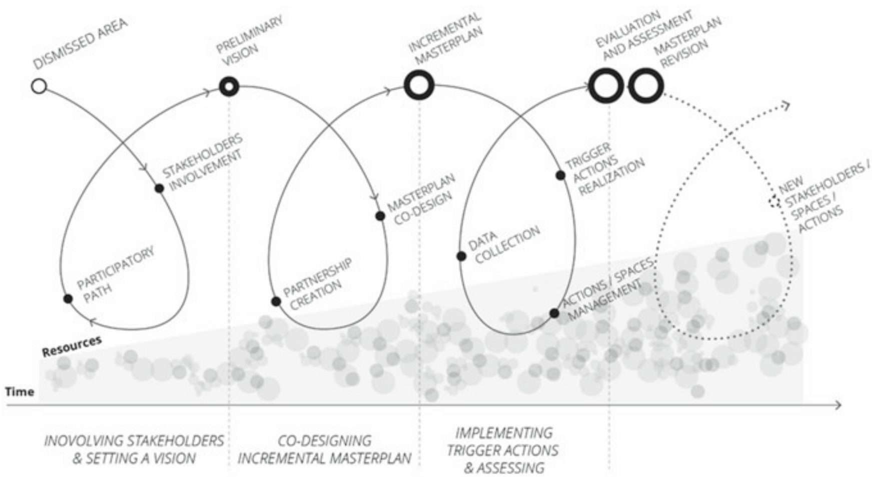

Fig. 16.1 KCity approach to Urban Regeneration—Incremental Circularity frame. The continuous line indicates the "planned" process, while the dotted one the "unpredictable" process. The gray circles at the bottom indicate the different types and intensity of resources (material and immaterial) involved

explicit the unfoldment of the process over time, articulating the main steps of our methodological approach:

1. the involvement of a large range of local actors (participatory activities and/or creation of specific partnerships) for setting a shared vision (or alternative development scenarios);
2. the co-design of an incremental masterplan identifying different actions to be realized along time (with the identification of some "trigger" actions or projects immediately doable);
3. the realization and management of trigger actions, in parallel with an assessment of the ongoing process for revising the masterplan and programming future actions.

Each of these points is a process itself and has its own "cycle of action," during which different types of local resources are collected and combined; at the same time, each phase feeds the other ones in a continuous and iterative process.

Structuring a process is a matter of organizational design and formalizing such a model also takes influence from different design cultures and disciplines. Particularly, our model is based on an evolutionary idea of the project as a process changing and growing over time, and draws on studies on design methods and literature on activity theory that are part of our background and contributed to structure our approach to UR (Cottino, 2009, 2018). Studying design processes and problems structures, Jones (1992 [1970], p. 316) explores a method called "System transformation" which pursues the change through an evolutionary pathway, removing step-by-step some faults from the system and adding some new components, that progressively interact among each other for reaching the complete transformation.

In a similar way, although in a different field, Engestrom (2005 [1987], p. 53) investigates the conditions for organizations to face change, setting out the idea of "cycle of expansive development": at the end of the cycle, participants are not at the same starting point, rather they reach an improved, different, more mature organization model, thanks to the internal learning occurred during the process.

Our perspective encompasses the lessons learnt from Jones and Engestrom into the building of our incremental circularity model. In particular, Jones shows the transformation as a process that progressively happens step-by-step, adapting itself to the context; Engestrom highlights that the result of a transformation process is an advancement in terms of knowledge, so the conclusion of a cycle is never the same point of the start.

16.4 Case studies

In order to give substance to the abovementioned structure and clarify its logic, we provide in the following paragraph some examples, coming from KCity consultancy experience, particularly referring to the Italian context. The brief descriptions give an overview of the cases and then pay particular attention to aspects related to the “incremental circularity” frame. In the first one KCity, on behalf of a private investor, designed an incremental masterplan for the regeneration of an abandoned industrial complex, involving a large community in the reuse of buildings and open spaces. In the second case KCity, on behalf of a Charity, engaged associations and representatives of the local community to transform an abandoned urban green area as the first step of a wider regeneration process within the entire neighborhood.

16.4.1 Ferrara: Pioneer Communities for Regeneration

In 2016 KCity has been commissioned by a private real estate company to devise an urban regeneration strategy for Alc.Este complex, a 20 Ha former distillery in Ferrara (Emilia-Romagna, Italy), located right out of the city center, close to the train station and at the crossing-point of two ancient and degraded water canals. The landowner was looking for ideas for conceiving and sharing with the Municipality a regeneration project, and selecting partners for its implementation. According to the real estate market trends, there was no need for new residential stock in Ferrara, so the challenge was finding different drivers for activating a transformation. KCity, after interviewing local experts on market trends and analyzing municipality’s development plans, proposed an alternative approach to development. Usually spaces for local services are seen as a “burden” by developers, who make profit mainly from housing; the idea for Alc.Este was betting on collective uses and local services as a precondition for creating and spreading interest about the area. The key concept here is then building local “pioneer” communities around a shared vision that can steer the social reappropriation of the abandoned area: the reactivation of some spaces for collective uses, led by the local community, is seen as the crucial element for triggering the regeneration process.

Looking at the graphic scheme (Fig. 16.2, top), the first point was to collect policies, projects and practices gravitating around the area, and interested stakeholders at different levels. The actors involved came from different sectors: municipality, university, NGOs, and active citizenship. All the collected elements contributed to the draft of a vision for development that has been debated in a first participatory workshop, and gave birth to three alternative scenarios, respectively focused on water, tourism and youth. In a second workshop the participants, supported and guided by KCity, agreed to choose the third scenario, which was further deepened for setting out the vision: Youth Alc.Este as a hub of services for students and young workers, a new neighborhood dedicated to scientific research, cultural events and *loisir*, able to become attractive especially for the new offer of collective functions and spaces. As a result of this public engagement path, KCity designed an incremental masterplan indicating three different phases for implementation and identifying some “trigger” projects immediately doable. These projects were focused on realizing a reactivation of spaces and social energies in the short period, in some cases even temporarily: the “temporary” dimension was seen as a phase for testing uses, verifying roles and

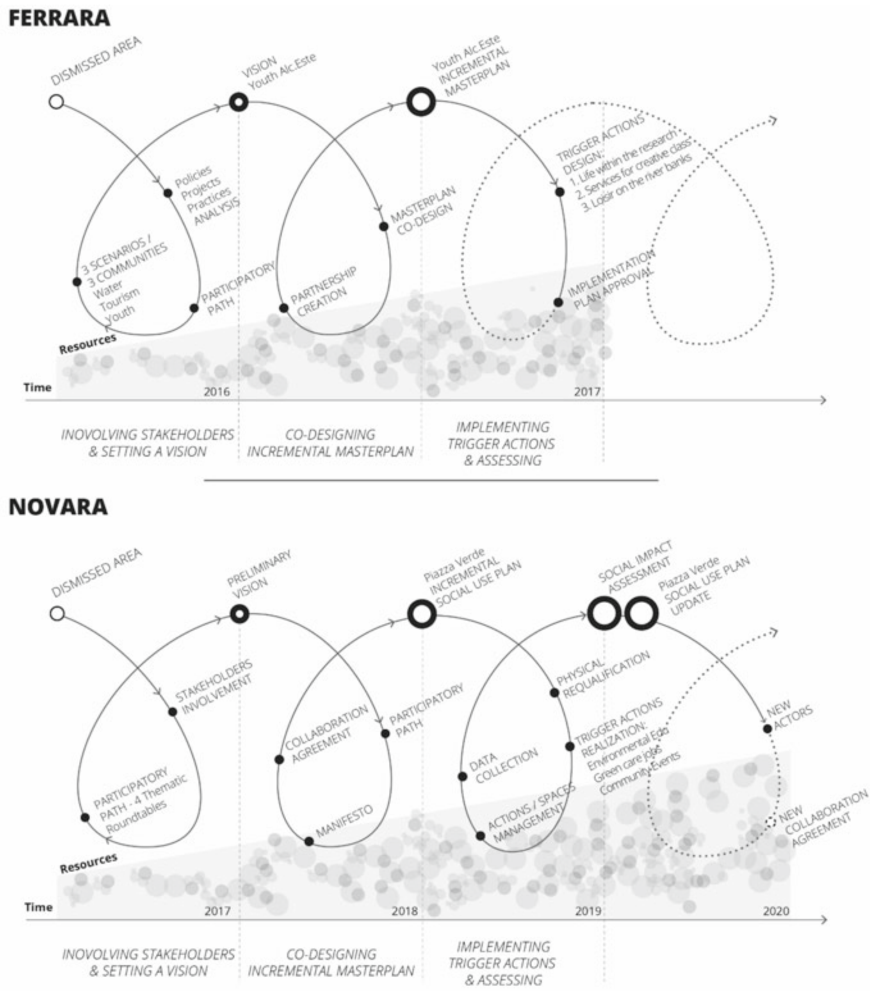

Fig. 16.2 Incremental circularity frame in case studies, Ferrara and Novara

responsibilities, attracting interests, in order to potentially reorientate the project toward the long-term objectives.

The whole process lasted for two years and led to the Implementation Plan approval ("Piano Urbanistico Attuativo," PUA in Italian) by the Municipality. Some initiatives have been activated and an application for EU-UIA (Urban Innovative Actions) funds has been delivered. Unfortunately, the bankruptcy of the landowner and a political change within the City Council has temporarily interrupted the process.

16.4.2 Novara: Triggering the Regeneration Starting from Commons

The second case study takes place in the city of Novara (Piedmont, Italy) in 2017 when De Agostini Foundation (DAF) decided to promote an emblematic intervention for the 10th anniversary of its establishment. They choose to intervene in Sant'Andrea, a former working-class and low-income housing neighborhood in the north of the city, which also hosted the historical De Agostini book factory. Together with the Municipality, DAF decided to renew a green area at the core of the neighborhood, which was an abandoned and inaccessible public property.

KCity, as a DAF consultant, participated in the project from the beginning, designing a strategy for community engagement and co-design, and has recently concluded the first Social Impact Assessment (SIA) of the intervention; the process lasted three years and is still ongoing. KCity took the garden renewal as an opportunity for imagining a long-term strategy for a wider regeneration process within the entire neighborhood: the lever of such a strategy was engaging the local community into the renewal project's design, both in terms of physical and architectural space and in terms of management of activities and events for animating the garden, in order for the space to become an urban common.

Referring to Fig. 16.2 (bottom), the first step was analyzing Sant'Andrea neighborhood in terms of history, spaces, social relationships, problems and strengths, through interviews with residents and businesses in the area. The preliminary analysis was discussed in a public meeting in the neighborhood and was the starting point of the participatory path. Four thematic roundtables were focused on specific themes: elderly people, young people, families, recreation for all. They gathered individuals, NGOs and small businesses for debating around the needs and the future activities to be developed in the park. The first output of the roundtables was the concept for the project's name: Piazza Verde ("Green Square"), intending the garden as a place to act and socialize rather than just to stay.

The process had some other major results: a Manifesto containing ten objectives to reach for making Piazza Verde an attractive, vivid and safe space for the entire community; a "Social Use Plan" ("Piano di utilizzo sociale"), a co-designed program of incremental actions the local organizations decided to undertake collectively for the project start-up. Also, the whole participatory process gave some inputs to the landscape team for the architectural design of the park.

Moreover, the process led to the signature of a Collaboration Agreement ("Patto di Collaborazione" in Italian),[1] a formal deal among Novara Municipality, DAF and eight local NGOs, establishing roles and responsibilities for the care of Piazza Verde as an urban common. The goal of the Collaboration Agreement is animating the

[1] The Collaboration Agreement is an Italian form of contract established between the Public Administration (usually a Municipality) and active citizens, which regulates roles and responsibilities of the parties in caring for commons. It was put in place first in 2014 by Bologna Municipality and is a form of realization of the "subsidiarity" principle declared in the Italian Constitution (art. 118).

garden through social, educational and recreational activities organized by and with the users themselves, and increasing the sense of active belonging of residents.

The garden opened officially on September 20th, 2019, taking the name of Giardino Marco Adolfo Boroli, and from that moment on KCity started the first Social Impact Assessment (SIA) of the intervention. The SIA lasted for six months and highlighted—even if in a preliminary way—success features, critical points, areas for improvement and new paths for future work.[2]

Following the incremental circularity frame, we might say the physical requalification was a new starting point especially for the NGOs involved, who took the leading role in the management and vivification of the place with the realization of the trigger actions. Unfortunately, some planned activities have been canceled due to Covid-19 restrictions (March–June 2020) but the garden turned out to be an extraordinary resource for people to gather and socialize also during the health crisis. Moreover, at the moment of writing this chapter, all the stakeholders involved in the process are working for drafting and finalizing a new Collaboration Agreement, adding new social actors, taking into consideration SIA results, and enhancing the social value of outdoor spaces.

16.5 Conclusions

The contribution of this chapter is definitely just an update of an ongoing reflection perspective, aiming at establishing a dialogue between critical points emerging from the theoretical debate on CE, and professional experiences of urban regeneration led by innovative methodological approaches. The hypothesis is basically that the CE debate can be enhanced by inputs coming from practices of urban regeneration. Particularly, the latter can be a vehicle for introducing incremental and social dimensions in CE implementation model, according to UM concept.

In particular, we may offer some lessons learnt from our experience and from case studies that might contribute to the debate, focusing on urban resources.

16.5.1 There Is No Circular Economy in Cities Without Social Component

In both case studies the community (although intended in different ways, as we saw) has been the driver for imagining or realizing the regeneration on the field. This shows the relevance of people (groups and individuals) as actors in transformations, and the importance of "designing" social change at the very beginning of the process.

[2] The SIA is available online in italian at https://gag-fondazionedeagostini.s3.amazonaws.com/wp-content/uploads/2020/10/VISFdeAper-sitowebAFMP20201014.pdf and the whole process for Sant'Andrea in Novara is illustrated in Cottino and Franchina (2020).

This also highlights that, in implementing CE, social value cannot be a by-product or just a consequence of circular physical resources management; rather social change has to be integral part of the process, and intended as an explicit objective of the shift toward circular principles.

16.5.2 Temporary Use of Spaces and Collective Uses as Trigger for Long-Term Transformation

Ferrara case shows that it is possible designing the revitalization of spaces starting from existing social resource as pioneers for a reactivation. In Alc.Este regeneration, the project identified the use of collective space as a trigger for attracting and collecting interests and new resources. In particular, we believe that the "temporary" use, intended as a testing phase of a long-term strategy, is a fertile dimension for turning on inactive social resources and activate new cycles of development.

16.5.3 The Outdoor Spaces as a New Urban Resource

The urban metabolism has clearly changed due to Covid-19 health crisis. Working system, shopping habits, transportations, supply chains, way of living and using private and public spaces, have been definitely affected by containment measures and are finding new balances. Within this new and uncertain context, the outdoor spaces are becoming increasingly important in reframing the social use of space in cities, hosting numerous activities traditionally carried out indoors as learning, socializing, physically training, and experiencing art. The case of Novara shown us the power of a public garden as community space, and clearly indicates that outdoor spaces will progressively have more weight in urban metabolism as an essential collective resource, to be protected, enhanced, improved.

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Chapter 17
Reloading Landscapes: Democratic and Autotrophic Landscape of Taranto

Francesca Rizzetto and Fransje Hooimeijer

17.1 Introduction

Italian cities are characterized by their density of population and economic activities, an internal mobility system largely oriented around the private car, and many of them by high levels of pollution from the presence of industrial plants with a detrimental impact on the environment.

In 2012 Taranto, a coastal city in Southern Italy, known as an important commercial and military port, was declared the city "with the highest risk of environmental crisis" in Italy due to a wide industrial area developed in the proximity of a highly populated urban settlement. The cause of pollution, a steel production plant, directly employs approximately 12,000 people and another 8,000 contractors indirectly making it Taranto's main economic driver (Pignatelli, 2013).

The conflict between economy and environment in the city of Taranto, make a peculiar case study when approached with the concept of the Democratic Landscape. This concept reads the territory beyond the natural environment, recognizing also the wellbeing of its inhabitants. Following the Greek words *demos* (people) and *kratos* (ruling), this term describes what potential each holds for the inclusion of civil society at different stages of a planning process, distinguishing between liberal, participatory, deliberative, and radical understandings of democracy (Knudtzon, 2018).

At the same time, cities are like "heterotrophic organisms", their economy is dependent on the environment, they cannot provide their own food, and are dependent on inflows of air, water, matter and energy. Unlike nature, they pollute their own habitat with the production of outflows of waste and emissions, extending over large areas beyond their own footprint. The data of the ecological footprint

F. Rizzetto (✉) · F. Hooimeijer
Department Urbanism Julianalaan, Delft University of Technology (TU Delft), Delft, Netherlands
e-mail: F.Rizzetto@tudelft.nl

F. Hooimeijer
e-mail: F.L.Hooimeijer@tudelft.nl

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_17

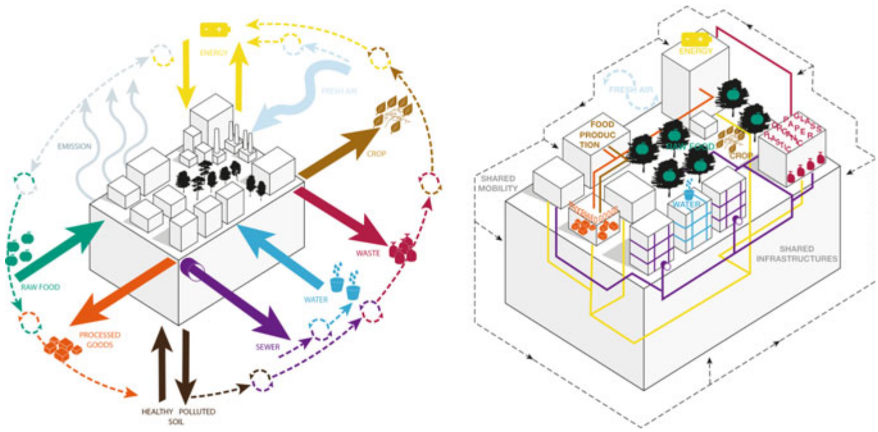

Fig. 17.1 Inflows and outflows in the "heterotrophic organism" and closed loops in "autotrophic organism"

of cities quantifies, emblematically, the imbalance between in- and outflows but also what remains: polluted air, water and soils. The rapid rate of urbanization is matter of serious concern, but as part of new developments it can be turned around with an approach in which cities become an "autotrophic organism". This is a primary producer that does not need a living source of carbon or energy and is the producer in a food chain, such as plants on land or algae in water. Autotrophs can reduce carbon dioxide to make organic compounds for biosynthesis and as stored chemical fuel. Most autotrophs use water as the reducing agent, but some can use other hydrogen compounds such as hydrogen sulphide (Kim et al., 2020) (Fig. 17.1).

This contribution explores the democratic landscape in transformation from a heterotrophic to an autotropic organism through the regeneration of the ecosystem and the economic regime.

The project "Reloading Landscapes: Democratic and Autotrophic landscape of Taranto" studied an area of about 400 km^2 of vacant territory, abandoned rural buildings, and heavily polluted soils (Rizzetto, 2013). Various categories of pollution have been distinguished: heavily and medium polluted soils, and polluted water. According to the level of pollution, the distribution of public spaces, land use, and accessibility of the areas are defined, providing aesthetic and economic sight in the landscape.

The research explains the transformation of the territory into a park made by different landscapes where a circular solution for remediating the landscape (soil and water) is connected with the production of energy. Meanwhile, on both clean and polluted territory, a network of *masseria*—former fortified farmhouses—becomes the new gravitational centre of a healthy metabolism. Production of fresh food in a polluted territory is done through greenhouses and processed in the requalified *masseria*, ready for exporting. *Masseria* are transformed into a cultural and short stay centre where all visitors, researchers and workers can share spaces and knowledge.

The project is used to explore the potential of democratic and anthropic landscapes to transform the production of the factory instead of closing it as part of a wider scenario in which the territory is remediated to improve the health and wellbeing of the population of Taranto. The theoretical starting point of democratic and autotrophic landscapes is presented in the next paragraph which is followed by the proposal and conclusions.

17.2 Democratic and Autotrophic Landscapes: Linking Open-Loop System Circularity

The internationalization of economy, the spread of Western values on a global scale, the acceleration of changes in products, the gap between society and the state and between delegation and decision-making power, society becoming individualistic and the fragmentation of the territory of memberships are defining aspects for the social relations and the forms of conflict, different from the past (Bird & Thomlinson, 2012).

In 2012, a declaration was made in Taranto for a progressive change in the spatial order of the city and a proposal to change the labour structure. It is an example of how the city does not recognize itself as industrial city anymore, but it needs to return to the historical relation with the natural environment: in a different project—for its "polis".

For this reason, the conceptual background of this analysis is based on the concept of a "democratic landscape". The importance of recognizing the landscape as common good, as part of a participatory process that Taranto's citizens may take part in the decisions. It is based on the idea presented in 2009 by the Danish environmental and planning philosopher, Finn Arler, who notes that "landscape democracy" came on the Council of Europe agenda without defining democracy in relation to landscape (Arler, 2008, 2010; Arler & Mellqvist, 2014). He presents three sets of democratic values that influence decision-making in landscape issues: co-determination and participation; private self-determination; and impartiality and respect for arguments. Alongside participation, procedures contributing to democratic decision-making include elections, consultation, markets, and informed argument. Moreover, the landscape is not formed simply by landscape policy, but also by commodity markets, globalization, and political decisions not concerned with landscape (Jones, 2018).

Activating Taranto's democratic landscape is necessary to build a knowledge of the territory and to promote a culture of localism, the identity of the territory in which it becomes possible to dissociate from the international industrial production. The concept of "identity" describes a person as a fixed and unchangeable unit, while also the empiric experience shows individual existences are made by contradictions, differences linked together, unexpected, and slow changes (Nistri, 2012). These aspects are useful to recognize as the social horizon in the city is a playing field and, at the same time, they are limiting because they become constraints and homogenate forms.

In the case of Taranto, the steal culture has evolved while suffocating the fishing and farming industries, creating a lack of identity in both physical relation to the natural environment, and in terms of traditional production like horticulture and fishing.

The need to recognize our “identity” is a fundamental necessity that is near to the reassuring sphere: it consoles uncertainty. The limit of the identity process is visible in current global developments, even if global competition makes the construction of an identity that is possibly unique more prosperous. Creating an identity that has the aim to be different and so, to avoid the others in order to secure our possibilities and opportunity, is in that sense creating a negative image. Identity in the case of Taranto is based on the impossibility to use the public space, the incapacity of reusing the existing built environment, and a lost relation to the productive landscape (Pignatelli, 2013). The application of the concept of autotrophic organism instead can give a new purpose to a more democratic landscape.

In redeveloping a city like Taranto, changing the status from heterotrophic organism to autotroph organism, the concept of the so-called “open-loop” recycling method is fundamental. This concept makes the connection between different loops in which the recycling of one material can be used in the production of another material like proposed in the work by Ekvall (2000) and Holling (2001). The system approach thinking by Holling addresses the interdependence and co-evolution of human economies and natural ecosystems over time and space. The concept of “panarchy” supports an understanding of the evolving nature of complex adaptive systems and how they affect each other over time and scale (Holling, 2001). This work has been very influential in the field of Ecological Economics that studies the interdependence and co-evolution of human economies and natural ecosystems over time and space. Especially for this research, the fact that nature has a set of critical self-organized variables that keep returning is an important notion to steer the human system that, different from the ecosystem, is characterised by foresight, communication and technology and changing the rules of the ecosystem instead of including these self-organised variables.

In the work of the MacArthus Foundation (2012) Holling’s logic of panarchy is expanded with the biological and the technical cycle, to support better the concept of circularity. The biological cycles are the non-toxic materials that can return to the biosphere and the technical cycles are the products, components and materials that are brought back to the market through repair and maintenance, reuse, refurbishment, remanufacture, and ultimately recycling (McDonough & Braungart, 2002; The Ellen MacArthur Foundation, 2012). For public space, these two cycles should be intertwined and brought into synergy on a smaller scale.

Because of the complexity of urban systems, open-loop is not enough. For public space, the “linking open-loop system circularity” describes better the system necessary that is already introduced on the building scale of reduce, reuse, recycle of use of recourses and output of waste going through the urban system (Hooimeijer et al., 2020). This is done by including waste (of public space) and material efficiency (like sand or paved surface in public space) in and hierarchy for cascading see Fig. 17.2 that describe the sequence of concepts.

The "linking open-loop system circularity" approach is about the development of a design personality, not specific design guidelines. Circularity is an attitude because it beholds many elements that can be considered generic for each project: it can be about recycling or reuse, about cutting costs or time and output of CO2 through reducing material inflow and the transport of materials. There are many choices and priorities that can be made or set, but it is crucial to have the right information on the table to be able to gain an understanding of all the possibilities. That is what is tested in the project "Reloading Landscapes: Democratic and Autotrophic landscape of Taranto", on two scales: on the landscape level proposing a multiple reuse of

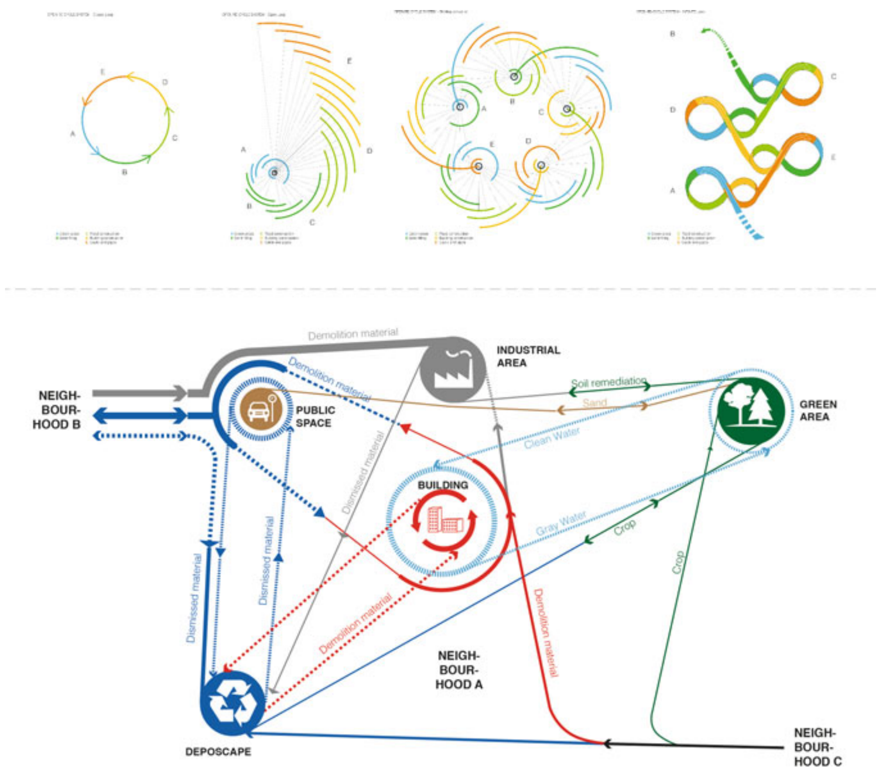

Fig. 17.2 Conceptual diagrams from left to right: **1** closed-loop recycling inside the neighbourhood, **2** open-loop with the 5 macro groups, **3** activation: each material can be stored in a deposit if not recycled immediately inside the transformed area and can be utilized in a different neighbourhood when needed and **4** Infinite loop: the process will start a chain of reutilizing all the materials from the de-constructed side. The infinite loop, is meant to be a chain of decomposed material market, reutilized inside the area but also, giving to another area to start a requalification process. The bottom image is the Open System—Infinite Loops, which allows interchanges among under renovation areas (Hooimeijer et al., 2020)

agricultural crops after the remediation and, at the local level, in rebuilding a portion of the city by reusing demolished buildings materials.

17.3 Reloading Landscapes: A Correlated Scenario for the Case of Taranto

Taranto is the third-largest continental city of Southern Italy with a population of 195,882 people. Since 1946, Taranto began to establish itself as an important industrial and commercial centre due to its strategic location on the Mediterranean Sea, without abandoning the ancient seafaring and military vocation. Because of this new industrial reality, between 1961 and 1971, about 30,000 farmers abandoned their fields, planted with olive trees and grazed by sheep, moving to the city to become workers in the steel industry (Regione Puglia, Report, 2009).

Two assessment reports in 2012, one chemical and the other epidemiological, have reported heavy pollution all over the neighbourhoods near the steel factory. This particular contamination came from the 70 hectares of red ore in an open mineral park (spread through the wind into the public spaces and onto the building's facades), the coke ovens that omit benzo(a)pyrene, and the chimney E312 of the agglomeration plant spreading dioxin (Regione Puglia, Report, 2009). The investigations were done as part of a lawsuit against the owners and directors of ILVA, and showed that over a span of seven years, the increasing rate of death caused by cancer has increased dramatically in and around Taranto and demonstrated that the origin could be linked to the industrial area (Vagliasindi & Gerstetter, 2015).

In the same years, the Italian government wrestling with the severe economic crisis in Italy, did not intend to close the factory. The decree ordered to reduce its emissions and bring the plant up to code before 2016. Meanwhile, at the local level, an ordinance forbade children from playing in public outdoor areas and both pasture and farming production within 20 km of the steel plant was prohibited.

In order to tackle the problems in Taranto, democracy and a technical understanding of territory and its problems need to be brought together to be able to recreate the economy and identity in the city. The project, Reloading Landscapes, presents three transition goals that will allow for major changes, and six transition leaps that represent the major urgent transformations. Both spatially and socially, the transition leaps require major adjustments. Their impact and mutual relationship are often still difficult to imagine and are based on infinite growth, and thus usually in conflict with the economic model on which Taranto is founded.

Attempting to answer the question of how to cope better with the human attitude and the capacity of the territory, the challenge is divided into manageable parts, with clear objectives at different scales: the level of the district or neighbourhood, the urban region, and at the national level.

The six transition leaps are a renewable energy landscape, healthy agriculture, caring living environment, space for biodiversity and water, a new mobility system and a (re)productive city. Designing these six leaps will explore the definition of a new socio-economic and political model.

There are numerous spatial exploration areas, initiatives and transformations that illustrate the fact that fundamental changes in our use and design of space must be combined with new laws and regulations, with alternative founding methods and with differently organized access to the control of knowledge, capital, raw materials, and production means.

This holistic system's perspective thinks beyond the current urban metabolism and circular economy trends. Like autotrophic organisms can produce their own food (using light, water, carbon dioxide, etc.), these three goals seek to explore solutions to transform the heterotrophic (consuming) city into an autotrophic (producing) one. Autotrophy is used here as a concept for cities to become primary producers for the survival of humankind, where all resources, processes, and structures are interlinked, interdependent and coevolving (creating long-term balance).

To accelerate the transition to a resilient and solidary living environment, the existing structures and pollutants in the territory are utilized and recycled. This is explored in three goals:

1. relocation, the new neighbourhood will relocate the inhabitant of Tamburi neighbourhood, this process will give people the ability to collaborate in the new district, and will propose different opportunities of living in a fragile territory;
2. territorial remediation, using Phytodepuration will provide a less intrusive method to reclaiming the polluted land. Phytodepuration in a large portion of territory is a valid opportunity both economically and feasibly;
3. economic alternative related to the territory in a new conscious landscape interaction.

The three goals are fundamentally related to building the main concept of the city and its territory as an autotrophic organism.

1. Relocation, Redesign with material flow

The area of Taranto was characterized by a strong agrarian structure, marked by the presence of a system of farms (*masseria*) and pastures strongly linked to natural features. It transformed into an industrial system with a high environmental burden, and the *masseria* were abandoned or became residual and embedded in a "red city factory".

The new suburbs, often marginal with low-performance levels, are the buffer between the city and the production areas. The countryside becomes the historical pasture in which a continuum of tourists visits the significant natural places such as wetlands, coastlines, and a network of channels.

The infinite fragmentation of the urban environment is seen as an opportunity to reorganize the territory in a sustainable way, where these portions may be considered self-sustainable entities disconnected from the grid.

The approach proposed is the "Redesign with material flow" (Hooimeijer et al., 2020). This approach uses material from the existing neighbourhood to create the new one. Drawing on literature, the framework of this approach was based on the RRR principle (Reduce-Reuse-Recycle) for Construction and Demolition Waste (CDW) that has been discussed by Bouanini (2013); Beijia et al. (2018) and Thirimoorthy (2019) among others. The RRR concept describes a dedicated waste management approach that aims at reducing primary resources in manufacturing, distribution and the consumption of products with maximum reuse, recycling and recovery" (Bouanini, 2013).

The proposed framework adapts to the composition of the three urban typologies, 1950s, 1970s, and 1990s, presented in the study Subsurface Equilibrium (2020). The novel idea was to explore the flow of construction materials through the urban system and analyse the spatial context in different layers of material use (Hooimeijer et al., 2020).

In the framework of sustainability, the new urban environment will recycle as much as possible in terms of energy and water, while the typology of block buildings with a courtyard will be used as an active element to recycle the water throughout the Phytodepuration concept.

2. Territorial remediation

The landscape of Taranto is morphologically characterized by a flat or slightly sloping landscape towards the sea. The agricultural function of the territory of Taranto is marked by a regular mesh network of canals and drainage systems. North of the Mar Piccolo is characterized by a vast plateau sloping slightly towards the inner basin, marked by rolling blades. The project area lies on the north side of the Mare piccolo on the east side of the steel plant.

Various categories of pollution have been distinguished in the area: heavily polluted soils, which will take a long time to clean, superficial polluted soils which will take less time, polluted water and clean water. According to the level of pollution, the distribution of public spaces, land use, and accessibility of the areas are defined, providing aesthetic sight in the landscape.

Three types of remediation turned out to be appropriate:

- Phytoextraction, the process in which plants remove pollutants from soil or water, in this case most usually heavy metals, metals that have a high density and may be toxic to organisms even at relatively low concentrations.
- Rhizofiltration, the form that involves filtering contaminated groundwater, surface water, and wastewater through a mass of roots to remove toxic substances or excess nutrients.
- Phytostabilization, that involves the reduction of the mobility of heavy metals in soil. Immobilization of metals can be accomplished by decreasing wind-blown dust, minimizing soil erosion, and reducing contaminant solubility or bioavailability to the food chain.

Certain plants, called hyper-accumulators, absorb unusually large amounts of metals in comparison to other plants. This long-term inaccessible area will be cultivated with particular plants, such as sunflowers, wheat, and corns useful for biomass

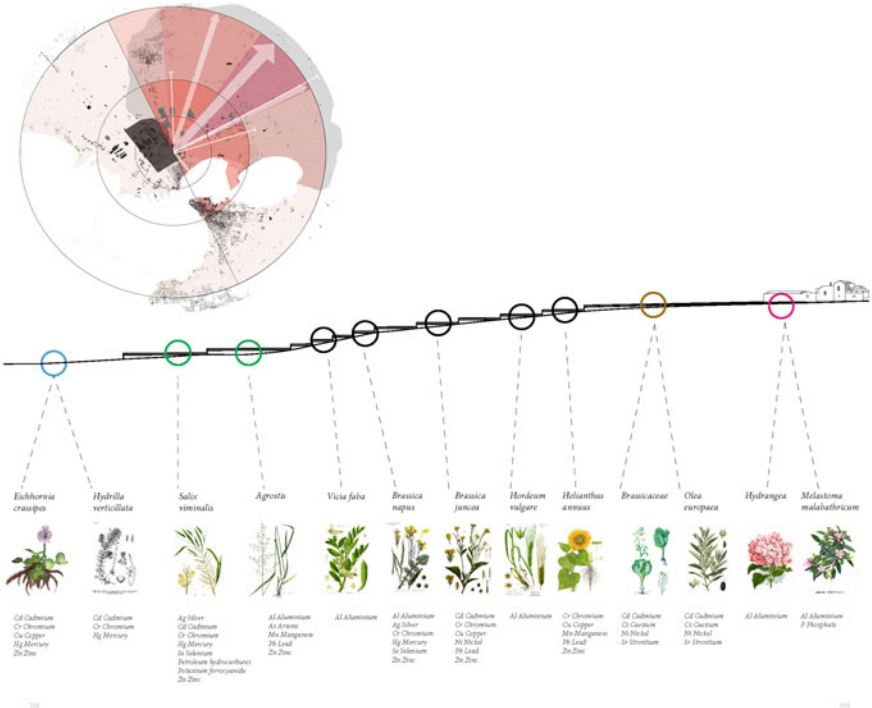

Fig. 17.3 Plan and section of the territory of Taranto with the polluted areas and the sequence of remediating plants

production as well, the process will contribute to the natural remediation as well as economic development (Fig. 17.3).

These three remediation types are brought together in the constructed wetlands in the area of Mare Piccolo. Constructed wetlands are natural systems in which the wastewater flows through a planted soil filter where the biological and physical treatment takes place. They combine most of the benefits of natural systems mentioned above: little use of energy, attractive landscape, wildlife habitat creation, low sludge generation, low cost, and recreational and educational uses (Pötz & Bleuzé, 2016).

The constructed wetlands are positioned in a void between the highway and the urban area which is enough space to be able to make it an efficient system. Another important issue is the acceptance by the community, due to the common belief that wetlands are home for mosquitos and bad smells. If the risk is significant, it can however be prevented in subsurface flow wetlands, with an appropriate design (correct choice of filtering material and dimensions to avoid an above-ground water flow) which require more space but is possible in our study case. Besides, as mentioned above, a benefit of constructed wetlands is that they can be incorporated into urban amenities, in a park for example. In this configuration, serious attention should be given to avoid direct contact between humans and the wastewater loaded with pathogens.

This follows the idea of constructing multifunctional urban landscape infrastructure which involves nature-based performance or performative assets, which becomes infrastructure in the sense that they contribute (generate and support) urban economies and urban life.

All around the Mare Piccolo a buffer area will be designed to purify water arriving from the canal and rivers. The water will be cleaned to restart the production of oysters and fish farming, implementing a traditional economy of the place.

In the proposal, the design process is seen as an opportunity to enforce the democratic landscape by involving the community, politicians, and designers. The aim is to build up a sustainable community where inhabitants use their resources to maintain current needs while ensuring and protecting resources for future generations. For example, the self-sufficient production of energy, a natural cleaning process for waters, and a different form of economic production. It will be the example of how parks in the future can be, not simply contained by the city, but as an open dialogue between ecologies, economies, and human life, where people can experience and learn from nature around them, within a new cultural landscape.

3. Economic alternative

The concept "Vita Activa" by Arent (Jansson & Wagman, 2017) is about promoting the strength of a creative and constructive path that induces ethical behaviour. In the case of Taranto, this concept is used to reformulate the relation between man and territory. It is necessary to consider the project in its physicality and subjectivity, the different dynamisms, but always as a set of interconnected dynamic actions. (Malavasi, 2007).

The Economic Alternative supports an interdisciplinary perspective that involves the ethical, political, economic, educational, techno-scientific, sociological, and anthropological horizon. This is in line with Magnaghi (2010): "Talking about sustainability requires a holistic and interdisciplinary approach that brings together unconventional institutions and disciplines while retaining their distinct identities".

In fact, the Brundtland report (1987) highlights a fundamental ethical principle, i.e. the responsibility of today's generations, towards future generations, touching two essential aspects of eco-sustainability: the first is the maintenance of resources and the second concerns the maintenance of the environmental balance of our planet. The concept of sustainability recalls the dimension of the future, the enhancement of everyone's potential and increases the hope of the possibility of changing reality, by encouraging behaviours based on respect, on principles of competence and responsibility, considering that responsible and participatory behaviour can transform into business opportunities (Logotel, 2010).

The project proposes a strategy of acupuncture in which small scale interventions add up to a larger funding mechanism, gradually building up the park's mass into a flexible patchwork of planted clusters (*Masseria*) mostly separated by open linear not designed areas. This will be staged in three phases:

1. Soil division (*Masseria* landscaping)
2. Pathway reconstruction or implemented
3. Programming plantation and activities.

The outcome of the project is a matrix of clusters covering 90% of the site, which is supplemented by playing fields and gardens. The park is meant to be a collaborative machine that has the daunting task of cleaning up the polluted soil, creating new job opportunities and initiating a new function for the abandoned landscape. The purpose is that capital generated from the park's appreciated land value could be spent to manage the park's infrastructure and to support future development in an evolving cycle of implantation.

Beyond cleaning, the park will be a source of green energy, creating space for windmills and, above all, the plants, used to clean up the soil in a natural way, will be recycled as biomass that can create biofuel.

The Land-Park is therefore an extensive bulk with a plan for adaptable growth. In the beginning it assumes the landscape's suburban context to be a virtue. Because of its central activity the park over time, its development will become the second type of industry in the area. The Land-Park landscaped clusters are programmed for various leisure activities like crossing paths to be used by cyclists, joggers, and pedestrians.

By continuing its landscape clusters and extensive pedestrian pathways into adjacent areas, the Land-Park can link up with the Creeks and Ravines, integrating the cleaning fields into a system of bushy river valleys, parks, and public paths so unique to the landscape of Puglia. The abandoned *masseria* will be recuperated for the new culture of the land farm. The *masseria* is the node of this system and the system of property that was born during feudal times should be elaborated and reused. The *masseria* is a fortified farm that is widespread in southern Italy and particularly in Puglia. The farm, years ago, was the expression of an organization linked to the geo-economic latifundia, the large estates that fuelled the revenues of the aristocratic classes and the bourgeoisie. The *masseria* were large and inhabited by the landowners, but the vast rural construction also included the homes of peasants, in some areas, even seasonal, stables, stores, forage, and crops.

The abandoned landscape will be reactivated by a plantation that can extract the polluted agents from the terrain, a classic reclamation of the land will be impossible in such a contaminated territory. Phyto-reclamation will be less incisive but will have the same results at the end of the cycle, and after 30/40 years the land could be renaturalized and transformed for a different use, agricultural or cultural. The biomass produced from collecting the plants could be utilized for the production of biofuel to create a new economy for the city and the people. A slow change of function in the factory would create mass unemployment, while this new land-production will create jobs.

This connects to the concept of the democratic landscape and shapes the proposed master plan. This regulates that the polluted area (20 km ray around the factory) will be approached as described above. Because this system is not only a cleaning system but also an economic proposal, it would be applied to the rest of the province of Taranto, in the land that is abandoned or uncultivated. The municipality will provide the tools in the form of local laws, and people in form of private, families, associations, or company, should own a portion of land. They could buy, or rent the property, or borrow the land only.

17.4 Conclusions

The profound environmental crisis is increasingly affecting our planet: climate change, global warming, reduction of water resources, pollution of water and the atmosphere, and a loss of biodiversity, are increasingly worrying us about the live-ability of the planet. At the same time, this indicates the unsustainable exploitation of natural resources while we reach the ecological limits of the planet. The statistics on the state of the planet and the indicators that record the state of health of our common home question the common conscience in acting in an educational and ethical way and that must lead to reflect on the nature and values of human development.

To understand the ecological question of Taranto, it is necessary to read it as a problem of public ethics, which means to believe that the essential aspects of it are played in the analysis of the visions of human life: the democratic landscape.

The complex environmental situation that characterizes Taranto's area and the reflections on the health conditions of the local communities require a reflection on the economic model that is intended to be adopted. The dramatic economic crisis that grips the present day can, however, be an opportunity to change the economic paradigm focused on labour saving and the distribution of scarce resources to bring the environment to the centre of attention. Common actions among public and private subjects, are essential in the development of a new path for the city of Taranto, as much as thinking of the relation between city and landscape as a unique system, can formulate a new economy based on the autotrophic concept.

The concept is explored in the project by stressing the necessity to begin with circularity at a different scale, as a new approach for future development. This is applied in all the different elements of the project; landscape and new development are integrated into a unique element collaborating for creating a new economy for the city of Taranto based on a democratic autotrophic landscape.

The methodology to reach this landscape is a concatenate approach in which "linking open-loop system", reading of the territory, and design are fundamental for spatial guidelines. Circularity can be about recycling or reuse, about cutting costs or time and output of CO2 through reducing material inflow and transport of materials. The need to rethink and redesign the flow of resources such as building materials, water, food, and energy is essential to the future sustainability of cities. It implies thinking about how to use existing resources rather than disposing of them in the linear model. It means also establishing new economic models to make a sustainable city, flows of intelligent growth, and creating an identity for a community sense of belonging. These together create a democratic, autotrophic landscape that sustains a future.

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Chapter 18
Hybridizing Artifice and Nature: Designing New Soils Through the Eco-Systemic Approach

Marina Rigillo

18.1 A Paradigm Shift

The increasing consciousness of being coping with complex and global challenges moves research interests towards more integrated approaches, explicitly posing the need of implementing the traditional top-down research methods (as for "hard sciences") with horizontal patterns, more collaborative and goal-oriented (Di Biase, 2016; Lazlo, 1985). This change has its theoretical roots in 1980s debate on both complexity and system theory, and it takes now more vigour from the current global trials (i.e.: climate change, resource consumption, and social challenges) (Bocchi & Cerruti, 1985; Lazlo, 2008; Latour, 2018).[1] The interest for such a new research pattern has been further feeding by the spread of the digital culture, which provides the common operational framework for converging a number of different disciplines. It focuses indeed on the heuristic method, and it is featured by a tactical approach based on trial-and-error mode and on self-education (Carpo, 2017; Di Biase, 2016; Rabinovitz & Geil, 2004).

These remarks highlight the need for a new cognitive ground for science, especially focusing on the evolving relationship between the digital culture and the anthropogenic environment (Losasso, 2020). In order to do this, studies in the fields of the natural sciences, humanities and landscape design posited the concept of "Ecological Thinking" as the conceptual ground for the Anthropocene: "the most important epistemological framework of our age" (Hight, 2014), and more in general a key concept for operating within the complex systems (Reed & Lister, 2014). Ecological Thinking is a kind of thinking that "seeks to eliminate the traditional dichotomy separating

[1] Ervin Lazlo, especially, foresaw the innovative figure of the "scientific generalist". The latter is committed to compose the advances produced by the "specialist scientists" within new creative frameworks. This is also the premises for implementing the so-called, meta-science (Lazlo, 1985).

M. Rigillo (✉)
University of Naples, Napoli, Italy
e-mail: marina.rigillo@unina.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_18

humanity (as subject) and nature (as object), as a route to understanding diverse, complex, multiply interconnected milieu" (Code, 2006, p. 27). Ecological Thinking is something more than a new theoretical concept. It represents the cognitive tool to govern the relationships within and among systems; it aims at appreciating differences and similarities, and it allows us to understand circularity more than causality (Bateson, 1979).

Looking that way, it is possible to state that ecological thinking is the paradigm shift of the contemporary scientific research, and specifically for the design theory (Code, 2006; Grierson, 2009). In fact, the design discipline is by definition a multidisciplinary domain, in which art and technology establish an open grammar of unexpected combinations by which realizing the "Darwinian evolutionary view of innovation" (Naam, 2013, p. 8). More in general, design brings together ideas not belonging to a single field of research, and it digs out innovative solutions (somehow embedded) thanks to both heuristic and collaborative processes (Carpo, 2017; Manzini, 2015). As steadily founded in the domain of techniques and creativity, design emerges as an effective tactic for shaping sustainable scenarios. It is far engaged in both social and ecological innovation, and it claims for a pioneering role as the creative agent of the contemporary challenges, so modifying the relationships between the "existing assets (from social capital to historical heritage, from traditional craftsmanship to accessible advanced technology) with the aim of achieving socially recognized goals in a new way" (Manzini, 2015, p. 11).

Within the field of the design disciplines, landscape architecture first guessed the importance of such cultural shifts. The 1999 competition for the Downsview Park in Toronto, Canada, represents the turning point in applying the system theory to design process. Here the assumption of systemic approach led the five finalists to implement the concepts of unpredictability and uncertainty as a key part of the project outcomes. The inherent complexity of the site led the design teams out to abdicate to provide fully defined project layouts, preferring instead to let developing the relations between nature and technology on its own. This tactic also implemented the ecological activation of new, and site-specific dynamics between the place and its inhabitants, including animals and vegetation.

The Downsview Park competition is a sort of "manifesto" for the landscape architecture design, as it defines the key points of current theoretical debate: the fascination for the emergent ecologies (as progressive, independent evolution of the design setting); the acceptance of "unpredictability", as part of the environmental potential (as it continuously shapes the site along times); the new opportunities in the relation between Nature and Technology, notably those inferring the digital domain (Cantrell & Holzman, 2016; Czerniak, 2001). The capacity of managing huge amounts of open data, as well as the opportunity of implementing on-field information (thanks to a range of digital devises able at sensing, visualizing and processing information) gave new emphasis to the scientific approach of design project making the latter as "a point of tangency between the production of scientific models (through testing and falsification) and the symmetrical activity of design (through model making and matching)" (Waldheim, 2006, p. 8). Their creative design enhances responsiveness as a key requirement for the built environment, as well as the digital sensors embedded into construction materials allow to measure and control the effective benefits of the technological innovation on the anthropogenic habitats (Brownell, 2010). Therefore, such new opportunities enhance the terms “responsiveness” and “collaborative”, either referred to the capacity of updating the design patterns, using digital devises as facilitators of the interactions between Humans and the other living and the non-living forms (Antonelli, 2019; Coccia, 2018; Corner, 1997).

According to these remarks, the paradigm shift is not only due for the amount of the information available, but rather for the provision of different operational patterns: the contemporary habitats have been rapidly evolved into techno-social environments, whose configurations do not only depend by the availability of data set, rather by the ability to develop “tailor-made” patterns that meets global and local needs.

Further, the combination of ecological thinking and digital technologies establishes the new epistemological grounds for design, and defines the operational framework by which overcomes the typical separation between artificial and natural. Notably, the capacity of producing creative hybridization between biotic and abiotic component seems to be the new frontier in the field of technological design and material engineering. The term *hypernatural,* proposed by Blaine Brownell and Marc Swackhamer in 2015, introduces the idea of a co-evolutionary process between nature and science, looking at humans’ technological capacity as a real opportunity for making biotic ad abiotic systems working together: “The ultimate aim of technology is not antinatural: it is hypernatural. It involves working directly with natural forces and processes—rather than against them—in order to amplify, extend, or exceed natural capacities” Brownell & Swackhamer, 2015, p. 18). Further, the main progresses in transferring hybridization into the construction sector require to fully include new material categories (Transmaterial, as for Blaine Brownell terminology)[2] emerging from the creative combining of recycled materials, digital tools and biological matter.

Looking that way, the work of the Mediated Matter research group at the MIT, Boston, Massachusetts provides an outstanding example for this new approach. As for the term “Hypernatural”, the notion of “Material Ecology” evokes the understanding of technology as a part of the co-evolutionary process between culture, science and nature. The focus goes to both design and material engineering, and it enhances the concept of “material ecology” as key point for defining unprecedented products coming from collaborative expertise (notably biology, computing, and materials engineering). The “Living Material Library “, produced within the MIT Lab, explores the field of digital morphogenesis, and gives an unprecedented emphasis to “the ability of living organisms to sense and respond to their environments” (https://www.media.mit.edu/projects/living-materials-library/overview/).

More advances in material engineering and design come from the research on organic concrete. The latter has even more understood as an effective opportunity for reducing anthropogenic impacts, notably those related to climate change. The production of multi-layered cement able at interrelating the internal biological

[2] See more at http://transmaterial.net/.

microstructure with the abiotic ones improves the surface's performances, and the capacity of the concrete elements to absorb the atmospheric CO2.[3] Similarly, the Israeli firm ECOncrete has patented, and widely tested, an environmental sensitive concrete especially designed for marine habitats. Such innovative material has been designed as a high quality and cost-effective concrete product. It is featured for being a typical precast or cast-on-site concrete product, engineered for quickly adapt to the marine habitats, both for the properties of the aggregate specific (a mix of biotic and abiotic components), both for the ecologically-based morphology of the different products.[4]

18.2 Recycling Construction Debris for Producing New Anthropogenic Soils

Such a new idea of materiality also increases the opportunities for implementing hybrid natures within the urban environments. The need of regenerating neglected areas (such as brownfields and/or former landfills), together with the growing importance of permeable and evapotranspiring soils in the cities (due to the need of providing ecosystem services) gives more interest to processes and techniques aimed at designing anthropogenic soils. In fact, the demand for implementing the stock of evapotranspiring soils in the cities is widely recognized in literature as the starting point for improving climate adaptation and city's resilience (Nelson et al., 2007; MEA, 2005; Niemela, 2011). Further, the urban redevelopment is often associated with relevant operations of environmental upgrade (including soil regeneration), which boasts a comprehensive socio-economic change in the cities land-use, enhancing lifestyles standards and the real estate values especially in the less performative urban areas (Costanza et al., 2014; Potshin & Haines-Young, 2010; Rigillo et al., 2016; TEEB, 2011).

Urban soils are by definition: "a soil material with a non-agricultural man-made surface layer more than 50 cm thick, that has been produced by mixing, filling, or by contamination of land in urban and sub-urban areas" (Bockheim, 1974, cited in Craul 1992, p. 86). The scientific acceptance of the urban soil as an engineered product even supports the introduction of the "technosols" typology within the World Reference Base (WRB) for Soil Resources in 2006. These soils are defined by the IUSS Working Group WRB, as "Soils modified by human activities (other than farming) and by human additions (artifacts), in the artificial environments associated with urbanization (roads and parking lots for example) and industrialization" (Chesworth

[3] See the Bio-receptive concrete panels developed by the Structural Technology Group at the Universitat Politècnica de Catalunya (UPC). This product is made by two types of cement: standard Portland cement and magnesium phosphate cement, which is slightly more acidic and thus conducive to biological growth. This technology allows the growth of small mosses, fungi, lichens, and microalgae http://transmaterial.net/biological-concrete/.

[4] See more at https://econcretetech.com/about-econcrete/#.

& Spaargaren, 2008), and they are listed “by design, […] as either Ekranic (sealed), Linic (lined), Urbic (rubbly), Spolic (industrial wastes), or Garbic (organic waste)” (Rossiter, 2007). Similarly, the Anthropocene Working Group in 2019 (AWG) highlights an unprecedented hard soils typology described as “technofossils". The term is a scientific neologism aimed at explicating the existence of such new kind of hard materials, which will be recognized by future archaeologists as one of the main tracks of the current civilization. As stated in the AWG Report, “they will persist for millennia or longer, and are altering the trajectory of the Earth System, some with permanent effect. They are being reflected in a distinctive body of geological strata now accumulating, with potential to be preserved into the far future” (AWG, 2019; Zalasiewicz et al., 2014).

An extended definition of urban soils come from the introduction of the term “anthropogenic soil”. The latter is aimed at posing the concept within the broader context of the human-altered soils either if not in the strictly urban context (notably peri-urban). Further, more recent definitions of urban soils (Morel et al., 2017) enlarge this typology to a wider range of soils including those relatively undisturbed or not yet altered by human activities or pollutants, if located in the urban areas (Pouyat et al., 2020).

The relevance for the evolving conceptualization of urban soils is due to the increasing awareness of the benefits provided by such “brown infrastructure” in the city environments. Even in the case of human-altered soils, the latter plays a key role in reducing climate impacts as well as in improving safe and healthy spaces. As far anticipated by the studies in the field of urban ecology, what is important now is the capacity of re-thinking the whole urban components (biotic and abiotic) within the common understanding of the cities as part of the Anthropogenic Biomes. Urban soils are then going to become a sort of eco-engineered resource, designed for providing a wide range of services, including the ecological ones, for sustaining the cities environment (Pauleit & Breuste, 2011). According to these remarks, design operations must be addressed at providing an innovative framework for the human–environment interrelations, also developing new ecologically oriented products which efficiency will be mainly related to the number and typology of the benefits provided.

Within the many, existing design typologies of anthropogenic soils in cities (i.e.: green roofs, de-sealed soils, soil-remediation, etc.), special attention goes to the production of new human-made soils. Here, the design approach properly refers to the hybridization models, due to both the converging of expertise and tools, and of the choice of the material.

In general terms, the technological soil design starts from the soil’s layers (properly horizons, or *pedon* as for the scientific glossary), according to the typical physical, environmental, and chemical characteristics of the site. Horizons are strategically designed to ensure the mixture of mineral components, biological components, and organic matter (Craul, 1999). Each soil layer must be consistent with the soil ecological functions, and its design implies compliance with the soil consistency, the soil structure, and the input of organic components for plant-available nutrient storage. These requirements correspond to a wider set of indicators aimed at complying with both technological and biological efficiency. Basic indicators are those related to the efficient growth for vegetation and trees such as the soil consistency, the permeability index, the PH characterization. More indicators concern the horizons texture and the organic matter content, according to the aim of improving buffering and filter functions of the soil, as well as the run-off management. Specific technological indicators, however, regard the slope stability, the soil resistance, and the interaction with the urban infrastructures and with land-uses.

Further specifications refer to the specific soil design product, that it is to "topsoils", or alternatively to "totally designed soils". The latter especially infers the entire soil profile, designing the several soil horizons according to their specific, proper sequence and functional continuity (Craul, 1999). As part of the category of the designed soils, the "sustainable soils" are those "comprised entirely by of recyclable products alone or in a mixture with derelict soil material [...] It contains little, if any, non-renewable resources" (Craul, 1999, p. 107). Sustainable soils therefore referred to the soil material characteristics, with special attention to the productive cycles of resources and flows, and even to local-based supply chains.[5] Restrictive constraints for this kind of soil come from regulatory requirements, due to compliance to safety and health standards, especially when the chemical and physical composition of the waste materials is unknown, or when it has high variability.

Despite that sustainable soils have been empirically built along history,[6] the need of controlling the whole life cycle of the designed soil process steers the operational approach towards an integrated real-time information (from design to site operations, and later the monitoring of its in-situ performances). In fact, the design process has been strongly implemented by digital technologies, as for the augmented capacity of sensing and processing data, as for the capacity of modelling and simulating the project results. Such new opportunities in managing on-field data effectively support the scientific approach to soil design.

According to these remarks, both lab tests and on-field tests have become part of the design process. They must be planned with the aim of matching soil specifications with the site constraints, including those depending on the vegetation palette, and other tests related to soil stabilization, run-off control and sediment control. As part of such protocological pattern, the soil design process defines a complex feedback loop between nature, technologies, and objects, creating conditions for enhancing site specificity as well as for engaging new relations between the site and its users.

According to the comprehensive goals of the soil design, further aims concern the reduction of the natural resource exploitation together with a general waste decrease (thanks to the recycle and reuse of C&D and organic waste). This seems to be a win–win strategy for providing both ecological efficient urban surfaces and reducing waste

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[5] Some example of materials available for sustainable soils are listed by Craul as: "Sand from river dredging or sand pits or recycled ground glass; Composed Organic material derived from biosolids, selected municipal yard wastes, food processing sludge, and so on; derelict soil material not otherwise useful such as selected mine tailings, basal glacial till, and so on; Dehydrated washing from aggregate plants, certain smoke-stack, fly ashes, and so on" (Craul, 1999, p. 107).

[6] War World II bombing debris management typically used C&D waste as hard soils, shaping artificial hills (rubble mountains) in the German cities (see https://en.wikipedia.org/wiki/Schuttberg).

production. This strategy is in line with the EU 2011 Roadmap to a Resource Efficient Europe that boosts for producing more value with less input, and for managing material resources more efficiently throughout their life cycle (EU, 2011 quoting in EEA report, 2016, p. 8). In order to do this, the design of anthropogenic soils can be intended as a new circular product for divesting the typical "take-make-dispose" approach (EEA, 2016, 2017), facilitating the "transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised" (EEA, 2016, p. 25).

18.3 Collaborative Processes for Designing Anthropogenic Soils

As introducing the report about the effectiveness of the circular policies within Europe, the 2016 EEA document states "the factors and concerns reported by countries as driving their work on material resource efficiency policies roughly fall into three groups: economic interests, environmental concerns and regulatory requirements" (EEA, 2016, p. 10). Especially for the anthropogenic soils, the constraints and prejudices about environmental risks (mostly referred to the typical NIMBY syndrome) reduce the opportunities of using construction debris for producing technological soils.

In order to overcomes these problems, the Italian team of REPAiR research has worked for connecting the operational soil design with a local-based network aimed at involving the main subjects of the waste supply chains. Either public and private sectors have been engaged as a prime expert group with the aim of deepening benefits and criticalities in replacing C&D waste as part of new anthropogenic soils. The design strategy aims at outlining an effective operational protocol for creating a stable connection between the landscape project and the whole demolition process. It works on the concept of eco-innovation as in the EU definition: "Eco-innovation refers to all forms of innovation—technological and non-technological—that create business opportunities and benefit for the environment by preventing or reducing their impact, or by optimizing the use of resources" (EC, 2012).

Therefore, circularity refers to multi-scaling design approaches and to innovative models of designing products, processes, and projects. Notably, the research considers sustainable soils as a further product of circular-based supply chains, and it finalizes the design process to both implement the technological requirements and overcome criticalities embedded in social and regulatory contexts.

The focus has specially given to the C&D waste and to organic waste as effective anthropogenic resources to implement an inclusive and circular waste metabolism due to either the waste typologies are indeed in the priority list of the EU Action Plan for the Circular Economy (COM (2015) 614 final) because of the value of their supply chains.

Fig. 18.1 Logical pattern for designing the overlapping networks

The research designs a collaborative process for producing anthropogenic soils thanks to the implementation of a locally based waste supply chain. As part of the wider design approach, the project develops a proper method for involving peers and stakeholders, designing a collaborative network for advancing in the co-design experiences. In operational terms, a number of Peri-Urban Living Labs (PULLs) were realized since the beginning of the project in 2016 (REPAiR, 2018). The latter aims at facilitating the knowledge transfer, according to the Lab participants specific.[7] The pattern adopted has named "overlapping networks", and it has designed as distinctive framework where both expert and not-expert subjects could merge different competences and wills (Fig. 18.1).

The purpose of these networks is to collaborate for shortening the supply chains of both C&D waste and organic waste. Such a method enhances co-designing as the operational driver of new "protocological" architecture (Burke, 2007), aimed at validating both products (techno-soils) and process (waste supply chain) within a sort of

[7] The PULL participants are technical members of the Regional Authority, professionals in the field of waste management, small local companies working in the urban waste management, academics from selected Italian Universities.

"evidence-based" design approach (Burke, 2007).[8] The term refers to the objectification of methodological steps, and it is strongly based on the information/decision relationship, as well as to the logical sequence of the design process. Further, the term highlights the importance of standardizing the collaborative decision model within the landscape design, enhancing the relevance of a scientific approach in co-design by which validate (or falsify) the project's results.

In operational terms, the networks have been organized thematically with the aim of stressing the diverse competences of the groups involved. Researchers acted as agents of communication streamlining the design process thanks to the digital tools support (i.e.: GIS, GDSE, scenarios modelling), so that participants can feel fully engaged for providing and validating effective solutions.

The problem setting has been structured in three phases:

(a) Collaborative Mapping.
(b) Depicting potential scenario.
(c) Programming and design.

The first step has been featured as a collaborative exercise for the site description. REPAiR Labs co-created a GIS tool by which implementing both analytical and qualitative information about the case study area, so that a set of thematic maps was carried out for describing the environmental and physical aspects, together with those related the site perceptions. Such an approach aimed at implementing a more comprehensive understanding of the peri-urban area, and it improves the site description with thematic maps, even those produced thanks to no analytical information. Further, more information has been produced within the REPAiR Labs for recognizing abandoned and neglected areas in the Sample Area (Russo et al., 2019). As part of the Lab's works, the REPAiR researchers implemented a dedicated GDSE system with the official dataset on waste flows.

The main goal of this phase is to streamline the main criticalities affecting waste flows management locally, and in operational terms, the expected results concerned a site sensible mapping.

The second phase is aimed at producing effective proposals for shortening the waste supply chains of C&D waste and organic waste. Starting with the digital waste flows analysis (C&D Waste and Organic waste) and by the thematic maps produced, the research groups developed three potential waste supply chains redesign scenarios. The latter were all consistent with the local regulatory systems, as well as with the amount of waste production in the study area, and on the territorial organization. The alternatives were mainly based on both the dimension of the organic waste treatment plants and the opportunities in promoting selected demolition in the regional context.

The result of the Labs discussion is a Master Plan for waste reduction.

[8] In deepening the concept of "protocological architecture", Anthony Burke wrote: "Protocol is what makes network and Empire functions; they are formal constructs that provide the vitality of network logics, yet they also identify a territory of control points, super-controlled hubs of potential leverage within a design context where information is exchanged and regulated" (Burke, 2007, p. 71).

According to the latter, the third phase is targeted on deepening innovative strategies for waste management (Rigillo et al., 2020). The research defines an Eco-Innovative Strategy (EIS) as "an alternative course of action aimed at addressing both the objectives and challenges identified within a PULL and develop a more Circular economies in peri-urban areas" (REPAiR, 2018). Basically, the researches provided three EIS named as follows:

- RECALL | REmediation by Cultivating Areas in Living Landscapes through Phytotechnologies, that works on soil remediation. Digital sensing and phytotechnologies were designed using typical local crops (Kennenk & Kirkwood, 2015).
- Re-Compost Land. EIS merges the recycling of organic waste (OW) and of C&D waste (CDW) within designed topsoils. A short supply chain is also designed by the hypothesis of a network of medium-sized treatment plants, linked to precise peri-urban locations between urban and rural contexts.
- Beyond INERTia. The strategy defines a new protocol of actions for construction debris. It starts with the implementation of the market-and-supply condition locally, and establishes a network of debris delivery points in the case study area. A special protocol for C&D waste characterization and recycling allows to realize new construction products and even totally designed soils (Fig. 18.2).

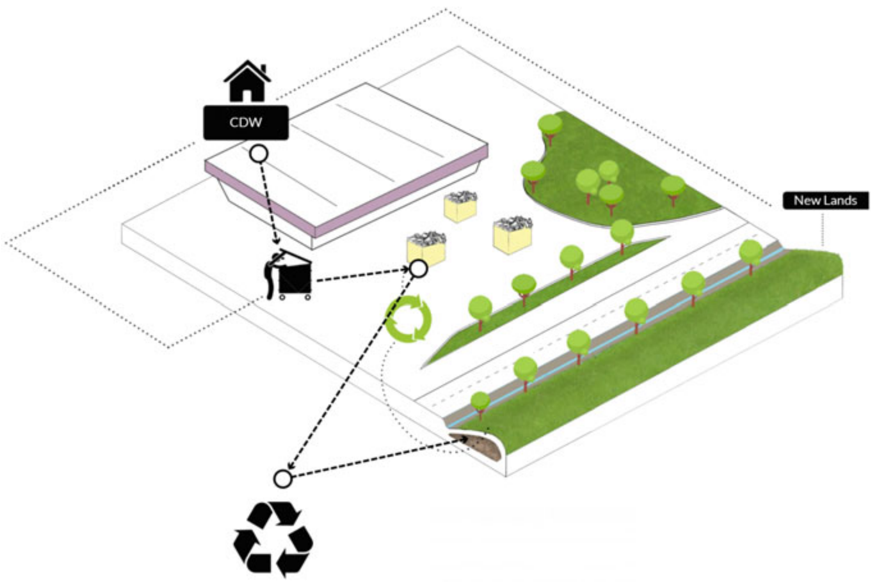

Fig. 18.2 New land production by C&D Waste recycling

18.4 Conclusion

In the light of these remarks, it is possible to conclude that "the driving element of product and process innovation is often a change in terms of meanings, values, identity: the production process and the social organization play a key role in shaping or re-shaping the architectural product and its language" (Faroldi, 2003, p. 17). The construction process becomes even more complex and systemic. It does not deal with single environmental issue, rather involves integrated changes and decision processes, so that economy, social habit and technological responses are linked together. By this perspective, the technological capacity becomes more dynamic and fluid according to the social requests of eco-innovation, especially focusing on hybridization, which is the cognitive medium for providing research advances both in the fields of design and material engineering.

Looking that way, the insertion of construction debris within the abacus of the anthropogenic resources revises the existing waste supply chains, as well as the design approach. It puts the demolition/ recycling/ reuse cycle into the construction process again, so enhancing a range of different technological solutions, including the unexpensive ones.

Therefore, sustainable soils could be an effective response for achieving the double objective of reducing waste production and claiming for an anthropogenic nature, able at "repairing" damages and impacts in the urban and peri-urban areas (Antonelli, 2019). Notably, sustainable soils can be used as a human-driven support for implementing such artificial nature with the aim of providing ecosystem services, as well as new public spaces for the inhabitants (Rigillo et al., 2020). According to the physical and chemical characteristics of the debris components, as well as the regulatory constraints, sustainable soils can be designed as tailor-made products for the urban environment, in order to facilitate the spreading of specific environmental performances such as planting trees, micro-climate regulation, run-off control, soil buffer capacity: "The hybrid nature of urban ecosystems – resulting from co-evolving human and natural systems – is a source of 'innovation' in eco-evolutionary processes" (Alberti, 2015).

The REPAiR project is an opportunity to prove the extent of this paradigm shifts in design and planning. Ecological thinking and collaborative approach have been here adopted as agents of creativity in a complex design framework (Attaianese & Rigillo, 2021). The results are mostly consistent with the theoretical premises: they carried out innovative design solutions, and orient the collaborative process towards new landscape architecture, widely confirming the relevance of collaborative networks of experts and stakeholders. Further, the research highlights new opportunities for hybridizing biotic and abiotic elements for designing the new technological soils, stressing the C&D waste and organic waste as potential elements of such artificial nature.

This cognitive upgrade opens up to a new set of human-made resources and construction products including soils. The latter deeply merges the concept of the "urban mining" as "a frame of actions for the systematic management of the anthropogenic resources (products and buildings) and waste, featured by a long-term goal for the environmental protection, stressing both the protection of renewable resources and the economic benefits coming from" (Cossu et al., 2012, p. 13) [Author translation].

In operational terms, the study especially deepens the opportunities of testing three typologies of anthropogenic soils, ranging from topsoils to totally designed soils and sustainable soils. The latter are mainly oriented to build a sort of "green-grey infrastructure" along the existing motorways, which became a sort of prime circuit of the C&D waste recycling (hosting areas for the C&D waste collection, and for the first treatment of post-construction waste). As part of the REPAiR project results, the anthropogenic soils fully correspond to the EU definition of eco-innovation by the extent of being consistent with the requests of merging together new products and new social-economic processes.

In form of conclusion, the last remarks concern the main perspectives of the research. The results can be immediately oriented towards the analytical (and more effective) implementation of the soil design proposals though out on-field tests. Similarly, a locally based supply chain can be specialized for devising more construction products coming from the C&D waste recycle, according to the regional regulatory system and to the specific requests of experts and stakeholders. Further, a demonstration project could be carried out within the wider case study area.

A final comment is about the methodological relevance of the REPAiR project. In fact, it defines a more creative role for the design discipline, even more engaged in shaping effective solution for producing sustainable urban environments.

Such an approach fully interprets the challenges of being living the Anthropocene, due to it claims a key role for innovation as the prime conceptual tool for adapting human needs to the Planet care. The research experience enhances: the collaboration between scientists and experts; the co-creation as opportunities for assuming differences and criticalities as a kind of super-understanding of the site and of the project's requirements; and finally the hybridization between biotic and abiotic components as the current frontier of sustainable design. More important, the method adopted for the case study project gives evidence to the common responsibilities in creating effective conditions for a better word, taking advantage of the unprecedented capacity of human technologies in a way that merges people, ecology, ethics and beauty.

According to these points, it is possible to conclude with Paola Antonelli words: "Good contemporary design is also about the ability to connect, identify with and projecting, the awareness that every object and every subject is a node of a complex network of complex systems" (Antonelli, 2019, p. 37, Author Translation). This has been the REPAiR pioneering effort, and we hope it will be successful.

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Chapter 19
Towards Regenerative Wasted Landscapes: Index of Attractiveness to Evaluate the Wasted Landscapes of Road Infrastructure

Maria Somma

19.1 Introduction

Over time, the planning process of cities has undergone enormous changes and ecological excesses. Cities have become involved, dynamic (Batty, 2008; Holling, 1973) and, at the same time, adaptive systems (Elmqvist & Bai, 2018; Elmqvist et al., 2018). They are non-linear systems capable of self-organisation, modified continuously by disruptive factors and processes within the system or exogenous factors, capable of triggering changes in urban systems, altering or modifying their state. Their development is closely linked to and influenced by cause–effect relations between the various social, political, economic and environmental components (Bottero et al., 2019).

The city's definition as a complex system capable of organising itself presupposes that it can be compared to an entire living organism with its urban metabolism (UM). The main studies concerning the relationship between the city's urban system and the external environment were first approached through socio-economic metabolism (González & Toledo, 2016) and then through urban metabolism. For decades, the latter has been the subject of many interdisciplinary studies by ecology, geography, landscape science and town planning (Fischer-Kowalski, 1998).

Anthropisation and the influences on the ecosystem—city have generated numerous impacts over time, leading to a change in its metabolism and the fragmentation of the territory, also implemented by planning that is not functional to the community's needs. All these interventions on the territory have generated abandonment and degradation areas, defined as drosscapes (Berger, 2007) and then wasted landscapes and wastescapes (Amenta, 2015; Amenta & van Timmeren, 2018; Geldermans et al., 2017; Russo et al., 2017).

M. Somma (✉)
Department of Architecture, University of Naples Federico II, Naples, Italy
e-mail: maria.somma@unina.it

L. Amenta et al. (eds.), *Regenerative Territories*, GeoJournal Library 128,
https://doi.org/10.1007/978-3-030-78536-9_19

Abandoned areas also compromise the proper functioning of ecosystem services, which are fundamental for the sustenance and health of living beings and the city's metabolic process. Their characteristics lie in the condition of disconnection between these spaces and the entire topological context. On the one hand, they are excluded from the city's active life or marginalised concerning the fulfilment of its metabolic cycles; on the other hand, they are necessary for the urban system's functioning but are purely serviceable, without territorial value, inaccessible and repulsive.

The basic principle of disposable is also applied to these places rejected by the city, impacting the natural and urban environment and causing a break in the various systems' ecological structure. This is understandable, especially regarding the process of deindustrialisation that has led to the urban expansion of cities towards the peripheral areas, resulting in a territory full of spaces that are no longer in keeping with current living requirements. Large areas of abandonment cause substantial impacts and risks on the territories, fragmenting the local societies' living contexts and those settled there (Russo, 2018).

So much so that, conceptually, the same principles of recovery and reuse applied to individual objects or architectural artefacts could be used.

Instead, the problem lies in implementing viable and advantageous solutions without endangering the environment's lives and its inhabitants. It continues to produce and feed the linear production chain—consumption—waste. There are two ways to find problems and the awareness of the solutions proposed' ineffectiveness, do not seek new solutions, more advantageous and sustainable. Still, it focuses on functionality without seeing the surrounding urban and landscape fabric. Although Europe continues to show the need for planning policies that tend towards zero land consumption, on the other hand, the soil is still being designed and waterproofed, and even more so, a territory that is not infinite is being tarred.

Technological innovation contributed even more to horizontal development and the production of places that had to be isolated from the urbanised context for purely functional reasons.

Consumerism's effects on the territory have generated vast neglect areas, incredibly close to the major arteries of road connection. These should not be considered separate entities, but as part of a network: a potential to define a strategy that preserves the territory and avoids further land consumption (Paolella et al., 2013).

As a living organism, the city has an intrinsic metabolism that works when every ecosystem network relates to the natural and built environment. The weakening and non-reproducibility of natural and environmental resources, caused by cities' uncontrolled growth, generate an imbalance between urbanised areas and the natural environment. Future transformations turn out to be unsustainable, because the territory is even more exposed to risks, not only environmental, which determine the impossibility of living in these places (Russo, 2018).

The critical interpretation of these wasted territories defines some aspects to be considered to define a sustainable, regenerative process. The loss of the environmental, natural and identity quality of the wasted landscapes of road infrastructures represents one of the challenges to intervene. These territories defined as a waste of the city must be treated as part of the landscape.

In particular, reference is made to abandoned areas, including roads interstices, abandoned subways or areas close to the same infrastructures that constitute the territory's negative aspect because they are considered urban waste (Ardita, 2009).

Contemporary planning must play a role in the regeneration of these degraded spaces. Roads create voids that generate consequent urban fragmentation, producing cumulative impacts to the detriment of the quality of life of those living there and the environment in general.

They are defined by Rem Koolhaas (2006) as "urban bubbles drawn by discontinuous and hidden boundaries". They are marked spaces recognisable in the dispersion of the contemporary city.

It is possible to focus on certain types of interstices that emerge mainly between significant roads, between ring junctions and to a lesser extent between neighbourhood streets. Each route is an insurmountable limit that creates a denial of living space. These large infrastructure networks appear to be increasingly detached from a shared, reasoned project capable of combining functional aspects with the area's identity. The monofunctional design of roads does not recognise a fundamental role. Still, it defines a negative taxonomy that inexorably determines voids and consequent urban waste. Urban voids can represent new scenarios for contemporary territories. Although they are considered the waste of uncontrolled expansion today, they can become the new porosity (Fini & Pezzoni, 2010) that triggers new mechanisms and transformations. They are strategic places for the city's sustainable development as they can be a fertile ground for experimentation in urban design. Abandoned areas are the driving force, together with roads, for urban regeneration that is attentive to sustainability principles and capable of producing quality with minimum impact on land consumption, reducing urban sprawl and activating new local economies.

In this study, wasted landscapes are explored through an evaluative key. The contribution gives importance to the general context in which the wasted areas are inserted, starting from the road system and connecting to the city context. In this sense, the evaluation of abandoned areas of the road infrastructure represents the integral key to trigger a regeneration process that is also attentive to local and environmental dynamics. By identifying areas of neglect close to infrastructures, specific indicators are analysed as decisive starting points for future planning and more specifically for the regeneration of waste landscapes.

19.2 The Wasted Land of Roads as a Resource

The road network is defined as a complex organism and articulated according to the landscape that crosses its seat involves a large territory. This road network is the structural and structuring element of the territory and the whole landscape (Guaralda, 2006). They can represent an opportunity when associated with wasted landscapes.

To implement regeneration operations for abandoned areas close to roads, it is necessary to define a series of government actions and good practices to counteract all the increasing urban development effects that have disfigured the territory and produced waste areas. It is necessary to identify these places' potential, which nowadays causes impacts for the landscape, society, and the environment because they are not connected to a utility (Russo et al., 2017).

Moreover, they cannot be considered urban waste yet, because they must be the gear that activates regeneration, the source of new opportunities. They are physical elements symbolising the rebirth of the contemporary city. Regenerating abandoned places in the roads' buffer zone generates new transversal relationships with the built and natural environment.

The various crossroads between infrastructure nodes become a privileged potential space for creating ecological corridors capable of regenerating ecosystem services that have been compromised over time. These can be new places of urban attractiveness or identity symbols of access to the city. It is essential to analyse these places to see if it is possible to define functional corridors between separate physical parts to create transversal interconnections that differ according to the context in which they are inserted. Such a process can re-evaluate the meaning of abandonment areas by thinking about innovative solutions linked to sustainability.

Each waste landscape of infrastructure (Berger, 2007) constitutes a key part of urban development to and generates new environmental value.

When building a new road, all the impacts it will have on the territory must be considered. Negative impacts are mainly linked to morphological and ecosystem fragmentation and define empty places without meaning. The positive impacts define new territorial connections, therefore new poles of attraction, and consequently an increase in tourism and economy.

The combination of urban regeneration and evaluation must be the engine that redesigns the urban and environmental system to sustainable development.

In this sense, it is necessary to structure an innovative process of regeneration by defining a methodology that can support the rethinking and the re-functionalisation of waste landscapes of infrastructure (Berger, 2007).

The challenge of sustainability must be fought in those territories that are already urbanised, in those places where economic development and urban growth must be reconciled with a necessary environmental and social balance, to move towards more sustainable city models (Coppola, 2016).

19.3 A Methodological Proposal for a Regenerative Process

The need to address current wasted landscape regeneration issues has led to a rethinking of traditional technocratic approaches. The approach to the sustainable development of a site can be described as dynamic (Cerreta & De Toro, 2002), as there can be no fixed solution (van Timmeren et al., 2012).

Each context presupposes different processes, which may change the construction and adaptive solutions to the different places they are inserted. Also, considering regeneration as one of the cogs that helps achieve urban sustainability goals means thinking about monetary investment (representative especially of regeneration processes) and social involvement and users.

From this perspective, evaluating the abandoned space and those who live in the territory is essential to help the political decision-maker in territorial planning choices related to functional aspects and the environment. The underlying complexity of urban regeneration processes is also due to the difficulty of collecting soft and hard data to track shared sustainable solutions. In this sense, the evaluation serves as a useful tool in regenerative processes. The assessment of preferred urban regeneration scenarios should be considered one of the decision-making process elements. In itself, the process of urban regeneration is one of the decision-making processes. It is essential to assess the area under consideration, define criticality and potential and then structure together with the different actors involved in which scenarios could be preferable. It is important to use indicators to define effective recovery and transformation scenarios to implement sustainable regeneration processes in an increasingly complex territory (Bottero et al., 2016; Cerreta & De Toro, 2002; Mondini, 2009; Spina et al., 2017).

The research methodology had started with the identification of the analysis context. The case study refers to Afragola, Casalnuovo di Napoli, Cardito and Casoria in Naples' metropolitan city. They are territories where the city's expansion process had defined new areas close to the road infrastructure that is now abandoned and lacking functionality. It had been defined for the first time in the Horizon 2020 REPAiR project.

Wasted landscapes close to road infrastructures refer to:

1. abandoned infrastructure buffer zones (WL1);
2. abandoned fields and agricultural plots (WL2);
3. public or disused equipment of public use or utility (WL3).

Two indicators of centrality had developed from these three types of wasted landscapes of infrastructure:

- Straightness centrality index (Barthélemy, 2011; Crucitti et al., 2006; Sevtsuk & Mekonnen, 2012; Vragović et al., 2005).
- Betweenness centrality index (Brandes, 2001; Freeman, 1977; Porta et al., 2006; Sevtsuk, 2010; Sevtsuk & Mekonnen, 2012);

Both had related to population density to estimate the number of the population served and how attractive and accessible those areas can be.

By identifying wastescapes as the focus of the analysis, it is possible to define two types of evaluation maps useful to understand if such spaces can represent an opportunity for the future development of territories.

By identifying wasted landscapes as the centroid of the analyses, two types of evaluation maps were defined, useful for understanding whether such spaces can represent an opportunity for the future development of territories. These metrics are similar to measures of spatial accessibility but have been applied to the network rather than on Euclidean space. The following paragraphs describe the study area, the central indices and the results.

19.3.1 Selection of Case Studies

The research had identified the municipalities of Aafragola, Cardito, Casalnuovo di Napoli and Casoria (east of Naples) as case studies (Geldermans et al., 2017).

These territories, located in the Neapolitan hinterland, are highly urbanised, and the presence of large road infrastructures defines a taxonomy that generates wasted landscapes (Amenta & Attademo, 2016; Geldermans et al., 2017; Russo et al., 2017) (Fig. 19.1).

In Table 19.1, it is possible to identify the main characteristics of the four municipalities. The table shows the surface area in km^2 of each municipality with its total population, referring to 2011. Also, the total area of the different types of abandoned areas was calculated for each municipality.

19.3.2 Presentation of Centrality Index and Results

Network centrality measures are mathematical methods that quantify the importance of nodes in a network. These metrics identify each element's centrality on the network, relative to surrounding systems and elements (Sevtsuk & Mekonnen, 2012).

Specifically, the Straightness index identifies the connection and interrelation that exists between two points. This interrelation is optimal when the path is straight. The expression can evaluate it:

$$Straightness[i]^r = \sum\nolimits_{j \in G-\{i\};\, d[i,j] \le r} \frac{\delta[i, j]}{d[i, j]} \cdot W[j] \tag{19.1}$$

where $\delta[i, j]$ is the distance between the wasted landscapes i and j, $[i, j]$ the distance between the shortest paths between the wasted landscapes, and $W[j]$ the weight of the destination j. Straightness can only be estimated if the impedance units are in a linear distance.

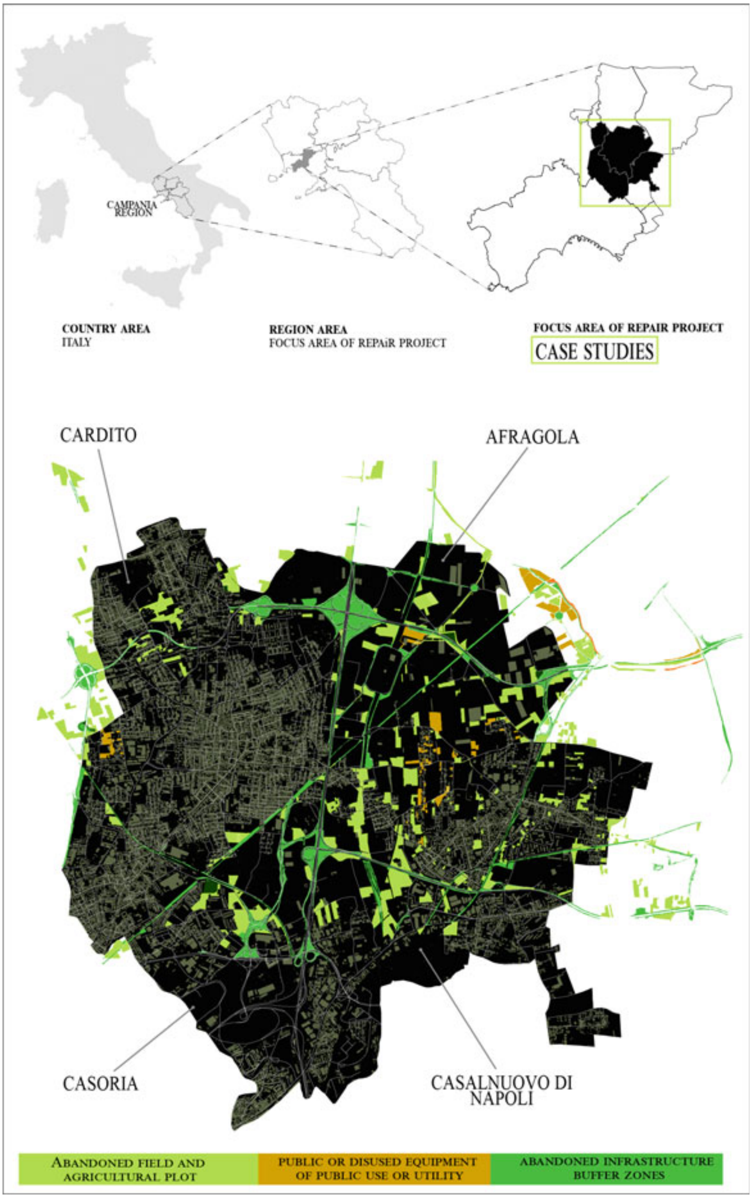

Fig. 19.1 The spatial boundaries of the study area. The study area is chosen to consider the Focus Area identified in the Horizon 2020 REPAiR project (Geldermans et al., 2017). The focus is on Afragola, Cardito, Casalnuovo di Napoli and Casoria in the north-east of Naples. In the four municipalities, wasted landscapes close to roads are mapped to the three identified typologies: abandoned infrastructure buffer zones (WL1), abandoned fields and agricultural plots (WL2), public or disused equipment of public use and public utilities (WL3) (*Source* Author's elaboration)

Table 19.1 Main characteristics of the 4 municipalities selected for the Metropolitan City of Naples and the area in km covered by wasted landscapes for each municipality

Case study name	Area [km^2]	Population (2011)	Area [km^2] of wasted landscapes (WL)
Afragola	17,803	63,820	2824
Cardito	3157	22,322	0151
Casalnuovo di Napoli	7886	48,621	0456
Casoria	12,109	77,474	0478

Note that the population data refer to the database of census plots produced by ISTAT for the year 2011. The database is implemented every ten years, which is why the most recent database has been used

Source Author's elaboration

The betweenness index (Sevtsuk & Mekonnen, 2012), calculated for wasted landscapes between the road network, defines the number of times that space is reached by defined short routes within a given radius. Each equidistant routes is assigned the same weight if a shorter route is found between two wasted areas. The index is calculated as follows:

$$Betweenness^r[i] = \sum\nolimits_{j,k \in G-\{i\};\, d[i,k] \le r} \frac{n_{jk}[i]}{n_{jk}[i]} \cdot W[j] \qquad (19.2)$$

where n_{jk} is the number of shortest routes between abandoned areas (j, k), and $n_{jk}[i]$ is the number of routes passing close to the areas, in a given radius, while $W[j]$ is the weight of wasted landscapes (Sevtsuk, 2014). The analysis has also been weighted to demographic data, so in Table 19.3, the potential number of population that can use that space is made explicit.

The first map in Fig. 19.2 shows the straightness centrality index calculated as a function of the roads that cross the wasted landscapes. The straightness identifies wasted landscapes located in an optimal position about the roads' complex network. So from green to red, we define those most walkable spaces because they are located on straight and long roads. The higher the index, the easier it is to get to those places. This is because these locations can be reached by several routes and in a direct way.

Furthermore, they are in an optimal location, unlike places with a lower index. Discontinuous roads cross these. The straightness centrality index is useful for identifying places closer to the surrounding building fabric because they are more connected. These wasted landscapes could be the first space in urban regeneration as they are already optimally connected to the urban context. On the other hand, the places identified as distant from the urbanised territory can become the new ecological corridors connected to their environmental texture.

On the other hand, the second map identifies how close the wasted areas are to the road system within a given radius. It calculated as the average of the shortest route's lengths used to reach the different wasted landscapes. The surface area of each wasted landscape is used as a weight to analyse this indicator. All wasted landscapes that are located along the main communication routes have higher results. This result is because there are more geodetic routes between the surrounding destinations (Tables 19.2 and 19.3).

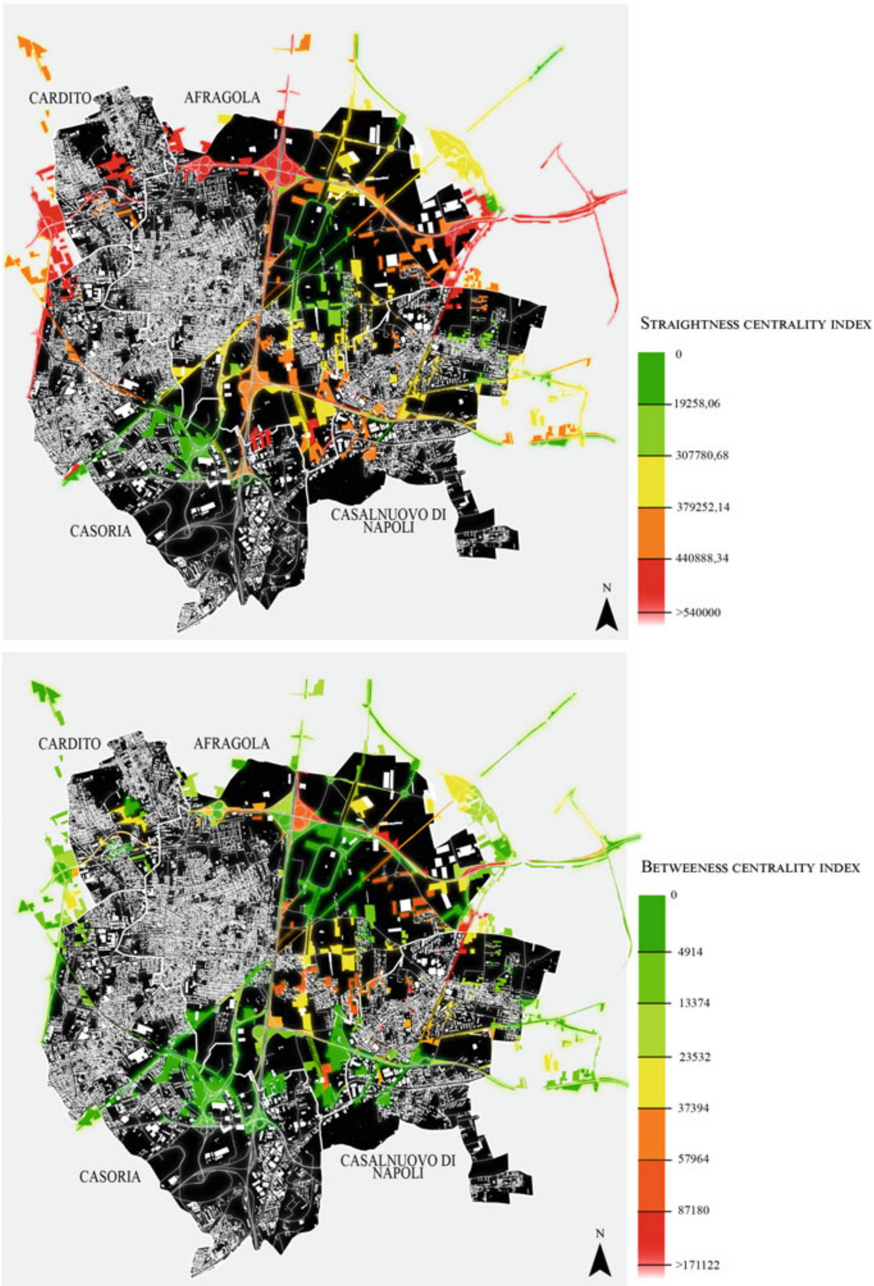

Fig. 19.2 Analysis of centrality index in Afragola, Cardito, Casalnuovo di Napoli and Casoria. In the first map, the straightness centrality index weighted by wasted landscapes area covered. In the second map, the betweenness centrality index in a 500-m network radius, weighted by wasted landscapes area covered and population density (S*ource* Author's elaboration)

Table 19.2 Area covered by the 3 types of wasted landscapes sites in Afragola, Cardito, Casalnuovo di Napoli and Casoria

Case study name	WL1 Area [km^2]	WL2 Area [km^2]	WL3 Area [km^2]
Afragola	1.10	1.483	0.240
Cardito	0.012	0.148	-
Casalnuovo di Napoli	0.132	0.320	0.002
Casoria	0.185	0.223	0.069

Source Author's elaboration

Table 19.3 Estimated population per cadastral section living within 5 10 and 15 min' walking distance of wasted landscapes (WL) sites in Afragola, Cardito, Casalnuovo di Napoli and Casoria

	Estimated population by census living:		
Case study name	5 min' walk from WL	10 min' walk from WL	15 min' walk from WL
Afragola	18,063	38,447	68,740
Cardito	10,377	10,556	18,366
Casalnuovo di Napoli	18,485	18,563	35,412
Casoria	16,338	47,519	47,519

Source Author's elaboration

19.4 Discussion and Future Perspectives

The emergence of the landscape concept as a complex system defines a conservative policy and considers the road infrastructure as the element that produces degradation and de-qualification. It is no longer necessary to consider road infrastructure as environmental detractors. Still, it is necessary to consider them as gears capable of creating connectivity between different abandoned places and restoring damaged ecological-environmental relations. It is necessary to use decision support tools to analyse such systems' criticality and potential to minimise impacts. Also, the Leipzig Charter of 2007 addressed processes related to integrated urban regeneration and land management strategies. Objectives have been defined concerning an integrated vision of urban policies, analysing territories' status quo and the connections between the natural and built environment. A shared vision between all actors involved in the process allows an open view of innovative solutions and creates convergence between social and natural environments. The evaluation also addresses the territory's complexity by assuming an analytical technique and defining the effectiveness and soundness of choices (Bentivegna, 1995).

The analysis shown so far has made it possible to identify wasted landscapes' possible potential, explicitly identifying the most easily accessible and attractive areas. Moreover, considering the high population density in these areas, abandoned areas can become new poles of attraction.

Furthermore, as the analysed municipalities have a high population density, it is assumed that spatial planning choices can also be influenced by those who live and inhabit the area. For these reasons, we stress the importance of evaluation in urban regeneration processes. In particular, it is necessary to rely on assessment tools that can support and guide scenarios and preferable solutions linked above all to sustainability and innovation by reasoning and bringing together different points of view (Cerreta & De Toro, 2002; Spina et al., 2017). Integrating regeneration planning processes with evaluation processes (Khakee, 1998; Lichfield, 1996; Spina et al., 2017) is the first step to trigger preferable solutions that address functional and environmental aspects and sustainability.

Future research developments aim to apply methodologies linking planning and evaluation. Constructing evaluation maps acts as a support for defining optimal solutions for the regeneration of wasted landscapes.

In particular, the research aims to identify the geodesign framework as the optimal tool for achieving these objectives. In particular, the framework developed by Carl Steinitz (2012) presupposes the identification of six decision-making models that guide the process of constructing planning choices.

The method identifies six main questions used to describe the study area and its functioning, to analyse the relationships between the systems of the territory and the status quo of the area with its critical and potential aspects. Furthermore, they are used to define possible transformations linked to physical and governance actions. The answer to the questions is defined through further evaluation models related to the presentation and then to the understanding phase of the territory under examination, developed by the different actors involved in the process with expert researchers' collaboration and followed by a process model. Other models are the evaluation and change model, the change model in which strategies can be defined, the impact model in which the efficiency of solutions is assessed, and the decision model (Campagna et al., 2016; Steinitz, 2012, 2014).

In particular, the framework is implemented by defining an open-source platform, geodesign hub (Ballal, 2015), to manage and organise the complex problems of the territories through collaborative decision-making processes. Such a platform can represent a field of experimentation in the regeneration of wastescapes as it combines the principles of web 2.0 with those of the planning support system (Campagna, 2016; Harris, 1989). In this way, the community collects data and takes part in the decision-making process to define preferable solutions (Haklay, 2017; Nov et al., 2014).

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Afterword

by Libera Amenta, Michelangelo Russo, Arjan van Timmeren

At the start of the proclaimed post-Covid 19 'roaring twenties' of the twenty-first century, research on the spread of the Covid-19 disease has been showing that the current pandemic, and probably in eventual future ones, could be related to increased stress on the environment (Urrutia-Pereira et al., 2020), and in particular of the relation between human culture and nature. The correlation is in the excessive exploitation and consumption of the (finite) natural resources of our planet, the consequent massive production of waste, deforestation and biodiversity loss, climate change, which are leading altogether to vulnerable interdependencies, forming a base for the pandemic spread of—in this case—the coronavirus. The Italian writer and physician Paolo Giordano even went so far as to state in his last book entitled 'Nel contagio' that: 'the infection is in the ecology' (English translation by the Authors) (Giordano, 2020, p. 45). Prior to this, other scholars, like in the field of ecology the brothers Eugene and Howard T. Odum (1953), half a century before introduced the 'eco-systems' perspective related to this. Their work was based on the previous general systems theory, and on authors like Tansley (1935) and Forrester (1969), as well as on the notions of 'eco-equilibrium' and networks of 'feedback loops' and how all systems stabilize themselves. Today, the high levels of urbanization and related excess of environmental limits, compromise the already fragile equilibrium between humans and nature, cities and environment, as well as between communities and territories (Amenta & van Timmeren, 2018). Generally, disasters jeopardize the very idea of urban and peri-urban landscapes, which are normally characterized by very fragile relationships among social, historical and cultural values together with ecosystem and natural characteristics of the territory (Russo & Attademo, 2020). In fact, every year we override this fragile equilibrium by surmounting the planetary boundaries in the so-called 'ecological overshoot', the act of converting renewable resources into waste, much faster than how waste can be turned back into resources (Global Footprint Network, 2006).

Even if a pandemic is not something new or unexpected, the diffusion of the virus Sars-COV-2 was able to show how, the most elementary form of life, possibly known, has been able to cause a crisis of the whole contemporary way of living and, to speak with Forrester (1969), how systems could stabilize themselves (again).

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https://doi.org/10.1007/978-3-030-78536-9

Whereas systems are the interplay of natural systems and human-made systems. Related to the latter, decision-makers have been forced to take urgent measures with the aim to stop the contagion and to contain the overload of the national health systems. Subsequently, these blockades resulted in huge socio-economic impacts, as for instance the need to implement a social distancing among citizens and to wear face masks in all public spaces. The effect has been that, if these novel rules, on the one hand, have been attempting so far to stem the pandemic, on the other hand, they are actually forcing all to make real changes in their daily routine, in the cultural habits, and in the ways of living in cities, and availability and use of the public (open/green) spaces.

As citizens within this context have a greater need to access public (open and often preferable green) spaces and facilities in a healthy and safe way, this complex historical moment seems to be the right one to re-establish through resilient and regenerative solutions and strategies the reciprocal equilibrium between man and nature which has been lost in the Anthropocene: 'If there is any chance that our civilization in its current iteration will survive to see the twenty-second century, there must be a serious reexamination of our guiding ethos and the reciprocal manifold between Man, Nature, urban areas, rural communities, technology and design. This must amount to not only drastic reductions in material and energy consumption, but a paradigm shift in societal norms and a complete rethinking of the human environment; that is to say, a redesign of our cities, landscapes, communities and their connecting infrastructures' (van Timmeren et al., 2013, pp. 9, 10), where a new sensitiveness to an ecological question and the use of the principles of circular economies in addressing planning strategies, assume a great importance. Forced by the emergency, this virus has been one of the most pressing causes, however not the sole one, raising new urban questions related with the urgency to find innovative and adaptive strategies to continue living safely in urban contexts and, to do so in principle, without sacrificing the quality of life. In this process, the virus disoriented us until losing priorities, while at the same time making people understand what are key values for life and liveability 'without embracing something more and something good' (English translation by the Authors) (Lévy, 2020). Another aspect this new context brought forward is that a personal choice could affect the collective well-being, even having global consequences, and therefore that it is important to think about ourselves as belonging to a larger community (Giordano, 2020).

As stated before, we live in an extremely connected society, and the tangible and intangible relationships which shape it, give form to what we know as the 'metabolism' of our society, or the 'urbanism metabolism'. The approach, or better stated analogy of the 'urban metabolism' was introduced in 1965 when Wolman explained the functionalities of cities specifically underlining their need of external inputs (resources) and related outputs (waste) (Wolman, 1965). The positive side of this approach is that the dynamics of cities can be studied [on more than 'traditional' mobility and relations built/(un)cultivated alone] in relation to scarcity, carrying capacity and conservation of mass and energy (Newman et al., 2009). However, there is also a counter side to this approach (van Timmeren, 2013): urban metabolism in a way is opposed to traditional urban planning, in which social, cultural, political and technical dimensions dominate over the biophysical dimension: hence, it synthesized environmental and biological science into the urban planning discipline. More recently, many interpretations followed concerning the industrial ecology and urban metabolism approach. Important to mention is 'The changing metabolism of cities' (Kennedy et al., 2007), which updated the definition of urban metabolism to 'the sum total of the technical and socio-economical processes that occur in cities, resulting in growth, production of energy, and elimination of waste'. It introduces the essential component of integration of both a technical as well as a social perspective.

Urban metabolism in the current conditions, should be interpreted as a functional notion to highlight the crisis of the contemporary territory in order to ecological issues, based on the transformations of biological organisms in balance between growth and reproduction of the life: a balance between input and output flows, between flows of energy and materials that cross the city as an open system (Wolman, 1965). Understood as mutation, as the transformation of the materials that enable life, metabolism has to do with the flows of materials and energy and the processes of their production, transformation, use and dissipation, in relation to "consumption" as a global phenomenon that draws contemporary urban societies (Russo, 2014). If the metabolism is inadequate, it determines an overproduction of non-recyclable waste with a strong imprint on the territories, with the effect of increasing risks, fragmentation, ultimately the crisis contexts of life of local societies and communities.

However, until today, social scientists still have critiqued the urban metabolism concept because it neglects the sociological fact that humans are malleable and conditioned by their social environment, and not by their natural environment (McDonald & Patterson, 2007). As such, human behaviour is determined by societal norms rather than natural laws, creating cities that are not as simple as large biological entities or ecosystems, but driven by more complicated rules than predictable physical laws (van Timmeren, 2013). Their evidence is the irrationality of humans, including the environmentally damaging choices. Within this context it is clear that the ability of urban design and planning to incorporate continuous change, preferably through 'regenerative design' (Tillman Lyle, 1994), is necessary in order to tune the complex structures of society, the flows considered, nature (and the natural processes) and spatial morphologies to each other (Forgaci & van Timmeren, 2014).

It also underpins the importance to focus on socioecological and spatial aspects and the need for (re)design of territories, landscapes, urban spaces abandoned, neglected or at the end of their life cycle (wastescapes), for the sake of a more sustainable (circular) urban metabolism. From the perspective of urban design research and practice, urban metabolism is explored by different researchers. From a theory perspective, Oswald et al. (2003) proposed a combination of morphological and physiological tools that attempt to move beyond urban metabolism analysis towards design in the book 'Netzstadt'. In addition, Goldstein et al. (2013) proposed a framework for coupling life cycle assessment to quantify urban metabolism. Some design practices also attempted to involve urban metabolism approach, e.g. MIT students used material flow analysis to provide a more ecologically sensitive urban design proposal for New Orleans (Quinn & Fernández, 2005) and students at the University of Toronto traced the flows of water, energy, nutrients and materials through an urban system and redesigned an urban neighbourhood to close the loops (Codoban & Kennedy, 2008; Engel-Yan et al., 2005). The notion of 'circular metabolism framework' brings together Urban Metabolism and Circular Economy conceptualizations. It still simplifies the complexity of today's urban systems, but aims to 'realize the vision of sustainable cities' (Lucertini & Musco, 2020, p. 141). The role (availability, use and quality) of space can be considered another, new important addition, even more strengthened by recent context of the global crisis related to Covid-19.

For urban planning, key concepts are quality and (ecological) conditions present that are taken as the starting point. Cycles are the condition for stability in nature to come into existence. For example, life is characterized by a cycle of matter in combination with an infusion of energy coming in as sunlight and disappearing as radiation, among other aspects. In a closed system, matter cannot go beyond its boundaries. In principle, energy can go beyond a system's boundaries. Water, nutrients, and other materials, by contrast, having no source of new supplies, are not lost or dissipated but instead are continually dispersed or recycled. A cycle may be part of one or more ecosystems. Usually, ecosystems are defined as parts or areas in a more or less isolated state that are capable of preserving their own balance, always open to influences from outside, or in simple words: the living species and nonliving materials and their interrelationships within a given landscape (Tillman Lyle, 1994). The ecosystem concept is based on the revelation that nature's fundamental order does not lie entirely at the molecular level, as reductionist thinking implies, but at every level (Tansley, 1935). Besides that, an ecosystem has consistent order. From the perspective of a more regenerative approach to spaces, ecosystems can be considered as natural parts of technical systems (e.g. buildings, districts or towns), in their turn being elements (parts) within larger (natural) ecosystems. These larger ecosystems, in nature, are continuously changing through processes of evolution and succession, generally in a trajectory of increasing complexity and efficiency.

The basis of this edited volume has shown to be in the interaction between integrated ecosystems and ecosystems in which the created technical system performs. It has illustrated that there is a reciprocal relation, as well as so-called ecosystematic order. This order consists of (1) 'Structural order': the composition of abiotic and biotic, or living and nonliving elements, like rocks, soil, and plant and animal species; (2) 'Functional order': the flow of energy and materials that distribute the necessities of life to all of the species within the ecosystematic structure; and (3) 'Locational Patterns': the local conditions of topography, specific soils and micro climate (van Timmeren, 2006). 'Development' always implies change in the ecology of landscape, and sustainable development can not be completely reached until the flows of materials can be closed and the cycle can be managed without devaluation of energy and losses of (other) materials. Besides this, in making their way through the ongoing cycles, materials can also be held inactive at some points awaiting eventual reuse.

The influence of 'space' and 'form' on a structural improvement of sustainability of the construction and use phases are often underestimated. An object, building

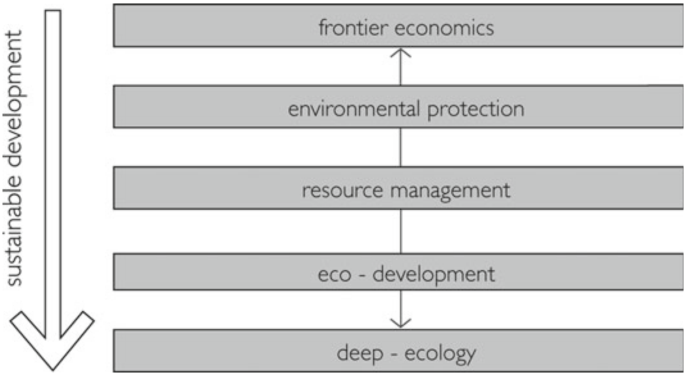

Fig. 1 Five paradigms for the relationship between man (culture) and nature (van Timmeren, 2006)

or space that is perceived as 'unappealing' or 'ugly', impractical or uncomfortable in its use, can become very 'unsustainable' in spite of its sustainability when the duration of use, i.e. the economic life span, is shorter than the technical life span, often leading to wasted space (as a resource). Therefore, it is clear that, within the regenerative approach aimed for, aesthetic criteria must be considered as important as environment-technical, functional and social criteria.

When developing new spaces, (infra)structures and more, urban developers are now expected to try and keep as much of the original nature intact as possible: bringing land under cultivation with respect for the nature that is there. Kockelkoren (1990) distinguished five different paradigms for the relationship between man (culture) and nature (Fig. 1). The paradigms vary from the self-centred 'Deep Ecology' to 'Frontier Economics', where man is put in the centre.

In the case of 'Frontier Economics', nature is considered as a free, unlimited source of materials and energy. The approach of 'Environmental Protection' tries to minimize the pollution of the environment to a level where health and general well-being for people are not threatened. In 'Resource Management' and in 'Environmental Protection', the threat to the environment and the natural sources is fully endorsed but worked out differently (more far-reaching or less so). In 'Eco-development', there is co-evolution of culture (society) and nature. The ecologizing of the economy is the starting point: the (existing) biodiversity is maintained. In Eco-development emphasis is put on environmental design. Environmental design, or eco-design, is where the earth and its processes join with human culture and behaviour to create form. In this sense it requires 'reestablishing some connections that began coming loose in the Renaissance and were entirely severed by industrialization' (Tillman Lyle, 1994). It is the stage in which regenerative systems become key, and the onset to what Kockelkoren (1990) defines as 'Deep Ecology'. In 'Deep Ecology', man is seen as a participant (as part of) eco-systems, and when man harms the eco-systems he destroys his own means of existence (van Timmeren, 2006).

The current crisis has clearly shown its space that has a very precise form, a *topology* linked to the relationship between man and environment. A space that is the product of a relationship between organism and environment, in which it is impossible to dissociate the organization of the perceived universe from that of the activity itself. The relationships that bring order to these spaces are *topological* in nature: measurement is not important, but the determination of the relationships that are played out in space. Those relationships are crucial that determine places, their meaning according to those who inhabit them. The most elementary order is based on the relationship of proximity: a human, existential space, whose measure is the *body*, with its presence, with the forms of its movement.

Authentic space is therefore that between people. Action and discourse "create a space between participants that can find its place in any time in any place" (Arendt, 1958).

This pandemic crisis has exposed an eloquent topology: the space of absence.

Its icon is the monumental squares isolated in the lockdown: cities without *civitas*, metaphysical architectures, stone spaces without bodies, without life: the city as an organism devoid of its vital flows.

A new idea of contemporary city must consider its topology as a medium between space and society, between regeneration and development, an idea with a highly political value, able to create cohesion around a dynamic notion of the common good: an idea *in fieri* not rhetorical nor taken for granted, to be built within a pact of innovation that starts from space and territory, to address human behaviours and their possible change.

To achieve regenerative systems, this volume has shown that it is crucial that we develop ecological technology, or as Freeman claims "a change in the technical–economic paradigm (Kuhn, 1970) in which we have been for a long time" (Freeman, 1992). It requires a shift in searching for technical means, to 'enable maximization of (financially defined) usefulness, when searching for technical means that enable production which fits in with sustainable ecology' (Vergragt, 1992). The notion of cities as part of an overall network of natural and artificial systems can be traced back at least to the 1960s and the thinking of H.T. Odum (see before). The different contributions to this volume reflect recent thinking, in which attempts are made to describe the interface space between humans and nature (of which cities are one example) as social-ecological systems. However, while there is a general consensus that social-ecological systems refers to the human–nature relationship, exactly how this relationship is to be comprehended and structured as an integrated system is still to be further explored in the coming years.

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