Chapter 7

Circular City: Urban and Territorial Perspectives

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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.

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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 and 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, underlining 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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