

From Cities to Circular Food Systems: Leveraging Spatial Agglomeration, Centrality and Agency

1. Introduction

In 2050, urban citizens will be responsible for consuming 80% of all food produced (Ellen MacArthur Foundation 2019). Cities as unique spaces where people cluster, not only represent hotspots of food consumption, but also of waste disposal. As cities could therefore play a crucial role enabling new pathways towards circularity, this paper unravels the forms of engagement of cities that could trigger such transformation at scale (Solecki et al. 2018).

The current food system is responsible for roughly a third of all anthropogenic greenhouse gas emissions (Crippa et al. 2021), and is a fundamental contributor to tropical deforestation, biodiversity loss, and pollution in soils and water (Poore and Nemecek 2018; Willett et al. 2019). These environmental impacts are increasingly growing due to huge inefficiencies and losses at all stages of the food system, from agricultural consumption to production (Alexander et al. 2017). To tackle these negative side-effects, the world needs to abandon the ‘take-make-dispose’ and move towards a circular food system (Jurgilevich et al. 2016).

Circular food systems are designed to use bio-based and technical materials more efficiently by connecting actors on a local, national and global scale and reduce, reuse, recycle and recover resource flows (Kirchherr et al. 2017). In order to reach a circular food system, the whole life cycle of food products needs to be transformed, so that material loops are closed, superfluous stocks reduced by the sharing economy, residual waste is minimized, and natural

environments are regenerated (Ghisellini et al. 2016; Aguilar-Hernandez et al. 2018; Henry et al. 2021). Advanced waste management practices are insufficient to achieve a circular food system, and it is unclear what can be leveraged to operationalize such a radical system change throughout all actors and institutions involved in the food value web across geographical scales (Ghisellini et al. 2016; Geels and Schot 2007).

We argue that cities could play a crucial role enabling new pathways towards circularity as they are complex hubs of government, cross-scale human interactions, commerce and transportation, characterized by the spatial agglomeration of population, economic activity and material metabolism (Fujita et al. 2001). Cities form major nodes in the global networks of resource metabolism linked to food and beyond such as information, goods, services, people, financial capital, energy, and water (Jensen and Orfila 2021; Hull and Liu 2018). Cities are also open systems of social and economic interactions factually operating beyond administrative limits with only fluid boundaries and with dense interlinkages with their spatial environments (Kasper et al. 2017; Murphy 2015; Batty 2016).

In particular when looking at the food system, it becomes evident that cities have a high degree of centrality in the global network of food-related flows (Jensen and Orfila 2021; Hull and Liu 2018), highly depend on water from neighboring river basins, on energy from other regions inside and outside national boundaries, and on global imports of food (Grewal and Grewal 2012; Cremades et al. 2021). This development is even projected to come to a head in 2050, when two-thirds of the world population are expected to live – and purchase, consume and dispose food - in cities (United Nations 2018). Thus, cities need to import high amounts of nutrients and, in parallel, export large amounts of human excreta and organic waste (Jensen and Orfila 2021;

Papangelou et al. 2020). Moreover, compared to rural areas, cities have larger and more clustered and specialized economic activities, more dense and multilayered social network structures, and higher levels of political power (Glaeser 2007; van Leeuwen 2020; Fratini et al. 2019). However, the special features characterizing cities and their possibilities to drive sustainability transitions, generally, and circularity transitions, specifically, have been long overseen (Coenen et al. 2012; Murphy 2015; Binz et al. 2020).



Figure 1. Cities in food systems

Here we argue that greater consideration should be given to the spatial dimension of circular food systems, the agency of cities on it, and the complex local, national and global interlinkages that could provide unprecedented momentum to materialize transitions to circularity. We also show how cities that are well-positioned in global networks can trigger large-scale positive change in other cities and rural areas with consequence at the national and global scales both in the Global South and North (Mörner and Binz 2021).

2. Cities as pathways towards Circularity

Cities' economic activities, political power and dynamic social networks can be leveraged to trigger circularity on multiple scales.

Cities are major hotspots of economic activity, which can be used to facilitate rapid investment, industrial symbioses, and innovative solutions.

Urban areas are projected to be responsible for approximately 90% of the economic activities world-wide (Solecki et al. 2018). That is because cities provide producers with direct access to suppliers of goods, distribution channels and skilled workers, causing knowledge spill-overs, super-linear scaling of economic outputs (Lei et al. 2021) and the reduction of transport costs (Fujita et al. 2001). This leads to the accumulation of companies from various sectors in urban areas that provides several opportunities for circularity. First, economic activity attracts national and global investment in urban infrastructures (Balland et al. 2020). This financial capital is required to facilitate structural change, e.g. logistics of waste collection, construction of recycling facilities. Second, the spatial proximity of companies from different sectors such as energy, water and food offers opportunities to create closed cycles of by-product and waste flows (Raimbault et al. 2020).

Indeed, food companies, restaurants and retailers produce large amounts of waste, leading to several opportunities to reduce, reuse and recycle waste flows in urban areas. Unused outputs from one sector can be used as input to another, which might even lead to competitive advantages (Chertow & Ehrenfeld, 2012). Third, the accumulation of population and companies in cities attracts talented and well-educated people who interact and create innovative ideas (Duranton and Puga 2001; Batty 2016). Cities can therefore serve as creativity hubs that leverage innovative circular solutions and technologies.

To do so successfully, government programs need to provide space for urban experimentation and grassroot initiatives (Fratini et al. 2019).

Cities are central transition nodes with high political power that need strong partnerships on multiple geographical scales. Cities high degree of centrality in the global food network provides them with vast unexploited leverage opportunities to speed up the transition towards circular food systems (Fratini et al. 2019). Thereby, cities can become critical actors, steering their local hinterlands as well as national and global regions to follow (Hsu et al. 2020; Jolly et al. 2020). Local governments are moreover associated with several levers for policy experimentation (Strumpf 2002). That is because the spatial agglomeration of institutions and relevant actors provides opportunities to connect, experiment and to form governance coalitions (Sonnino et al. 2019; Ostrom 2010). For example, novel governance programs could work towards more circularity in land management, neighborhood infrastructures, canteens of public institutions and waste recycling (Brand et al. 2019). However, due to the increasing speed in which cities grow, some urban governments might miss the institutional capacity (Wiskerke 2015). Especially for a circularity transition, it is important that different governmental departments (e.g. education, health, economic development etc.) work together to come up with solutions (Halliday, 2019). Moreover, urban food systems are complex and strongly intertwined with local, national and global food systems (Jensen and Orfila 2021). Especially in order to advance in circularity, potential multiscale needs to be considered, i.e. the direct and indirect interdependencies and trade-offs of urban solutions on multiple geographical scales (Mörner and Binz 2021; Binz et al. 2020). Thus, cities need to form strong partnerships across multiple scales within and beyond their administrative boundaries, to close material cycles efficiently and to continue learning, adapting, and transforming (Jensen and

Orfila 2021; Rosenzweig and Solecki 2018). To do so successfully, urban government programs and institutional structures need to be transformed to be in favor of multi-level change through the engagement of all relevant food system actors (Fratini et al. 2019). However, there exists no “off the shelf” concept for the circularity transition, but geographic unevenness as well as territorial and social embeddedness need to be considered as factors influencing the transition processes and dynamics (Fratini et al. 2019).

Cities are characterized by highly dense and dynamic social networks with strong bottom-up agency on food systems. World-wide, more than 4 billion people live in cities, making up half of the world population. Individuals living in cities have been found to differ in various ways compared to their rural counterparts (Kelly and Lobao 2019) that make them more susceptible to circular food behaviors. For example, urban citizens are more likely to be highly educated, gain higher incomes and show more trust in the political system (Kelly and Lobao 2019; van Leeuwen 2020). These differences occur due to the non-random clustering of similar people into areas where they can best meet their preferences, but also due to the influences of urban-rural differences in infrastructures, politics and cultures (van Leeuwen 2020). As cities demand great amounts of food products, urban citizens could become active to push the circularity transition by changing their consumption behaviors or engaging in the creation of circular solutions. Indeed, many citizens use this opportunity already as can be observed by the increasing number of grassroot initiatives and places for experimentation in cities (Fratini et al. 2019). However, in comparison to residents from rural areas, the food system is less visible in urban areas (Pothukuchi and Kaufman 1999). Urban citizens have less opportunities to connect with green space, wildlife, and agricultural food production. This can lead to a lack of awareness of what is locally produced and a lack of ascription of responsibility to

change the system (Brand et al. 2019). Therefore, cities need to invest in green spaces and in agricultural production inside the city (e.g. vertical farming, urban gardening) for education purposes and to raise awareness for food production (Forster et al. 2015).

3. Research avenues

There are prevalent gaps in the current literature to understand transitions that limit the opportunities, so that we can help cities to reach circularity. Future research should provide predictive insights when possible, and rank determinants of success across policies and actions for circularity, while detailing major barriers and how they relate to regulation and to lock-ins from past or present decisions. Based on that, we need to understand diffusion across cities, locate bottlenecks in cross-national city networks of leadership and influence. Next, we need to capture networks of supply chain and their implications for regional sustainability in the same region or in other countries' telecoupled regions. Moreover, we need to create local scale models able to connect with input-output economic modelling at the urban scale to understand indirect effects across sectors and regional and national economies. Lastly, we need to understand how spatial and cultural differences steer food system transitions, and observe the factors that impact citizen circular behaviors.

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