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Urban agriculture — A necessary pathway towards urban resilience and global sustainability?

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HIGHLIGHTS

- Urban agriculture to deserve stronger consideration in land-use planning.
- Urban agriculture enhances urban resilience, sustainability and multifunctionality.
- Social and ecological vulnerabilities of and in cities are underestimated.
- Global teleconnections of agricultural imports are disregarded in land-use planning.
- Accounting for multifunctionality still requires stronger efforts.

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ABSTRACT

The Covid-19 pandemic newly brings food resilience in cities to our attention and the need to question the desired degree of food self-sufficiency through urban agriculture. While these questions are by no means new and periodically entering the global research focus and policy discussions during periods of crises — the last time during the global financial crisis and resulting food price increases in 2008 — urban and peri-urban agriculture continue to be replaced by land-uses rendering higher market values (e.g. housing, transport, leisure). The loss of priority for urban agriculture in urban land-use planning is a global trend with only a few exceptions. We argue in this essay that this development has widely taken place due to three blind spots in urban planning. First, the limited consideration of social and ecological vulnerabilities and risk-related inequalities of urban inhabitants, food shortage among them, in the face of different scenarios of global change, including climate change or pandemic events such as Covid-19. Second, the disregard of the intensified negative environmental (and related social) externalities caused by distant agricultural production, as well as lacking consideration of nutrient recycling potentials in cities (e.g. from wastewater) to replace emission intensive mineral fertilizer use. Third, the lack of accounting for the multifunctionality of urban agriculture and the multiple benefits it provides beyond the provision of food, including social benefits and insurance values, for instance the maintenance of cultural heritage and agro-biodiversity. Along these lines, we argue that existing and new knowledge about urban risks and vulnerabilities, the spatially explicit urban metabolism (e.g. energy, water, nutrients), as well as ecosystem services need to be stronger and jointly considered in land-use decision-making.

1. Introduction

Urban agriculture (UA) has become a new cultural-political expression and land-use fashion as a source for social cohesion, environmental education, and as a recreational hobby around the globe (Camps-Calvet et al., 2015; Coles & Costa, 2018; Hardman et al., 2018;

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Robineau & Dugué, 2018), while remaining an important foundation for food security and subsistence for the global urban poor (Bellwood-Howard et al., 2018; Schwab et al., 2018). Notwithstanding, an increasing interest in UA not least by scientific scholars, the area devoted to UA is declining globally, both in the global north as well as in the global south (Bren d'Amour et al., 2017; García-Nieto et al., 2018). As wars and economic crises before, the current global sanitary crisis has newly raised awareness for the vulnerability of global food supply chains, and the need for resilience in the long-term food security of cities (Barthel et al., 2019; Barthel & Isendahl, 2013). After the COVID19 epidemic set off all alarms, people emptied out grocery stores and in some cities food supply has been critically affected (Zhou & Delgado, 2020) – especially for those who have seen a lowering in their purchasing power to buy food (OECD, 2020). Especially the global poor are still under threat of a larger starvation as the recent Sustainable Development Goals Report (UN, 2020) highlights; for instance, in India strict lockdown measures have limited labor migration during the harvesting season and cut-off supply chains to urban markets. Responses have come in different ways. While queues in front of social feeding centers became longer, urban agriculture has quickly been excluded from the lockdown measures in Southern Europe and exceptions on travel bans were implemented to allow for harvesting migration to Western Europe. In China, the need to diversify both supply chains and local agriculture production (Fei & Ni, 2020) has been highlighted as part of the 'new normal'. The episode of the global Covid-19 pandemic newly brings to our attention the need to question the level of food sovereignty we would like to see in urban and peri-urban areas. However, the current sanitary crisis is by far not the only concern regarding food security in future cities, given a projected increase in the demand for food by 100–110% in 2050, with an ever growing global population and planetary urbanization processes, which radically change peoples' (food) consumption patterns (Tilman et al., 2011).

In the long history of cities, the current geographical decoupling from sources of food supply is a unique exception. As the German agro-economist Johan Heinrich Von Thünen observed already in the early 19th century, transport cost and storage capacities are core variables in describing the spatial distribution of agricultural production in the surrounding of urban markets (Von Thünen, 1875). Consequently, the spatial decoupling and global production of food has only become possible since the great acceleration in the mid 20th century (McNeill, 2014; Will et al., 2015) through cheap and abundant availability of energy inputs, both for the transport and storage of food in concert with global market liberalizations. Accordingly, urban and peri-urban land was no longer prioritized for agricultural production, but replaced by other land-uses, primarily by those rendering higher market values (e.g. housing, transport areas, leisure activities) — thus broadly in line with Von Thünen (1875). This is a process still ongoing and projected to continue in many urban and peri-urban areas around the globe, not least in the global south (Bren d'Amour et al., 2017; Bellwood-Howard et al., 2018). Yet, global concentration processes and extended food supply chains cause large social and ecological externalities (Paterson et al., 2015), (re-)producing unfair distributions of social-ecological vulnerabilities, burdens and benefits through teleconnections (Haase et al., 2018; Barthel et al., 2019; Langemeyer & Connolly, 2020). So called 'urban land teleconnection' (Seto et al. 2012) link urban consumption patterns with land-use changes globally, and have widely triggered transformation patterns that are unsustainable on the long-run (Cadillo-Benalcazar et al., 2020).

In this perspective essay, we claim that UA deserves a much stronger consideration in planning for urban resilience and global sustainability strategies, in the face of a global population projected to grow to 11 billion global inhabitants by the end of the 21st century. We argue that UA could synergistically help build urban resilience, understood here as the *capacity of an urban system to absorb disturbances, reorganize and maintain essentially the same functions during its development along a particular trajectory* (in line with Elmqvist et al., 2019, Andersson et al. 2021), while enhancing global sustainability and delivering multiple co-benefits (or '*ecosystem services*') for cities and their inhabitants. All three aspects, resilience, sustainability and multi-functionality, need to be separately and explicitly evaluated, but taken into account in an integrated way. Along these lines, we further argue that the loss of UA has widely taken place due to three blind spots in urban land-use planning (Fig. 1): First, the limited consideration of social and ecological vulnerabilities of urban areas and their inhabitants, including food shortage, in the face of different scenarios of change, such as global climate change, pandemic events such as Covid-19 and expanding future food demands (Barthel et al., 2019; Tilman et al., 2011). Second, the disregard of negative social and environmental externalities from agricultural production and supply chains (e.g. urban land teleconnections), as well as environmental degradation (e.g. deforestation) due to larger spatial demands and increasing fertilizer needs in remote monocultures on formerly non-arable land (e.g. Bren d'Amour et al., 2017). Third, the lack of accounting for the multifunctionality of UA and the multiple benefits it provides beyond the provision food, including run-off mitigation, reduction of urban heat events, as well as social benefits for instance the maintenance of cultural heritage and social-cohesion (e.g. Guitart et al., 2012; Lovell, 2010; Langemeyer et al., 2016) as well as deep feelings of biophilia, individual realization and empowerment (Camps-Calvet et al., 2016; Cilliers et al., 2020). In the following we will discuss these three aspects along global examples.

2. Urban vulnerabilities and food resilience

Resilience theory highlights the importance of diversity (Berkes & Folke, 1998; Walker & Salt, 2012). Paradoxically, while the diversity of choices in the supermarket food shelves has never been larger, the diversity of food production sources is increasingly concentrated, both in terms of the producers and global production areas as well as in agricultural varieties (Calvet-Mir et al., 2012; FAO, 2017; Barthel et al., 2019). From a Ricardo-free-trade perspective[1] this seems to be a rational choice, owing to the benefits of the economies of scale. However, a rational choice from an urban resilience perspective with the objective to achieve food security for all (United Nations, Sustainable Development Goal 2) might look different. Whereas urban agriculture land-use is not given much priority in urban areas under "normal", non-crisis circumstances, UA flourishes in periods of crisis (e.g. Barthel & Isendahl, 2013; Camps-Calvet et al., 2016; Webb, 2011). For instance, Barthel & Isendahl (2013) estimated for the city of Stockholm that its residents would starve in two weeks' time if being cut off from external food supplies. Consequently, during the Covid-19 mitigation measures, in most cities, and largely unrecognized by the mass media, the initial strict lockdown measures were rapidly softened with regard to access to UA to sustain local livelihoods. This follows a common pattern for the role of UA in the past century, not only in the global south, which had its last culmination during the global financial and food crisis in 2008 (e.g. Cohen & Garrett, 2010).

In cities of the global north, the trend toward UA in episodes of crisis is often grounded in the motivation of citizens and larger urban movements to counteract global dependencies, to gain control of food production capacities and to foster local networks toward social change and resilience (Camps-Calvet et al., 2015; Kirkpatrick & Davison, 2018; Tidball & Krasny, 2007). Often not taken seriously by urban planners and parts of the scientific community (Webb, 2011), these grassroots UA, as for example observed when Hurricane Katerina hit New Orleans in 2005 (e.g. Tidball et al., 2014) or when the global financial crisis hit Spain in 2008 (e.g. Camps-Calvet et al., 2015), might also be interpreted

[1] David Ricardo (1772–1823) developed the theory of comparative advantage. Ricardo assumed that for two nations, trade could result in increased total output and lower costs than if each nation produced in isolation. His theory became highly influential among free international trade advocates.

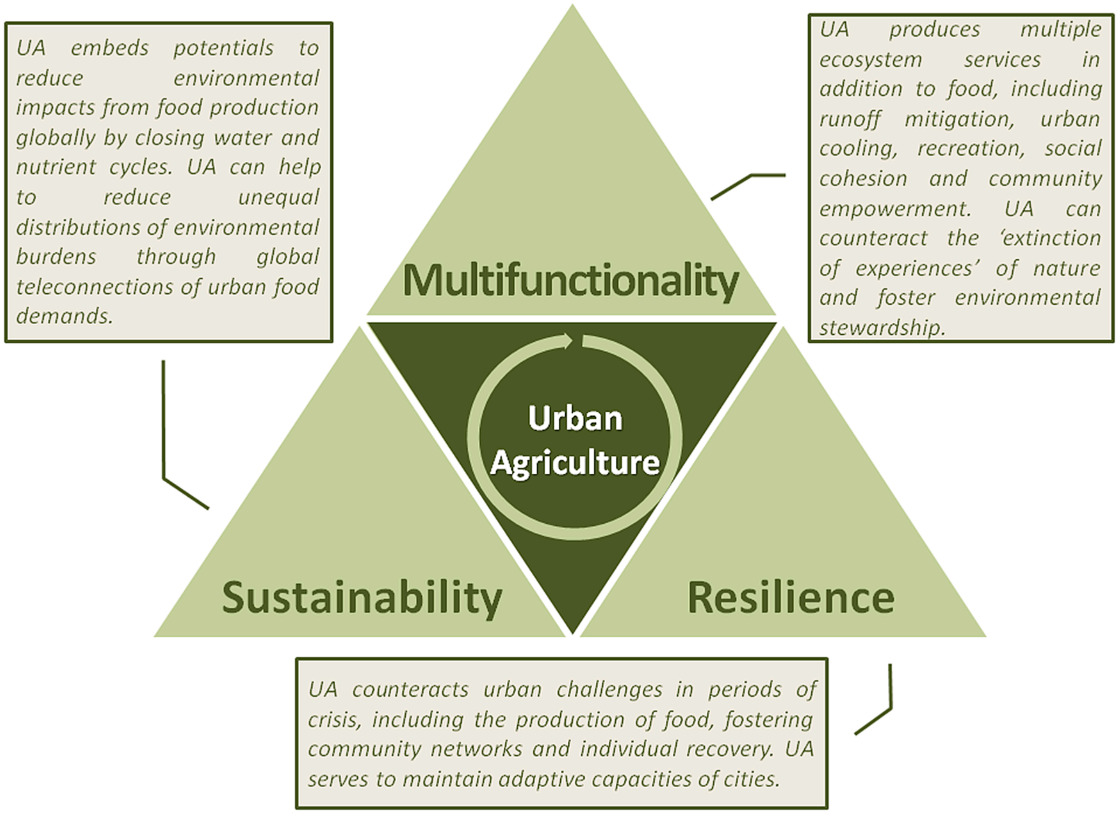

Fig. 1. Urban agriculture triad: Resilience, sustainability and multifunctionality.

as a necessary pre-step for building adaptive capacities, physically, institutionally and knowledge-wise (cf. De Luca et al., 2021), in order to mitigate more severe food crisis. Even if UA is only playing a limited quantitative role for the supply of food (Webb, 2011), the recovery of agricultural knowledge is playing a critical role for people to build psychological and social resilience in periods of crisis. Barthel et al. (2014) argue that urban gardens further act as pockets of social-ecological memory for the preservation of agrobiodiversity maintaining local landraces, agricultural practices and local ecological knowledge (Calvet-Mir et al., 2012), that can be activated in times of crisis and thus enhances a food resilience. For instance, in the twentieth century, UA has been critical in Europe and North America to sustain the after-war urban population with food (e.g. Barthel & Isendahl, 2013). More recently in the early 1990s, Havana implemented a large UA system after the dissolution of the Soviet Union, which keeps maintaining substance to 2 million city inhabitants (e.g. Altieri & Nicholls, 2020; Buchmann, 2009), and Freetown in Sierra Leone heavily relied on UA for the food supply of its 1 million inhabitants during a decade-long civil war starting in 1992 (e.g. Larbi & Cofie, 2007, cited by De Zeeuw et al., 2011). The most recent global scale stressor for urban food resilience was the financial crisis in 2008, and the related food crisis (Rosset, 2008). While global food prices doubled, many cities faced important social upraise and protests triggered by food shortage, including Port-au-Prince in Haiti, Ouhigouya in Burkina Faso, and Mahalla El-Kobra in Egypt (Baker, 2008), and foot shortage is often assumed to have played a major role in the formation of the Arab spring unrest (e.g. Harrigan, 2014; Rosenberg, 2011). Remarkably, some urban areas, such as the mega-metropolitan region of the Ganges-Brahmaputra Delta, including Dhaka in Bangladesh and Kolkata in India, were much less affected, arguably due to functioning local UA production systems (e.g. Barthel et al., 2019; Keck and Etzold, 2013).

In periods of wage reduction, job losses and increases in food prices, the urban poor are particularly vulnerable due to a lack of agricultural production to fall back on (Baker, 2008; Cohen & Garrett, 2010). This is primarily but not only true for urban poor in the global south, as COVID-19-related impoverishment in the USA is currently indicating. UA plays (and has always played) an important role as 'a survival strategy for the urban poor' in enhancing food security as well as healthy nutrition for the most vulnerable parts of the urban society not only in periods of crisis (Barthel et al., 2019; De Zeeuw et al., 2011; Zezza & Tasciotti, 2010). It is too early to say how severe the ongoing Covid-19 crisis will affect urban food supply (UN, 2020), but Covid-19 should be another reminder that planning urban futures must consider also unlikely scenarios of change. The fear for starvation has haunted cities over centuries (Steel, 2009:7), and even in cities in the global north, vulnerability in food security must not generally be excluded from land-use decision-making. When making our cities fit for future challenges, vulnerabilities of urban societies (including all its sub-groups) need a more careful consideration that is currently not given. As the examples show, UA is not only a keeper of 'social-ecological memories about food production and past crises' (Barthel et al., 2014) but also a way forward to build food resilience by diversifying the urban food sources. Interestingly, land must not necessarily be dedicated to UA practices at all time, if the potential for a quick transformation into UA production areas is given. This is the case in many Central and Western European cities in form of extended allotment gardens that are nowadays primarily used for recreational purposes but which preserve strong adaptive capacities for being turned into food production areas whenever needed (e.g. Keshavarz & Bell, 2016; Langemeyer et al., 2016), arguably for both reasons they gained strong popularity during the current Covid-19 crisis. Similar potentials have also been described for urbanized former farmland in the Chittenden County, Vermont, USA (Erickson et al., 2011); although the potential for quick transformations seems to erode with time passing without land being used for UA. That means maintaining potentials for implementing UA requires a strong and continued general awareness for vulnerabilities, and urban land-use planning to maintain UA potentials in a state that can rapidly be activated as source of food security. Especially, during longer periods without crises, during which UA is not essential for the provision of food, such awareness for vulnerabilities erodes and UA is getting under pressure by other urban land-uses (see Box 1).

In brief, despite wide evidence for the potential of UA to enhance urban food resilience (Barthel et al., 2019), for urban planning to activate this potential a more comprehensive understanding of vulnerabilities needs to be developed, including questioning for whom, when, where, and why (cf. Meerow & Newell, 2019). The lacking understanding of social-ecological complexity and awareness of potential future scenarios that might limit the supply of food imports and food security (e.g. Cadillo-Benalcazar et al., 2020; De Luca et al., 2021), leads to an under-prioritization of UA by urban land-use planning. To counteract this lack of awareness for urban vulnerabilities in urban planning, a stronger consideration of multiple interacting drivers of change is demanded, alongside a broader set of vulnerability indicators, covering social, ecological and technical parts of the urban system and its global dependencies (cf. Grimm et al. 2016, Depietri & McPhearson 2017).

Box 1 Eroding urban agriculture: The example of Barcelona, Spain

Barcelona, Spain, E.U., is a good example for an urban planning context where UA is not considered a priority any longer. Recently, a panel of experts, primarily made up by green space and land-use planners, was asked to prioritize urban deficits to be addressed by land-use planning. While planners, at the regional (Province of Barcelona) scale considered food provision as a relevant land-use planning goal, the importance dropped substantially at the Metropolitan scale, and zooming down to the Barcelona Municipality the priority in land-use planning for food provision was reduced to zero. Likewise, a similar exercise in the context of prioritizing different green roof types with regard to city needs showed very low priorities for food provision, compared to other urban needs, such as thermal regulation and runoff control (Langemeyer et al., 2020). The lacking importance of food provision in relation to local land-uses is mirrored by an important loss of UA. Just in the past two decades, the surface dedicated to the production of vegetables in the Province of Barcelona (which includes the Metropolitan Area and close-by towns) has been reduced by more than half: from 8,586 ha in 1999 to 3,007 in 2019 (IDESCAT, 2019); thereby outperforming global trends in UA reduction by far (Bren d'Amour et al., 2017). Local agricultural production has consequently decreased from 212,264 to 82,281 tonnes during that time period (IDESCAT, 1999). At the same time, innovative approaches to local food production, such as the commercial use of green roofs, are still not considered legal under Barcelona's current Metropolitan master plan. A consumer report of 2014 estimated that people in the Province of Barcelona consume on average about 190 kg of fresh fruits and vegetables per person, per year. Based on a population of 5.5 million people, we can quickly estimate that the Province of Barcelona is able to supply about 7.8% of its own consumption of fresh fruit and vegetables. This is even below other large city such as New York City and Los Angeles, U.S., for example, which can support about 10% of their populations with a 50-mile food-shed radius (Zumkehr & Campbell, 2015). The figures indicate a low sensitivity for vulnerabilities related to food shortage among Barcelona's city planners, also reflected by results from a recent resilience assessment in this city, which concludes that changes related to global climate change are more tangible to urban planners than other (more immediate) changes at the regional scale (De Luca et al., 2021; Andersson et al., 2021). This is somewhat surprising in a context where, the financial crisis in 2008 required school canteens to open during the summer break in order to guarantee proper nutrition of vulnerable children. However, the global decline in UA indicates Barcelona not to be an outlier but rather representing a global trend when it comes to prioritizing UA in urban land-use planning (e.g. Cilliers et al., 2020; García-Nieto et al., 2018).

3. Negative externalities and sustainable food supply

Global urban land teleconnections characterizing the urban food supply (Seto et al., 2012; Barthel et al., 2019) deserve stronger consideration by urban planning not only for reasons of urban food resilience but also in the face of sustainable global food production. In simple words, urban resilience goals must be aligned with global sustainability objectives (Elmqvist et al., 2019). For instance, the ongoing agricultural concentration may not be aligned with global sustainability objectives. It leads to severe damage of the environment (cf. Seto et al., 2012) and increases social inequalities globally (cf. Barthel et al., 2019), through, what Elmqvist et al. (2013) call, 'obscure indirect feedbacks' — compared to direct feedbacks that characterized pre-industrial cities, which were depending on their rural hinterland for food supply. Due to the historic dependency on local agricultural production, cities are generally located in the most fertile world regions, which consequentially means that urban expansions, taking place globally since the large acceleration, are affecting the most fertile soils (e.g. Güneralp et al., 2013), for instance in the Nile Delta (Bren d'Amour et al., 2017). Reduction of UA areas can hence not be compensated one-to-one elsewhere, and increases the pressure on global ecosystems disproportionally by enhanced intensification and larger surface demands on less fertile soils (Barthel et al., 2019).

One major concern of intensified agricultural production on less fertile soils is the massive use of mineral fertilizers on which already about half of the global food production relies (Dawson & Hilton, 2011). For example, to meet the global fertilizer demand, approximately 20 million metric tons of phosphorus are extracted every year (Liu et al., 2008) and it has been estimated that at current consumption rates the mineral fertilizer resources will at the most be a couple hundred years' worth (Villalba et al., 2008, Van Vuuren et al., 2010). The production of mineral fertilizers is extremely energy intensive (Edrisi et al., 2016) and responsible for approximately 5% of the global food production's carbon footprint — amounting to about 575 mega tons of CO_{2eq} per year (Gilbert, 2012). This is significant, as one third of our global GHG emissions come from agriculture (Gilbert, 2012). Especially nitrogen based fertilizers are problematic and recognized by the IPCC as major driver of global N2O emissions — a potent greenhouse gas (Smith et al., 1996). For instance, in 2017, 58% of the world's agricultural nitrogen fertilization came from urea with a total of 78 million tons used in agriculture alone (FAO, 2020), amounting in 2017 from 160 to 400 mega tonnes of CO_{2eq} only due to global urea production. While transportation itself has been found to be a minor source of carbon emissions from food imports (Weber & Matthews 2008), other externalities of distant food production are embedded in urban food imports. Sustainable urban planning must develop a more coherent understanding of the urban system and its global dependencies and teleconnections obscured through complex supply chains in order to reduce environmental impacts globally stemming from urban demands. More importantly, this understanding must be coupled to decision-making about urban and peri-urban land-uses.

Cities are a rich source of nutrients and UA offers the opportunity to effectively use phosphates and nitrogen recovered from urban wastewater and solid waste, thereby reducing negative externalities through the primary extraction of mineral fertilizers. For the Metropolitan Area of Barcelona, it has been estimated that integrating phosphate and nitrogen recovery technologies in the wastewater treatment plants could supply between 5 and 30 times the amount of phosphates required to fertilize the entire UA in the area (Rufí-Salís et al., 2020). The recovery of compost from the organic fraction of municipal solid waste offers additional opportunities for nutrient recovery, reducing both impacts from mineral fertilizer production as well as emissions from land-filling organic waste. UA offers the opportunity to reduce the N2O emissions not only by using less nitrogen fertilization but also from the use of more efficient technologies. For instance, using hydroponics in urban agriculture can reduce N2O emissions by half (Llorach-Massana et al., 2017). In addition, an increase in UA would significantly reduce food losses associated to the long supply chain incurred by importing crops from thousands of kilometers. Caldeira et al. (2019) estimated that for the EU, an annual total input of around 638 Mt primary food commodities results in approximately 129 Mt (about 20%) of food waste generated along the food supply chain, with the highest losses for fruits and vegetables. Shortening the food supply chain by enhancing UA, primarily for the latter goods, would hence allow lowering the amount of food production and accordingly the environmental impacts and surface requirements of food production it demands. However, the extent to which UA reduces environmental impacts depends much on the configuration and cross-sectorial integration of UA, which can be exemplified along the use of irrigation water.

Agricultural irrigation already accounts for about 85% of the global water use; with increasing urbanization, food and consecutively water demands are expected to rise further. Shifting from importing food to local UA production means avoiding the water costs elsewhere (Paterson et al., 2015). Whereas it is naïve to expect that UA can be implemented at no environmental cost, those impacts can be widely ameliorated through integrated urban water management strategies (Levidow et al., 2014). For instance, rain water harvesting and re-use can cover 18% of the irrigation needs even in arid climates such as in Khartoum (Sudan) (Mahmoud et al., 2014), a shift to drop irrigation can increase water yields from 60 to 90%, whereas the use of alternative agriculture techniques like hydroponics can reduce water requirements by about 30% (Rufí-Salís et al., 2020). Furthermore, urban planning must not shy away from influencing the selection of climate adapted crops and enforcing rotation techniques in UA, which results in important water savings with respect to non-adapted monocultures (Van Schilfgaarde, 1994).

In summary, fostering local food production through UA embeds large potentials to avoid a long list of detrimental environmental and social impacts that are generally not considered in urban land-use planning. This potential may be harnessed by the deployment of highly efficient and integrated UA systems. Yet, as a first step sustainable urban planning needs to base land-use decisions for and against UA within a wider context of urban food imports and negative environmental impacts through global teleconnections. Comparisons (for example based on Life-Cycle Assessments) of environmental impacts from local food production through UA and the alternative of food imports and its embedded impacts globally, including energy, water and nutrient consumption, as well as emissions to air, soil and water, offer a broader more robust knowledge base for truly sustainable urban planning.

4. Multifunctionality and ecosystem services

Beyond its potentials to enhance urban resilience and foster global sustainability, a third aspect of UA that should still find stronger acknowledgement in urban land-use planning are potential multifunctionalities (Lovell, 2010; Vásquez et al., 2019), or the provision of multiple ecosystem services beyond the supply of food that urban agriculture provides (Langemeyer et al., 2016; Lindley et al., 2018). Although ecosystem service assessments are on the rise, in the context of urban green infrastructure and nature-based solutions especially in Europe and North America (e.g. Gómez-Baggethun et al., 2013; Haase et al., 2014; Raymond et al., 2017), their uptake and incorporation into urban and peri-urban land-use planning is only slowly progressing, and did not considerably raise the relevance given to UA by urban planning despite large evidence bases. Green infrastructure approaches highlighting the multifunctionality of UA especially lack adaptations to urban realities in the global south (e.g. Lindley et al., 2018). While there is a new green fashion in urban planning, which includes the creation of avantgard UA rooftop gardens, maintaining existing UA at larger scales is less fashionable (Abo-El-Wafa et al., 2018; Bren d'Amour et al., 2017; García-Nieto et al., 2018). Still, enhanced food resilience and reduced environmental impacts are only reached if UA provides a substantial share of the urban consumption, which requires a certain level of intensification. This embeds trade-offs and reduces the multifunctionality of UA. Nevertheless, urban planning can help fostering an active societal debate about 'ecosystem service justice' (Langemeyer & Connolly, 2020) and the benefits that are most needed and thus to be produced by UA, in addition to food. It can further help steering UA activities towards prioritized co-benefits.

The potential co-benefits are manifold (Artmann & Sartison, 2018; Cilliers et al., 2020; Langemeyer et al., 2016; Lovell, 2010) and include erosion prevention and soil fixation by plant roots (Edmondson et al., 2014), buffers against flooding and storm water runoff through water retention by leaves and unpaved surfaces (Watts & Dexter, 1997) and related mitigations of negative environmental impacts on aquatic ecosystems, as well as pollination and seed dispersal by providing nutrients for bees and other pollinating insects (Andersson et al., 2007; Theodorou et al., 2016). With extreme heat events projected to be among the most severe and lethal effects of global climate change in cities (e.g. IPCC, 2014), urban micro climate regulation should be highlighted as another core potential of UA (e.g. Vásquez et al., 2019). Plant evapotranspiration increases the air humidity and which can create a buffer against urban heat island effect. Larger vegetated areas are reported to reduce air temperature in cities by up to 7 °C (e.g. Zupancic et al., 2015), while smaller areas such as green roofs still create temperature reduction by up to 3° (Smith & Roebber, 2011; Santamouris, 2014). The actual temperature reduction primarily depends on the species composition, and the leaf area, but might (potentially) also vary with the intensity of irrigation, with higher irrigation leading to a higher cooling effect (Broadbent et al., 2018). From a social perspective, urban farming has been reported to favor social inclusion and empowerment, not least for women in the global south (Orsini et al., 2013; Slater, 2001) and might thereby help to reduce social inequalities exacerbated by urbanization. Furthermore, citizen-led UA has shown to strengthen community-ownership and empowerment, which fosters bottom-up planning approaches not least in the global south (Cilliers et al., 2020). Another important prospect for multifunctional UA, primarily described for the global north, lies in the creation of co-benefits through recreational opportunities. This can consist in physical exercises, such as cycling and running and walking in UA landscapes, but also relaxation and disconnection from stressful urban life (Hawkins et al., 2011; Van den Berg & Custers, 2011), as well as nature experiences based on observations of seasonal changes and growing cycles (Wilson, 1992) and active engagement in gardening practices. The development of recreational potentials of UA is critical, because local recreation is often spatially concentrated in the remaining urban and peri-urban green areas, and this might lead to trade-offs and conflict over land-use (cf. Olsson et al., 2016; Turkelboom et al., 2018). However, trade-offs between UA and recreation seem to be avoidable and there might even be beneficial synergies (and additional income opportunities for farmers) if urban planning actively addresses and integrates these two land-use demands. Even more so, UA can foster important cultural ties between urban inhabitants and the hinterland. While these relationships are often glorified and romanticized (i.e. generally not fully grasping the reality of UA production, Steel, 2008) they have shown to shape urban people's sense of place and belonging (e.g. Tidball et al., 2014; Okvat & Zautra, 2014). This is core, not only for people's individual wellbeing, but cultural bonds between urban dwellers and UA might also help to break or at least alter the vicious circle of the 'extinction of experiences' (Miller, 2005) where physical distance to nature and its processes leads to a lack of understanding of human dependence on healthy ecosystems, which again leads to an underappreciation of nature and the need for its conservation. With a projected 70% of the global population to be living in cities by 2050 (UN, 2018), fostering these cultural ties (romanticized or not) seems to be essential in order to build the base for transformative change (cf. Theurl et al., 2020). Even small scale UA, in form of school, community, or allotment gardens, with limited or no contributions to food production can endorse nature experiences, and embed opportunities for environmental education and learning (e.g. Beilin and Hunter, 2011; Camps-Calvet et al., 2016; Schreinemachers et al., 2019), which can be seen as a foundation for support to sustainability objectives and might promote environmental stewardship by urban people (cf. Langemeyer et al., 2018).

In summary, UA provides multiple benefits to people and the environment beyond the production of food, including urban temperature regulation and recreational opportunities and allows for the creation of cultural bonds between urban inhabitants and their surrounding landscapes. Many of these benefits jointly produced with food are critically needed in an increasingly urban global society. Despite wide scientific evidence for this prospective, multifunctionality is hampered by classical zoning in land-use planning, low emphasis on green infrastructure planning compared to build infrastructures as well as lacking legal planning frameworks supporting UA combined with informality in urbanization in large parts of the urban south. The potential provision of multiple ecosystem services is still not sufficiently accounted for in praxis and thus does not positively influence land-use decisions in urban and *peri*-urban areas, which we assume another core reason for UA to have a difficult stand.

5. Concluding remarks

In this perspective essay, we discuss the importance of UA, in the face of urban food resilience, global sustainability, and multifunctionality, and argue that current models of urban land-use planning are insufficiently considering these three aspects. Most cities show a small degree of food sovereignty (Zezza & Tasciotti, 2010), and ignore the risk for urban food shortage, while UA has been shown to provide large potentials to counteract vulnerabilities in relation to global food supply chains and concentration processes in the agro-food business and thereby to enhance food security and adaptive capacities in cities in times of crisis (Barthel et al., 2019). UA production has the potential to reduce the environmental impacts associated to conventional agricultural production and the global food supply chains, because it can close nutrient and water cycles in urban areas and avoid agricultural production on less fertile soils (e.g. Bren d'Amour et al., 2017). While sustainability is high on urban planning agendas in many parts of the world, the obscured complexity behind urban food supplies and the teleconnections (Seto et al., 2012) of environmental externalities that food imports embed are hardly considered in urban land-use planning. Critically needed are new urban planning paradigms highlighting the importance of non-built-up areas in general (Nadal et al., 2018) and supportive legal framework for UA in particular (Chaminuka & Dube, 2017). Today, urban land-use planning is still underestimating the potential of UA as multifunctional nature-based solution (Artmann & Sartison, 2018) that provides multiple ecosystem services and counteracts a wide set of other urban challenges beyond the provision of food. At least at this last frontier it seems that urban planning in the global north is increasingly picking up on the scientific advances with ecosystem service research gaining increasing influence over urban and peri-urban planning decisions, which might also influence future evaluations of UA land-use. Unfortunately incorporating food resilience and global sustainability into urban land-use planning still faces more challenges, both, in the global south and in the global north.

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