Chapter 4

The Circular Metabolic Urban Landscape: A Systematic Review of Literature

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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

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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 aforementioned 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 multi-dimensional 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 (Cerreto 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 (Cerreto 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 (Cerreto 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 private 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.

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