Dimensions of Circularity for Healthy Metabolisms and Spaces

Russo, Michelangelo; van Timmeren, Arjan

DOI
10.1007/978-3-030-78536-9_1

Publication date
2022

Document Version
Final published version

Published in
Regenerative Territories

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 reciprocities (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.

References

Amenta, L., & van Timmeren, A. (2018, December 20). Beyond wastescapes: Towards circular landscapes. Addressing the spatial dimension of circularity through the regeneration of wastescapes. *Sustainability, 10*(12), 4740. http://www.mdpi.com/2071-1050/10/12/4740.

Balducci, A. (2019). Post-metropoli. In C. Perrone & M. Russo (Eds.), *Per una città sostenibile. Quattordici voci per un manifesto.* Donzelli Editore.

Baiani, S., & Altamura, P. (2018). Waste materials superuse and upcycling in architecture: Design and experimentation. *TECHNE-Journal of Technology for Architecture and Environment, 16*, 142–151.

Barthel, S., Isendahl, C. Vis, B. N., Drescher, A., Evans, D. L., & van Timmeren, A. (2019). Global urbanization and food production in direct competition for land: Leverage places to mitigate impacts on SDG2 and on the Earth System. *The Anthropocene Review, I*, 27. Sage. https://doi.org/10.1177/2053019619856672.

Beloin-Saint-Pierre, D., Rugani, B., Lasvaux, S., Mailhac, A., Popovici, E., Sibiude, G., Benetto, E., & Schiopu, N. (2017). A review of urban metabolism studies to identify key methodological choices for future harmonization and implementation. *Journal of Cleaner Production, 163*, S223–S240.

Bren d'Amour, C., Reitsma, F., Baiocchi, G., et al. (2017). Future urban land expansion and implications for global croplands. *Proceedings of the National Academy of Sciences, 114*(34), 8939–8944.

Broto, V. C., Allen, A., & Rapoport, E. (2012). Interdisciplinary perspectives on urban metabolism. *Journal of Industrial Ecology, 16*(6), 851–861.

Brown, L. (1981). *Building a sustainable society*. Opinion Papers.

Carson, R. (1962). *Silent spring*. Houghton Mifflin.

De Toro, P., & Iodice, S. (2018). Ecosystem health assessment in urban contexts: A proposal for the metropolitan area of Naples (Italy). *Aestimum, 72*, 39–59.

Dijst, M., Worrell, E., Böcker, L., Brunner, P., Davoudi, S., Geertman, S., Harmsen, R., Helbich, M., Holtslag, A. A. M., Kwan, M.-P., Lenz, B., Lyons, G., Mokhtarian, P. L., Newman, P., Perrels, A., Ribeiro, A. P., Carreón, J. R., Thomson, G., Urge-Vorsatz D., & Zeyringer, M. (2018). Exploring urban metabolism—Towards an interdisciplinary perspective. *Resources, Conservation and Recycling, 132*, 190–203.

Ellen MacArthur Foundation. (2013). *Towards the circular economy*. Economic and business rationale for an accelerated transition.

European Commission, Joint Research Centre, & Institute for Environment and Sustainability. (2010). *General guide for life cycle assessment: Provisions and action steps*. Publications Office. https://data.europa.eu/doi/10.2788/94987.

European Commission. (2012). *Eco-innovation the key to Europe's future competitiveness*. https://ec.europa.eu/environment/pubs/pdf/factsheets/eco_innovation.pdf.

European Commission. (2015). *Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities*. https://ec.europa.eu/programmes/horizon2020/en/news/towards-eu-research-and-innovation-policy-agenda-nature-based-solutions-re-naturing-cities.

Forgaci, C., & van Timmeren, A. (2014, June 18–20). Urban form and fitness: Towards a space morphological approach to general urban resilience. In *20th annual int. sustainable development research conference*, Norwegian University of Science and Technology.

Gao, H., Tian, X., Zhang, Y., Shi, L., & Shi, F. (2021). Evaluating circular economy performance based on ecological network analysis: A framework and application at city level. *Resources, Conservation and Recycling, 168*, 105257.

Geddes, P. (1915). *Cities in evolution*. Williams & Norgate.

Gemeente Rotterdam, IABR, FABRIC, JCFO, & TNO. (2014). *Urban metabolism sustainable development of Rotterdam*.

Girardet, H. (2015). *Creating regenerative cities*. Taylor & Francis.

Golubiewski, N. (2012). Is there a metabolism of an urban ecosystem? An ecological critique. *Ambio, 41*, 751–764. https://doi.org/10.1007/s13280-011-0232-7.

Grubb, M. (2001, November 9). Relying on Manna from heaven? *Science, 1285*.

Haken, H. (1983). *Synergetics, an introduction: Nonequilibrium phase transitions and self-organization in physics, chemistry, and biology* (3rd rev. enl. ed.). Springer-Verlag.

Hammond, A. (2001, October 3). Remarks delivered at form of the American Enterprise Institute-Brookings Institution Joint Center for Regulatory Studies. In Hayward, S. F. (2006). *'Environmental science and public policy', Social Research.*

Henriquez, L., & van Timmeren, A. (2017). *Under pressure: Water and the city*. TU Delft & AMS Institute. ISBN 978-94-6186-860-2.

Horbach, J., Rammer, C., Rennings, K., Horbach, J., Rammer, C., & Rennings. (2012). Determinants of eco innovations by type of environmental impact: The role of regulatory push/pull, technology push and market pull. *Ecological Economics, 78C*, 112–122.

Howard, E. (1902). *Garden cities of To-Morrow, Swan Published 1889 as 'Tomorrow: A Peaceful Path to Real Reform'*. Sonnenschein & Co.

ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale. (2018). Rapporto Rifiuti Urbani, Roma.

Jacobs, J. (1961). *The death and life of great American cities*. Random House.

Kuhn, T. S. (1962). *The structure of scientific revolutions*. University of Chicago Press.

Legambiente. (2017). *Rapporto Cave*. https://www.legambiente.it/sites/default/files/docs/rapporto_cave_2017.pdf.

Korhonen, J., Nuur, C., Feldmann, A., & Birkie, S. E. (2018). Circular economy as an essentially contested concept. *Journal of Cleaner Production, 175*, 544–552.

Loconte, P., Partipilo, V., & Rotondo, F. (2013). Multidimensional approaches to evaluate urban planning scenarios. In B. Murgante, S. Misra, M. Carlini, C. M. Torre, H.-Q. Nguyen, D. Taniar, B. O. Apduhan, & O. Gervasi (Eds.), *Computational science and its applications—ICCSA 2013* (Vol. 7974, pp. 556–571). Springer.

Loiseau, E., Aissani, L., Le Féon, S., Laurent, F., Cerceau, J., Sala, S., & Roux, P. (2018). Territorial Life Cycle Assessment (LCA): What exactly is it about? A proposal towards using a common terminology and a research agenda. *Journal of Cleaner Production, 176*, 474–485.

Marshall, A. (1920). *Industry and trade* (8th ed.). Macmillan.

Mininni, V. (2013). *Approssimazioni alla città. Urbano, Rurale, Ecologia.* Donzelli Editore.

Odum, E. (1953). *Fundamentals of ecology*. Saunders.

Palestino, F. (2017). Urban political ecology vs. teoria e pratica del planning. Come affrontare le tante "terre dei fuochi" italiane. In M. Russo (Ed.), *Abitare Insieme. Il progetto contemporaneo dello spazio condiviso.* Clean Edizioni.

Padilla-Rivera, A., et al. (2020). Addressing the social aspects of a circular economy: A systematic literature review. *Sustainability, 12*(19), 7912.

Pataki, D. (2010). *Integrating ecosystem services into the urban metabolism framework: Public interest energy research (PIER) program of the california.* Energy Commission: Sacramento, CA, USA.

Pérez-Soba, M., Petit, S., Jones, L., Bertrand, N., Briquel, V., Omodei-Zorini, L., Contini, C., Helming, K., Farrington, J. H., Mossello, M. T., Wascher, D., Kienast, F., & de Groot, R. (2008). Land use functions—A multifunctionality approach to assess the impact of land use changes on land use sustainability. In K. Helming, M. Pérez-Soba, & P. Tabbush (Eds.), *Sustainability impact assessment of land use changes* (pp. 375–404). Springer.

Pincetl, S., Bunje, P., & Holmes, T. (2012). An expanded urban metabolism method: Toward a systems approach for assessing urban energy processes and causes. *Landscape and Urban Planning, 107*(3), 193–202. https://doi.org/10.1016/j.landurbplan.2012.06.006.

Raworth, K. (2017). *Doughnut economics: Seven ways to think like a 21st-century economist*. Random House Business Books.

Rees, W. E. (1996). Revisiting carrying capacity: Area-based indicators of sustainability. *Population and Environment: A Journal of Interdisciplinary Studies, 17*(3), 195–215.

REPAiR. (2018a). *D5.3 Eco-innovative solutions Naples.* EU Commission Participant portal. Brussels. Grant Agreement No 688920. Retrieved from http://h2020repair.eu/wp-content/uploads/2019/10/Deliverable-5.3-Eco-Innovative-Solutions-Naples.pdf.

REPAiR. (2018b). *Process model for the two pilot cases: Amsterdam, the Netherlands & Naples, Italy. Deliverable 3.3.* EU Commission Participant portal. Brussels. Grant Agreement No 688920. https://doi.org/55988e03-ea52-406d-a18f-57ff00630fbd.

Robiglio, M., Artigiani, E., Manzone, L., & Davit, J. P. (2014). *Adaptive reuse. Bonifiche e rigenerazione urbana. Nuove strategie per un mercato in evoluzione.* Available at http://porto.polito.it/2625491/.

Röling, N. (2000). *Gateway to the global garden.* Eighth Annual Hopper Lecture. University of Guelph.

Russo, M. (Ed.). (2014). *Urbanistica per una diversa crescita.* Donzelli.

Russo, M. (2017). Resilient urban landscapes: Strategie progettuali e cognitive per cambiare il progetto urbanistico contemporaneo. In (a cura di) C. Gasparrini, A. Terracciano, *Dross city: Metabolismo urbano resilienza e progetto di riciclo dei drosscapes* (pp. 122–133). LISt Lab.

Russo, M., Attademo, A., Formato, E., Vittiglio, V., & Amenta, L. (2017). Economia circolare, scarti e rigenerazione del periurbano: il progetto REPAiR. In *Proceedings from the conference Atti della XX Conferenza Nazionale SIU* (pp. 1235–1242). REPAiR 2017_02.

Sagoff, M. (1988). *The economy of the earth: Philosophy, law and the environment*. Cambridge University Press.
Sassen, S. (2004). *The global city: New York, London, Tokyo*. Princeton University Press.
Saxenian, A. (1994). *The limits of Autarky: Regional networks and industrial adaptation in silicon valley and route 128*. HUD Roudtable on Regionalism, Social Science Research Council.
Sitte, C. (1889). *City planning according to artistic principles*. Included as: 'The art of building cities'.
Soja, E. (2011). Beyond postmetropolis. *Urban Geography, 32*, 4.
Swyngedouw, E. (2006). Metabolic urbanization: The making of cyborg cities. In N. C. Heynen, M. Kaika & E. Swyngedouw (Eds.), *In the nature of cities: Urban political ecology and the politics of urban metabolism* (pp. 20–39). Questioning cities series. Routledge.
Tjallingii, S. P. & Reh, W. (1989). *Landschap en milieu, ontwerpgrondslagen voor gebouw en stad* (in Dutch only). Faculty of Architecture, Delft University of Technology (TUD).
Toffler, A. (1984). *Future shock*. BANTAM Books.
Torricelli, M. C. (2015). *ES-LCA e Patrimonio Naturale Life Cicle Analisi Ambientale e Sociale Di Un'area Protetta*. Firenze University Press.
Torricelli, M. C., & Gargari, C. (2015). Sostenibilità ambientale e sociale di un territorio naturale protetto. In M. C. Torricelli (Ed.), *ES-LCA e Patrimonio Naturale* (pp. 59–70). Firenze University Press.
van Berkel, J., Schoenaker, N., van de Steeg, A., de Jongh, L., Schovers, R., Pieters, A., amp; Delahaya, R. (2019, 30 September). Materiaalstromen in Nederland. *Materiaalmonitor 2014–2016, gereviseerde cijfers*. (in Dutch only). CBS, ENR 305106, Den Haag.
van Timmeren, A. (2006). Autonomy and heteronomy—The need for decentralization in a centralizing world. In *Conference Proceedings Int. Conference 'Ravage of the Planet'*, WIT Press.
van Timmeren, A. (2013). *ReciproCities: A dynamic equilibrium*. Inaugural speech, Eburon. TU Delft.
Vittiglio, V. (2020). *Recycling wasted landscapes: Circular perspectives and innovative approaches on landscape remediation*. University of Naples Federico II.
Van Vliet, J., Eitelberg, D. A., & Verburg, T. H. (2017). A global analysis of land take in cropland areas and production displacement from urbanization. *Global Environmental Change, 43*, 107–115.
Walters, G., Janzen, C., & Maginnis, S. (2016). *Nature-based solutions to address global societal challenges_2016 036*. http://dx.doi.org/10.2305/IUCN.CH.2016.13.en.
Wang, N., Lee, J. C. K., Zhang, J., Chen, H., & Li, H. (2018). Evaluation of urban circular economy development: An empirical research of 40 cities in China. *Journal of Cleaner Production, 180*, 876–887.
WCED (World Commission on Environment and Development). (1987). *Our common future* (p. 4). Oxford University Press.
Winblad, U. (2000). Development of ECO-san systems. Ecosan (Ecological sanitation). In *Int. conference 'Closing the loop in wastewater management and sanitation'*, plenary session 2, Bonn.
Wolman, A. (1965). The metabolism of cities. *Scientific American, 213*(3), 178–190. https://doi.org/10.1038/scientificamerican0965-178.
Yaneske, P. (2003). Visions of sustainability. In H. W. Frey, *The search for a sustainable city: An account of current debate and research*. Department of Architecture and Building Science, University of Strathclyde, Int. Conference on Passive and Low Energy Architecture (PLEA04), Eindhoven.