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Global Urbanization and Food Production in Direct Competition for Land: Leverage Places to Mitigate Impacts on SDG2 and on the Earth System

Abstract

Global urbanization and food production are in direct competition for land. This paper carries out a critical review of how displacing crop production from urban and peri-urban land to other areas---due to issues related to soil quality---will demand a substantially larger proportion of the Earth's terrestrial land surface than the surface area lost to urban encroachment. Such relationships may trigger further distancing effects and unfair social-ecological teleconnections. It risks also setting in motion amplifying effects within the Earth System. In combination such multiple stressors sets the scene for food riots in cities of the Global South. Our review identifies viable leverage points on which to act in order to navigate urban expansion away from fertile croplands. We first elaborate on the political complexities in declaring urban and peri-urban lands with fertile soils as one global commons. We find that the combination of an advisory global policy aligned with regional policies enabling robust common properties rights for bottom-up actors and movements in urban and peri-urban agriculture (UPA) as multi-level leverage places to intervene. To substantiate the ability of aligning global advisory policy with regional planning, we review both past and contemporary examples where empowering local social-ecological UPA practices and circular economies have had a stimulating effect on urban resilience and helped preserve, restore, and maintain urban lands with healthy soils.

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1. Introduction

Soil is a key resource for all terrestrial food production systems. The aim of this paper is to highlight and discuss effects on sustainability resulting from land-use shifts following a predicted increase in spatial urban encroachment on fertile soils of crop production (Bren d'Amour et al., 2017). We focus on the sustainability aspects highlighted by Sustainable Development Goal 2 (SDG2): to achieve food security for all (United Nations, 2015). A series of interrelated global social-ecological change trends are cause for serious concern regarding the ability of the world to feed its population equitably and sustainably (Godfray et al., 2010; Springmann et al., 2018). First, healthy soils—defined as soils that have the capacity to function as a vital living system, to sustain biological productivity and diversity, maintain environmental quality and promote plant, animal, and human health (Doran and Zeiss, 2000)—are degrading (Montgomery, 2017). Second, the global population is growing (UN-Population Division, 2017: 2–3). Third, the global share of food producers is decreasing (FAO et al., 2017: 89–90; World Bank, 2017). Fourth, urbanization is a major driver of land-use shifts as the share of the Earth's population that lives in urban landscapes is predicted to reach two thirds by 2050 (UN- Population Division, 2014; UN-Habitat, 2016). Fifth, global inequalities are surging (Stiglitz, 2018), with some estimates suggesting it is at an all-time high (Kohler et al., 2017). Sixth, the total global acreage of land used to produce food is decreasing owing to competition for other land-uses (Ramankutty et al., 2008). Among these contenders are competing crop production (e.g. for cattle feed, biofuels, and fiber for the clothing industry), infrastructure, industry, and different kinds of urban land-uses that cover or remove soils (Bren d'Amour et al., 2017). Seventh, converting additional land for agriculture triggers climate change and biodiversity loss, which in turn result in cascading interactions that are predicted to negatively impact food security due to increased frequency and intensity of extreme events, including pest out-brakes, flooding, and drought (IPCC, 2014; MEA, 2005).

These interconnected trends and processes of global social-ecological change are the new normal in the Anthropocene. Originally proposed to describe the present time interval characterized by anthropogenic transformations of the Earth at the global scale, in particular biosphere species extinctions associated with changes in the chemical composition of the atmosphere (Crutzen, 2002), the Anthropocene carries emblematic significance that designates negative human impacts on environments more generally (Waters et al., 2016). In political ecology a persuasive argument has been made that by suggesting that humanity as a whole is the driver of change, the Anthropocene is a misleading notion. Critique emphasizes that the Great Acceleration of human-induced change (i.e., since about 1950) should be credited to unregulated global capitalism and to the consumption patterns of developed countries (Hornborg, 2017; Malm and Hornborg, 2014; see also Steffen et al., 2015). From the perspective of urban ecology, a similar case can be made that processes of change are particularly driven by global urbanization processes that accumulate, concentrate, and centralize value, matter, energy, and people in hubs of ‘modern urban lifestyle mass consumption’, suggesting that the present more precisely can be described the Urban Anthropocene, or the Urbanocene (West, 2017).

While processes driving global social-ecological change are interconnected and highly complex, we argue here that curbing urban encroachment on urban and peri-urban land with soils suitable for food cultivation is essential for maintaining and building food security, particularly in the Global South (Bren d’Amour et al., 2017). Conceptually, we draw on the notions of economic globalization (Stiglitz, 2018), open access and global governance (Galaz et al., 2012; Ostrom et al., 1999), land grabbing (Rulli et al., 2013; Steel et al., 2017; Zoomers et al., 2017), urban agriculture (Cruz and Medina, 2003; De Neergaard et al., 2009), and urban resilience (Barthel and Isendahl, 2013) to review challenges associated with urban encroachment on landscapes of food production and to discuss strategies to navigate and mitigate such land-use shifts. Initially, we discuss drivers and the adverse consequences that contemporary patterns of urban area expansion have on global sustainability in general and on food security in particular (figure 1 and figure 2). We then discuss open access dilemmas associated with globally imposing common-pool resource regulations in the current context of market liberalization and privatization. We proceed with a search for solutions that can resist and intervene in the destruction of urban croplands (figure 3). We identify leverage places to intervene in the alignment of advisory global land-use policy with regional planning for enabling the full bloom, plurality, and potential of urban and peri-urban agriculture (UPA).

2. A forgotten issue in global sustainability: urban encroachment on agricultural land

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; Vliet et al., 2017). Increasing intensity levels in food production, converting uncultivated land for agriculture, and increasing food trade may combine to mitigate the effects of emerging land-use competition in urban contexts, but cascading effects on the Earth System and potential asymmetric effects on wealth and risk may follow, as discussed below.

2.1 Urban expansion on land with soils twice as productive as the global average

We argue that the most important options remaining to address SDG2 are to maintain the current stock of land with soils suitable for food production, safeguard it from competing forms of land-use, and sustain strategies that promote and maintain soil health. However, surrendering land with agriculturally highly productive soils to land-uses other than food production is precisely what is happening. Urban expansion on agricultural lands is recorded around the world (Bagan and Yamagata, 2014), for instance in China (Chen, 2007; Li et al., 2015; Tan et al., 2005), Ghana (Naab et al., 2013), India (Ahmad et al., 2016; Fazel, 2000; Goldman, 2011; Pandey and Seto, 2014), Kenya (Mundia and Aniya, 2006), Thailand (Kamal et al., 2017; Losiri et al., 2016), and the United States (Haase and Lathrop, 2003; Mar Lopez et al., 2001). Bren d'Amour et al. (2017) estimate that urban encroachment of urban expansion on agricultural land will destroy c. 2% of the Earth's soils by 2030 (0.3m km^2) unless current drivers are mitigated (see also Vliet et al., 2017). Land conversion is predicted to occur mainly in the Global South (c. 90%), and is estimated to continue until at least c. 2050 (UN-Population Division, 2014: Vliet et al., 2017).

The fact that the soils on land surrounding urban areas are relatively fertile comes as no surprise to historians since both Adam Smith (1776) and Heinrich von Thünen (1842) noted the spatial correlation between cities and intense terrestrial or aquatic food production, with the produce sold on urban markets (Bairoch, 1988; Deng et al., 2006; Isendahl and Barthel, 2018; Satterthwaite et al., 2010; Sinclair et al., 2019; Yang and Xiubin, 2000). Hence, spatial encroachment is estimated to be on land that, based on yields in quantitative terms, is approximately twice as productive as the global average (Bren d'Amour et al., 2017).

It is estimated that about 80% of the global reduction in cropland for food production will take place in Asia and Africa. Egypt, Vietnam, and Nigeria are predicted to lose c. 34–38%, 15–17%, and 11–13% respectively of their national crop production capacity owing to the loss of their most fertile lands to urban expansion (Bren d'Amour et al., 2017). Cuts in national production capacities increase often already high dependence on food imports, with, for instance, Burundi currently importing 25% and Rwanda 22% of their cereals (FAOSTAT, 2013). The land-scarce region of South Asia is also at particular risk (Bruinsma, 2003: 130).

In China, emerging as the economic super power of the world, over 45% of the population lived in urban areas in 2011 and by 2050 this share is estimated to increase to 75% (Moyo, 2012). Between 1997 and 2008 China's agricultural land decreased by 1m ha due to urbanization, equaling national agricultural production losses of c. 8.2–9.8% (Bren d'Amour et al., 2017). Furthermore, 40% of China's arable land is subjected to desertification (Bruinsma, 2009) and a substantial proportion has been polluted by heavy metals (Chen, 2007). Hence, the linked processes of increasing urbanization and decreasing agricultural acreage present tremendous challenges to provide food security for China's 1.3 billion inhabitants. China's challenge is addressed by three main strategies: (1) investing to increase the productivity of the national agricultural resource base (meaning the relative cost of domestic food production goes up, at least initially); (2) increasing food imports (greater connectivity to the global food system); and (3) private investors initiate strategic purchase or lease of land, typically in countries with weak regulatory institutions (particularly in Africa, eastern Europe, South America, and Southeast Asia), in order to produce food crops for direct import to China (Arezki et al., 2015; Rulli et al., 2013).

2.2 Increased trade and social-ecological teleconnections as prospected consequences

Since two thirds of the world's soil resources are already degraded (FAO et al., 2017), further urban encroachment on fertile land poses global sustainability challenges. Most obviously, regional urban food security may become increasingly dependent on food imports. Food trade is and will likely remain a major factor for building local food security resilience (Bren d'Amour et al., 2016). If performed fairly and on functioning markets, food supply chains benefit everyone involved in the food value chain, from the farm sector through the increasingly productive midstream segment to trade (see Reardon, 2015). However, import dependence for food security involves risk, including reliance on the efficiency and fair functioning of complex food supply chains. When a greater number of actors intertwine with a controlling global financial system this generates vulnerabilities (Isakson, 2014; Moyo, 2012; WEF, 2017). Arguably, if the global financial system is structured by policies that amplify an asymmetric distribution of wealth (Stiglitz, 2018), financialization of food causes distancing that 'affects the distribution of power and influence over the governance of the food system' (Clapp, 2014: 798). Subsequently, the asymmetry of access to both food supply chains and the financial system exacerbates (Clapp, 2014; Isakson, 2014; WEF, 2017). Asymmetric access can form the root of unfair social-ecological teleconnections (Meyfroidt et al., 2013; Seto et al., 2012), which causes indirect degradation of distant social-ecological systems (for instance food systems) affecting producers, consumers, institutions, and organizations intertwined with the land, soil, and organisms involved (figure 1). This chain of events is particularly likely to occur if the financial capital stocks between the parties are biased already at the onset.

Food trade may involve control over distant social-ecological systems abroad to provide national food security. The obvious example is cash crop production in the Global South that increase national income from the export of agricultural produce—potentially contributing to overall development and poverty alleviation—but that also may reduce local capacity for food security. Several countries in this region have comparative advantages (climate, productive soil, cheap labor costs) to produce agricultural commodities for food, feed, fuel, and fiber (the quadruple F) in vast quantities for export (e.g., cacao, coffee, cotton, soybean, tobacco, tea, etc.). To be profitable, however, cash crops are typically produced in high-input monocultures, causing land-use change that compromises local ecosystems and their services as well as the capacity for smallholder subsistence farming (e.g. Meyfroidt et al., 2013; Zoomers and Otsuki 2017).

The external control of productive landscapes in the Global South may lead to increasingly unfair social-ecological teleconnections (figure 1), particularly if involving large-scale land acquisitions—or land grabbing— claiming ownership of the productivity of soil nutrients and water resources (Dell'Angelo et al., 2017a, 2018). Maintaining food security principally from food trade and land grabbing nations may potentially undermine their own domestic agricultural resource base and put these areas to other uses found more beneficial, but not without tradeoffs.

Land acquisitions in the Global South usually come with greater productivity and cost efficiency than the lost domestic production capacity that they compensate for (Cotula et al., 2009). Transnational food and agricultural corporations and, increasingly, corporations active in the digital agriculture market, may not technically operate as land grabbers, but their strategies to dominate markets and control food production chains—from seed, soil and pest management, to the process of acquiring the harvest and, subsequently, storing, transporting, and distributing it for retail sale—are similarly intrusive (Word et al., 2014). In a sense, land grabbing is a particularly invasive form of food import strategy with strong colonialist tendencies, since not only the produce is purchased but also the means of production. Notwithstanding, land grabbing has become increasingly common to address national food security across economically powerful nations (Rulli et al., 2013). Since agricultural land with soils suitable for food production is a finite resource, land grabbing can be likened to a zero-sum game in which one agent (the land grabber) increases its national food security at the expense of the capacity for food security of the other (the land provider) (cf., Hornborg, 2009).

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Many high-income countries depend on food imports to build food security. Between 1960 and 2005 global food imports quadrupled, leading to a more distributed access, but at the same time increasing the spatial distance between producer and consumer, creating vulnerabilities to potential spikes in food prices and cuts in trade-flows (cf. Bren d'Amour et al., 2016; Clapp, 2014; Gordon et al., 2017; Isakson, 2014). To remedy this risk, high-income nations continue to increase their control over subsistence resources in low-income countries via transnational food and agriculture corporations, sovereign wealth funds, and other non-national entities (Rulli et al., 2013; UNEP, 2012). Full-scale land and water grabbing is perhaps the subsequent step in a logic of securing food by economically internalizing external resources. Unless regulated nationally and internationally, grabbing practices may emerge even more strongly in the future as a strategy to respond to the vulnerabilities of trade dependency for food security by high-income countries (Rulli et al., 2013).

These food security strategies typically lead to unfair gains by already privileged nations and corporations. Land grabbing and transnational domination sustains and deepens structures of socio-economic inequality, and increases asymmetrical access to food. Food exports generate income for many countries in the Global South, and are important sources for economic development and poverty alleviation, but ‘free trade’ is often a misnomer for these relations, because the rules of globalized markets do not provide equal benefits for all parties involved. Global market rules are biased towards premiering large corporations and wealthy nations—indeed these actors have largely set the rules (Stiglitz, 2018). Furthermore, free trade as a response to the loss of domestic food production capacity may be deceptive for high-income countries too. Under normal conditions, when food can be more cheaply imported from elsewhere, it masks the tradeoffs of dependence, as well as has a negative impact on environmental sustainability and climate change (Fraser and Rimas, 2010; Steel, 2010). An analogy with the 1973–1974 oil crisis (when OPEC shock-raised the price of raw oil on the global market) and subsequent—poorly masked—petroleum wars (Tainter and Patzek, 2012) is not far-fetched, because it illustrates some of the consequences of being dependent on the competitive global ‘free’ market to access a vital resource. The chosen response cannot be the emerging practice of land grabbing, thus compromising the access to food of others and environmental sustainability, if our goal is equitable and sustainable food security for all.

Hence, under current regulation, global economic liberalization is highly unlikely to be a trajectory towards sustainable and equitable global food security. The indirect land changes it causes have detrimental effects on countries in the Global South with weak regulatory institutions that are susceptible to lose not only peri-urban land to urban expansion but also other land with high-quality soils due to cash-crop export industry or full blown land grabbing. Significant proportions of the land at risk are already being farmed and in common-property systems, displacing local populations (cf. Dell'Angelo et al., 2017b; Messerli et al., 2014; Zoomers et al., 2017). Contrary to sustainability and equitability, the biased dynamic of free trade as practiced under conditions that tend to stimulate asymmetrical flows of food commodities (rather than distributional reciprocity), reduces options to obtain food security and diminishes national sovereignty and maneuvering-space to impose policies and regulations that stimulate food production for domestic markets. The vulnerability of domestic markets is particularly worsened and apparent when multiple stress-factors simultaneously act on the global financial sector and the global food system (as happened in the 2007–2008 food crisis) (Arezki et al., 2015; Bren d'Amour et al., 2016; Cotula et al., 2009). During such crises in the food supply chain staple food prices spike on the global market, creating severe shortages leading to surges in food prices on local markets in weak economies that expose the most vulnerable—in particular the urban poor in the Global South—to impoverished access to food. Inaccessibility establishes the basic condition for urban food riots, resulting in considerable further human suffering.

Data (FAO et al., 2017) suggest that annual global food production averages are currently sufficient to provide food security for all, and that reducing food waste while combating asymmetrical access to the total global food resource framework remains the major challenges. For countries that import a substantial and increasing portion of their total food consumption, the loss of domestic production capability threatens to erode their resilience to the volatility of global food prices that result from a number of causes, including regional social conflict (Basher, 2014; Fader et al., 2013) and commodity speculation on food following failing harvests (Cotula et al., 2009; Isakson, 2014). Since the structures that perpetuate asymmetrical access to the world's collective food produce will persist if present trends are not reversed, more food will need to be produced to empower those most susceptible to food insecurity (Hunter et al., 2017).

In conjunction with demographic changes and expected dietary shifts at the global scale (Pingali, 2007), fluctuating crop yields due to climate change impacts and the pressure on cultivable land to provide not only food, but also feed, fuel, and fiber, increases competition for land and, therefore, the likelihood for higher global food prices (Holt-Giménez et al., 2012; Ramankutty et al. 2018; Timmeren, 2006).

2.3 Amplifying effects on the Earth System when cultivating pristine ecosystems

To compensate for the loss of peri-urban croplands to urban expansion without risking food security there are calls to improve cultivation practices by way of intensification and by opening up of new croplands by converting pristine ecosystems (Balmford et al., 2005; Battisti and Naylor, 2009; Foley et al., 2011).

The conflicting development goals to, on the one hand, conserve biodiversity and, on the other, to maintain food security have focused the solution-driven debate on the 'land sparing–land sharing' dichotomy (Brussaard et al., 2010; Grau et al., 2013). Yet, it is acknowledged that our current scientific knowledge is inadequate to appropriately quantify the tradeoffs of land-use at applicable decision-making scales (DeFries et al., 2004; Fischer (J) et al., 2014; Grau et al., 2013). Nevertheless, owing to the expectation that tradeoffs and amplifying dynamics will significantly increase environmental, economic, and social costs, converting previously uncultivated terrestrial ecosystems for agricultural food production is not a viable solution to build food security (Phalan et al., 2011; Ramankutty et al., 2002; Smith, 2013).

Since croplands in near-urban contexts are about twice as productive as the global average (Bren d'Amour et al., 2017), shifting crop production to other areas will demand a substantially larger proportion of Earth's terrestrial land surface than the surface lost to urbanization (Figure 2).

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Recent observations show that the major gains in all new cropland are generated by deforestation (Gibbs et al., 2010; Hosonuma et al., 2012; Lambin et al., 2011). This indicates that land cover change caused by urbanization multiplies the loss of existing cropland and involves telecoupled deforestation (Seto et al., 2012; Vliet et al., 2017). In addition to the direct impacts of urban encroachment onto croplands, massive urbanization processes influence land cover changes through a number of other indirect relations (Seto and Ramankutty, 2016). For instance, a shift from a rural to an urban lifestyle has been associated with dietary changes towards a higher consumption of meat, fruits, and dairy products (Pingali, 2007). Hence, these and other behavioral shifts associated with urbanization require additional land for agriculture (Kastner et al., 2012).

Land cover changes triggered by urbanization may thus involve a series of cascading effects towards Earth System tipping points (Steffen et al., 2018). Tipping points include overshooting global carbon budgets due to decreased levels of natural sequestering, loss of genetic and species diversity, decreasing albedo effects, shifts in terrestrial water cycles, as well as instigating local soil nutrient depletion and soil erosion (Andrews et al., 2017; Brussaard et al., 2010; Green et al., 2005; Le Quéré et al., 2018; MEA, 2005; Rockström et al., 2017; Smith, 2013; Sterling et al., 2013). For instance, c. 25% of anthropogenic greenhouse gas emissions are sequestered in non-cultivated terrestrial ecosystems (Rockström et al., 2017). There are vast tracts of re-forested agricultural lands in the former Soviet Union that are possible to re-cultivate to attempt to mitigate global food shortages, but re-cultivating those may potentially contribute to shifts in global carbon budgets (Kuemmerle et al., 2015). Furthermore, non-cultivated terrestrial ecosystems typically maintain high biodiversity and a series of ecosystem services necessary for the function of the Earth System (Lewis, 2006: 195–196). It is important to note that we are referring here to agricultural land-use of the recent (i.e., since the Great Acceleration)—not ancient—past. Although the detailed historical ecology of the world’s different biomes is poorly understood, archaeological research shows that several environments that until very recently were understood as pristine—for instance, the tropical rain forests of the Amazon Basin (Arroyo-Kalin, 2019; Balée, 2013)—have co-evolved under significant human influence, including soil and plant management for agricultural food production. These environments—unless cultivated since the Great Acceleration—are here regarded as non-cultivated terrestrial ecosystems, and thus in need of protection from unsustainable re-exploitation. Respecting the consequences of converting previously uncultivated land to agriculture (MEA, 2005), continuing to do so risks setting off cascade effects in ecosystem responses over several spatial and temporal scales (Creutzig et al., 2019; DeFries et al., 2004). Therefore, achieving SDG2 is impossible without the sustainable management of existing agricultural land and associated soil ecosystem services (Barthel et al., 2013; Foley et al., 2005; Gordon et al., 2017).

Consequently, there is a need to focus on managing long-term soil health in landscapes that are or recently have been in agricultural food production. Meanwhile, the capacity to increase yields on land currently in food production circulation is limited by a global tendency towards soil health decline. Soils under high input-based agriculture have typically been mismanaged and lost their capacity to produce independently without the subsidy of significant inputs of various chemical cocktails (Montgomery, 2017).

2.4 Intensification and soil-restoration

Can restoring land (Lal and Stewart, 1992) mitigate the losses of land with fertile soils? Even if we assume technological advances (Walter et al., 2017), the answer is not straightforward. The main reason is that land per se is not a fully substitutable resource. Variability in sunlight, water, soil nutrients, and erodibility limit agricultural production differently. This is particularly so if the idiosyncrasies of local social-ecological conditions and agricultural knowledge are not well managed (Isendahl et al., 2013) or adopted within alternative, landscape-specific agro-ecological regimes (Altieri, 1987; Barthel et al., 2013). In addition, much of the world's prime cultivable land is already under cultivation (Alexandratos and Bruinsma, 2012; Bruinsma 2003; Fischer et al., 2014). Yield trends often stagnate for key crops owing to degrading soil productivity that follows from poor management practices as initiated globally through the green revolution bundle of agro-technological solutions. Intensification is highly dependent on inputs to maintain crop yields at economically sustainable levels, even over the short term (Foley et al., 2011; Lobell et al., 2011; Ray et al., 2012).

Instead, the restoration and conservation of productive land seems a more effective option. Currently, soil restoration—rebuilding productive agricultural soil through restorative measures of soil and crop management (Lal and Stewart, 1992)—is critical for building food security sustainably. For this to work, however, the duration of soil restoration (the time between commencing the restoration and the point at which it has been sufficiently restored) must not exceed current rates of soil degradation. However, given the fact that soils are heterogeneous, there is no clear timeframe for soil restoration (Ruzek et al., 2001). For instance, a series of soil conservation management studies suggest that soil organic carbon (SOC) content recovers after 25 years of conservation tillage, as opposed to conventional tillage (Alvarez, 2005). Other studies demonstrate significantly shorter recovery times. Hart et al. (1999) measured microbial biomass recovery in degraded soil following Nitrogen (N) fertilizer application and found that N had recovered to 65% after only three years. Similarly, Hernández et al. (2015) studied a range of physical and chemical soil indicators (water holding capacity, aggregate stability, total N, pH, and electrical conductivity) after the addition of commercial compost, reporting significant improvements in all indicators after five years.

It is clear, therefore, that recovery time is dependent on multiple factors, including climate, parent material, hydrology, soil texture, soil biology, soil quality prior to management, economic resources, and the specific soil restoration management strategy put in place. Although it is undeniable that soil restoration forms a pillar for building food security sustainably, it does neither provide a one-size-fits-all quick-fix nor is it the only solution needed or on offer. Conventional agriculture, however, has partly ignored restoring soil fertility to focus on the use of petroleum-derived fertilizers, pesticides, herbicides, GMO, heavy machinery, irrigation, and, increasingly, digital monitoring and communication tools (Altieri, 1999; Ramankutty et al., 2018; Walter et al., 2017).

To feed a growing population equitably within planetary boundaries remains a global challenge facing humanity. Since land per se is not a fully substitutable resource and opening up new land for cultivation is riddled with uncertainties relating to cascading effects on the Earth System, there are strong arguments for safeguarding, conserving, and restoring productive land for food production in urban landscapes.

3. Exploring governance strategies to protect croplands in urban landscapes

Although the destruction of urban land with soils suitable for agriculture is a process that plays out at the local scale, the aggregated effect of soil loss is indeed a global sustainability issue. Viewed from the perspective of the urban poor in the Global South, loss of domestic production capability threatens to erode their resiliency to the volatility of global food prices. Halting urban encroachment onto landscapes of food production moderates predicted social costs, but also—since cultivating pristine ecosystems will strain planetary boundaries—navigates away from Earth System tipping points.

3.1 Governing urban cropland as a global common-pool resource

The aggregated scale raises the question if the world's assets of land productive for agriculture need to be considered a single global commons (Creutzig, 2017). Drawing on the work of Elinor Ostrom (e.g. 1990), Creutzig (2017) argues that insights synthesized from successful collective management of local commons can be scaled-up to the global level of contemporary economic systems to achieve a sustainable and just distribution of the resources collectively generated from all global lands.

There is an urgent need for institutional innovations in the field of global land-use governance (Steffen et al., 2018), at the same time as there are political challenges of implementation (Galaz et al., 2012; Oliver et al., 2018; Ostrom et al., 1999). Galaz et al. (2012) argue that the main challenge to global collective action is the high transaction costs resulting from working across the fragmented settings of all implicated institutions. In the near future (2050), the global population will be between 9.8 and 11.1 billion people (UN- Population Division, 2017); a population with vast cultural, socio-economic, and ideological diversity, living in societies at various levels of development, and that experience and prioritize societal challenges differently. The multidimensional heterogeneity of the global community presents difficulty to establish and organize institutions at appropriate scales and to agree on and enforce regulation. With the present rise of protectionist national policies, the idea of finding shared interests and understandings is losing global momentum. This problem is exacerbated by 'North–South' conflicts, which largely stem from a colonial past and a neo-colonial present that typically reinforces economic inequality. For good reason, such conflicts introduce distrust between countries in negotiations for fair regulations (Ostrom et al., 1999; Stiglitz, 2018).

To date there has been no global government, so the basic rule of collective choice for global governance needs to be based on voluntarily compliance with negotiated treaties (Ostrom et al., 1999). Fifty years have passed since Hardin (1968) published the influential article 'The Tragedy of the Commons'. Most economists agreed with Hardin's metaphor that users of a commons are caught in an inevitable process in which the common good will be lost due to self-interest that eventually will lead to the destruction of the very resource on which they depend. Hardin's hypothesis was later rephrased as 'the tragedy of open access' (Ostrom, 1990). Accordingly, Ostrom et al., (1999) problematizes cross-scale situations, or cross-national resource systems, as these often result in open access to common resources owing to the complexities involved in working out the conditions for how to clearly define institutional boundaries. These political complexities are incurred, for instance, when defining group boundaries, when matching the rules that govern the use of commons with local needs and conditions, when providing means for local populations to dispute or modify established rules, or when imposing sanctions on violators.

From a global outlook, global governance of fertile soils in urban landscapes share many open access dilemma features. It is likely that costs exceed gains at the level of interest and influence of policy makers. Local costs for maintaining soil health and fertility for future agricultural production will be substantial, including forfeit investment, services, housing, business, or tax revenues. Urbanization results in scarcity of land, accompanied by an increase in land prices, and the subsequent subdivision of land; a process that favors the growth of smaller parcels of private land ownership, where each is used by the purchaser to maximize profit (Barzel, 1997; Lee and Webster, 2006), and where each parcel is subjected to global financial speculative investment (Batty, 2008; Fazel, 2000; Harvey, 2012; Sassen, 2014). As Ryan-Collins et al. (2017: 190) note: 'Lands primary economic function evolved from being the site of food production to being the site of capitalistic industrial production, to becoming the site of a near-universally entitled consumption good—the family home—in the twentieth century and increasingly the source of speculative investment. During all these periods, land has also served as a source of wealth, power and status, and so the control of land, and the laws governing its ownership, transfer and use, has always been a central focus of political contestation'.

Even if national and regional governance may recognize the importance of protecting land with fertile soils for crop production, planning institutions are typically weak or even absent where massive and rapid urban development takes place (Bhatta, 2010; Drescher, 2001b; Mougeot, 1996; UN-Habitat, 1998; Zoomers et al. 2017). Urban governments in different geographical and cultural contexts are corrupted to different degrees, hold different governance capacities, prioritize different needs for development, and perceive risks differently (Keck and Etzold, 2013; Mukherjee, 2015; Rhaman et al., 2013). Therefore, urban governments differ greatly in their capacity to establish institutions and enforce regulation. A global common-pool management approach to protect urban land with fertile soils implies a series of difficult collective action dilemmas at the level of scale-appropriate institutions and enforcing regulations. Hence, global policies cannot be regulatory, only advisory.

3.2 Urban and peri-urban agriculture (UPA) as leverage places

Gordon et al. (2017) argue that parts of the food system need to transform in order to meet food and nutrition security while remaining within planetary boundaries. They make three proposals that counteract the distancing generated by financializing the food system (Clapp, 2014): (1) enhance the transparency between consumers and producers; (2) foster biosphere stewardship behavior among key actors; and (3) reconnect people with cultures of cultivation. Urban and peri-urban agriculture (UPA) often includes Gordon et al.'s (2017) sustainable practice principles and could act as living laboratories for a wider transformation that sustains global food security (Hebinck and Page, 2017; Oliver et al. 2018; Shepon et al. 2018). Can UPA also play a part in navigating the competition for land between food production and urbanization? Below we discuss why policies protecting croplands as one global common-pool resource can be supported by UPA and regional zoning in urban landscapes.

Any global blueprint solution is illusive for navigating the direct competition for land between food production and urbanization. However, from a global outlook shaping the spatial form of urban growth is crucial to strike a balance between the resilience of the biosphere and urban sustainability (Güneralp et al., 2017; Samuelsson et al., 2018; Soga et al., 2014). Hence, a global advisory policy aiming at treating urban lands with fertile soils as one global commons needs to be informed by the sustainability implications of urban form. Arguably, regional zoning policies may be an effective tool to guide land-use-considerate urban expansion (Bhatta 2010; Viljoen and Wiskerke, 2012). Soil quality is, however, rarely considered a resource in the governance of land in urban landscapes (EEA, 2015), which is one reason for involving inhabitants in UPA (Egerer et al., 2018). Investing in the management of healthy functioning soils is a basic principle of UPA (De Neergaard et al., 2009), not least since the main limitation of UPA is the availability and access to land.

The contemporary global UPA movement began in the late 1970s and early 1980s (Smit, 1996), with subsequent research examining nutrition promotion, alleviation of hunger, scavenging, waste treatment and nutrient recycling, and the dynamics of the informal sector (De Neergaard et al., 2009). Canada's International Development Research Center (IDRC) was a leading initial supporter of research and development in the Global South, and created the Global Facility for Urban Agriculture (GFUA) in 1996. The United Nations University, through its Food–Energy–Nexus Program, had a significant influence on UPA research in the 1980s (Sachs and Silk, 1990), with international development cooperation to support UPA accelerating in the 1990s (De Neergaard et al., 2009; Drechsel and Kunze, 2001). On the international level the Support Group on Urban Agriculture (SGUA) was formed by the UNDP in 1992 to examine issues related to food security and UPA, especially in the Global South. In 1996, SGUA took the initiative to set up a Resource Centre on Urban Agriculture and Food Security (RUAF), based in the Netherlands and consisting of a network of regional resource centers. RUAF remains an international key organization in the promotion of UPA. An informal working group on UPA was created at the Food and Agricultural Organization of the United Nations (FAO), which was later formalized as the Priority Area for Interdisciplinary Action (PAIA) Food for the Cities working group (http://www.fao.org/fcit/fcit-home/en/). PAIA hosts the important global mailing list Food for the Cities. IDRC supported the Latin American Network for Urban Agriculture (Red Aguila), established in 1997 to promote UPA in the region, with initial success particularly in Argentina, Cuba, and Mexico. Following IDRC's withdrawal from funding in the early 2000s, several initiatives came to a temporary standstill and some organizations, such as GFUA and SGUA, disappeared. Although these international organizations were initially important, decentralized research on UPA (supported by European Union programs and national initiatives) has become dominant more recently.

Restoration of soil health in urban spaces is a complex objective. The properties of urban soils, including their capacity to resist and recover from perturbation, are to a large extent dissimilar to those of non-urban environments (Pavao-Zukerman, 2008). Given the heterogeneity that exists among urban soil systems, restoration decision-making is often employed at the site-specific level. Although some have advocated that the collective expertise of scientists from a range of disciplines should be funneled into specific urban localities (Kumar and Hundal, 2016), this approach fails to recognize the existence and value of local experiential community knowledge. For example, the practical horticultural knowledge of South African Americans was recently employed to create an Okra plantation in New York City (Krasny and Tidball, 2012). As a form of civic learning, social-ecological ‘memories’ (Barthel et al., 2010), were passed on within the local community. Civic learning (and civic teaching) is becoming a prolific urban movement in efforts towards restoring degraded urban soil and maintaining ecosystem services, whereby food systems become more self-reliant, re-localized, and de-standardized (DeLind, 2002). In Cuba, the Agricultural Knowledge and Information System (AKIS) is a collective platform for small-scale farmers sharing indigenous knowledge and experience, literature, places of education, and research institutions that all contribute to propagating urban agriculture (Carrasco, 2001; Carrasco and Acker, 2001). Marshall (2011, cited in Krasny and Tidball, 2012) refers to ‘Action Ecology’ to describe how collaborative knowledge is produced based on the multi-scalar integration of scientific research, policy making, and local community knowledge.

These collaborations can help to provide economic and infrastructural support to local community innovations. DeLind (2002: 222), however, argues that part of the success of civic urban agriculture is dependent not only on circular economies in urban areas (recycling nutrients from local waste water, for example), but on a more epistemological basis of whether local communities value soils as a ‘public trust, a commons, and a source of cultural energy’, rather than just a medium to grow food. Whilst valuing soil in this way does not guarantee the rehabilitation of degraded urban soil, investing in generating healthy functioning soils should be a bottom-up creative endeavor and a basic principle of sustainable UPA.

The social, economic, and political contexts of these UPA movements are very different. Some of the 20th and 21st century examples—typically those in the Global South, eastern

Europe, and wartime Europe—emerged out of necessity owing to a lack of food (i.e., grow your own or starve) and represent responses to crises and the failure of 'normal' food systems to provide food security. Most UPA social movements in the Global North since the 1970s, however, tend to be driven by highly individual lifestyle choices, including food sovereignty; access to superior or rare qualities in food for consumption; supplementary income, saving, and exchange; health; well-being and exercise; education and knowledge transmission; reducing ecological footprints; environmental, political, and economic empowerment; recreational pastime and self-realization; experiencing nature; aesthetics; socializing and strengthening community, cultural, and neighborhood ties (Kortright and Wakefield, 2011; Opitz et al., 2016; Pourias et al., 2016; Ruggeri et al., 2016). UPA as a lifestyle choice also differs about the forms of agriculture practiced and their contribution to the total food consumption, as well as the extent to which they have enjoyed official or public support; if they have been subjected to economic, political, or social resistance; and the shape that support or resistance has taken in each context.

Historically, in Germany and several other European countries, allotment gardens are the dominant form of UPA, starting as political or social movements. Originally, the German allotment gardens—the 'gardens for the poor'—were of social public utility to fight hunger and poverty. The first small allotments of 200–400 square meters were founded in Leipzig in 1864. During World War I and II allotments became particularly important for food security and survival in cities. Shortly after WWII nearly 200,000 gardens existed in Berlin; today around 75,000 still remain (Drescher, 2001a). The European allotments' common property rights system of land management is key to safeguard the gardens against urban expansion (Colding et al., 2013).

More recent examples of social popular movements targeting food production in the Global North are differently motivated. The ‘Edible Cities’ movement, begun in the UK in 2008, declare cities as ‘edible’ on the basis of inclusion, sustainability, localization, and open access to food (http://ediblecities.co.uk). Other social movements include the transition town movement; the Right to the City coalitions; the ecological sanitation (Ecosan) movement focusing on the reuse of human waste as fertilizers in UPA, combined with water saving measures; and supporters of local or regional community Food Systems. For instance, the Community Supported Agriculture (CSA) movement—which seems to aim for a re-establishment of a sense of connection to the land for urban dwellers, and to foster a strong sense of community and cooperation with a decided social justice goal to provide food security for disadvantaged groups (Adam, 2006; see also Ertmańska, 2015)—operates globally. In the United States alone 7,398 farms sell their products directly to consumers through a CSA arrangement (USDA, 2016).

Thus, social urban food movements have emerged mainly in the Global North, while UPA in the Global South is typically uncontrolled, unregulated, and self-organized, responding to local economies and subsistence necessities. This is obvious, especially for the Sub-Saharan African situation and mirrors the clear lack of institutional capacities of many local governments in the global South, as well as ‘outmoded and unreformed town planning schemes’ (Parnell and Pieterse, 2010: 155). Such situations can only be overcome by social and political reforms and through civil society empowerment (Parnell and Pieterse, 2010; Satterthwaite et al., 2010). Quite similar to the North European allotment gardens, UPA in Cuba developed with governmental support to mitigate food shortages among urban dwellers. Today stable land-use regulations are pivotal for the endurance of UPA in Cuba since vacant urban space is a limited resource under heavy competition for different kinds of land-uses.

Contracts of land lease are often negotiated and agreed with city urban planning and state agencies, depending on the political context. Urban cultivation plots are managed as semi-autonomous common property rights systems, where membership and public entrance and inclusion is regulated, and where there are management regulations related to how and what to grow, and where. Land lease contracts are valid over a period of up to 20 years. Members self-organize to determine regulations about how to manage land and take active part in food production and resource management (Cruz and Medina, 2003).

Strong economic drivers tend to push towards division and privatization of agricultural land for more profitable urban land-uses (Ryan-Collins et al., 2017). Although food production is part of urban policies in many European countries, this does not prohibit secondary densification or 'inner city development' that removes or covers productive soils in urban landscapes. Advisory policies at the global level strengthening CSA-types of bottom-up stakeholders in combination with regional planning tools such as biosphere reserves (Barthel et al., 2013) are interesting multi-level policy designs that could help protect land with fertile soils that are in direct competition with urban expansion (figure 3). Including people involved in UPA and CSA is critical not only for managing soils, but also for upholding urban common property systems, such as cooperatives and community land trusts (Colding et al., 2013; Thompson, 2018), and in enacting local public support for protecting land from exploitation (Barthel et al., 2015). While the regional planning sector has been championed as the main vehicle for safeguarding croplands in urban landscapes (Viljoen and Wiskerke, 2012), planning is in itself a highly politicized process influenced by vested interest groups, such as construction companies, political leadership, and land owners (Barthel et al., 2015). In cities with weak governance systems, urbanization processes develop seemingly uncontrolled, leaving civil protest the only remaining option to influence land development (figure 3).

…….INSERT FIGURE 3 ABOUT HERE……….

Hence, practicing UPA increases urban food security by utilizing the more productive soils in proximity to cities. This diminishes reliance on complex and distant food supply chains dominated by the global market. When land used for UPA is appropriately protected by land-use planning regulations and regional zoning, it also resists harmful loss of fertile soils by densification, inner city development, and urban encroachment.

3.3 The human resilience argument: a bottom-up driven circular economy for urban food security

Designing sources of human resilience in cities may serve as an additional motivation for protecting urban croplands and supporting individuals, social movements, and organizations engaged in UPA. As cities rarely can be fully self-sufficient in terms of food production, UPA is often put in the context of 'crisis' (Gonzales and Murphy, 2000; Jacobi et al., 2000; Santandreu et al., 2009). There are many examples of cities where UPA has emerged as a crisis response. For instance, in response to inflation and food shortages, Venezuela has installed a Ministry of Urban Agriculture and is trying to meet 20% of its food needs in 2021 by massively promoting small-scale urban agriculture (Dobson, 2018).

The spatial patterning of urban metabolism, including food support systems, food and waste processing, and consumer choices, is a determining factor for the sustainability and resilience of cities (Deelstra and Giradet, 2000; Hackauf and Timmeren, 2014; Isendahl and Barthel, 2018). UPA can contribute to a relatively circular urban metabolism. Urban organic waste is returned as fertilizers for food production, environmental impacts are relatively low due to reduced transport requirements, and energy is used more efficiently when fresh produce is consumed in the direct vicinity of the production site (Jongerden et al., 2014; Keck and Etzold, 2013). Evidence emerging from archaeological and historical research provides an important frame of reference supporting the claim that UPA increases the capacity for local resiliency functions against food supply perturbations (Barthel et al., 2015; Barthel and Isendahl, 2013; Isendahl and Stump, 2019; Simon and Adam-Bradford, 2016). This capacity was ensured especially through maintaining access to land that could be used for cultivation as well as soil and plant management knowledge in the event of a food production crisis.

Barthel and Isendahl (2013) argue that policy makers are well advised to draw on insights from the historical and archaeological record on the resilience building capacity of UPA—for instance how cities coped when divorced from trade flows in the past. Examples of UPA in the ancient past abound, for instance Angkor (Cambodia), the cities of the Aztecs (Mexico), and Constantinople (Turkey) (Barthel and Isendahl, 2013; Fletcher, 2009, 2011; Hawken, 2013; Isendahl and Smith, 2013). The 'agro-urban landscapes' of the pre-Columbian Maya (Belize, El Salvador, Guatemala, Honduras, and Mexico) offer some insight on how these systems worked (Isendahl, 2012). Pre-Columbian Maya state-level polities emerged in the first millennium BC and hundreds of cities and towns developed over a period of about two millennia. Many resources were traded both short- and long-distance, including food items such as cacao and salt (McKillop, 2002; Staller and Carrasco, 2010), but scarcity of transport energy (no beasts of burden or wheeled carriers, and relatively few navigable streams) put a relatively high cost on exchange of staples (e.g., maize) and stimulated a widespread practice of UPA (Barthel and Isendahl, 2013; Isendahl, 2012; Isendahl and Smith, 2013). Although there is significant variation among pre-Columbian Maya cities in terms of settlement density and spatial planning, most follow a general urban layout pattern of dispersed domestic household dwellings in an extensive agro-urban landscape that inter-fingered built and other urban space conserving land for agricultural food production. Civic-ceremonial and elite residential building sectors provided centralized economic, political, social, and religious urban functions. Farmsteads concentrated agricultural knowledge and practice and might have been able to function and maintain food security independently, but were also flexible to form the basic production unit and building block of large, complex Maya agro-urban landscapes. Thanks to residential proximity household gardens, infields in different stages of succession, orchards, and other green areas were easier to tend to carefully. Urban household organic waste would have been used to enhance and maintain soil fertility. It is instructive that the farmstead institution survived phases of political turmoil and widespread collapse of Maya cities that took place at the end of the Classic period (c. AD 800–1000) and later also Spanish colonization (Alexander and Hernández Álvarez, 2018). Today, after two centuries of Mexican national governments, small-scale Maya farmsteads continue to exist in peri-urban areas of Yucatán, but are threatened by urbanization processes that commodify common land and change modes of agricultural production and the nature of housing (Cabrera Pacheco, 2016; Hernández Álvarez, 2016).

It is largely assumed that the benefits of spatial proximity to landscapes of food production have become outmoded. Contemporary cases of different kinds of UPA, particularly in the Global South, demonstrate a move against trusting single-handedly in the mechanisms of large-scale centralization and globalized trade to provide food security sustainably and equitably whereby the distance to production decreases food security. Cuba is probably the best example of how local food systems can be revitalized in times of crisis (Cruz and Medina, 2003). Since 1960 Cuba has been suffering from the United States' embargo and political isolation. This situation aggravated in 1989 after the breakdown of the Soviet Union. The loss of former political alliances and trading partners resulted in an immediate cut-off from food, fuel, fertilizer, and animal feed imports as well as income from exporting agricultural commodities (sugar cane in particular), forcing fundamental changes in agricultural production (Cruz and Medina, 2003). This was the start of the promotion of UPA in Havana, set to provide fresh vegetables for the city's two million inhabitants. The model created by the Cubans, and supported by the Cuban government, is often highlighted as a best practice example for a sustainable urban food system and for food security in cities; a model for other cities in the world (e.g., Altieri et al., 1999; Viljoen et al., 2005).

Another contemporary case is that of the mega-metropolitan region of the Ganges-Brahmaputra Delta (MMGBD). It illustrates the resilience function of UPA in contemporary mega urban agglomerations (Isendahl and Barthel, 2018; Keck and Etzold, 2013; Mukherjee, 2015; Rhaman et al., 2013). The MMGBD has an urban population of over 40 million people, with about half living in informal settlements. Included are cities like Dhaka in Bangladesh (with c. 17 million inhabitants the 11th largest city in the world), Kolkata in India (with a population of c. 15 million, the 14th largest), and several other large cities (UN- Population Division, 2014: 26).

In 2007–2008, Bangladesh suffered from a natural disaster—catastrophic flooding and a cyclone destroying paddy fields in the rural north of the delta—at a time when the price of staple foods on the global market doubled rapidly (United Nations, 2011: 64). In many regions, for instance the Middle East and North Africa, surging food prices ignited urban food riots and protests against the failures of political regimes, calling for change, but also spiraling violent social conflict that causes unfathomable suffering and despair, for instance in Syria (Brinkman and Hendrix, 2011; Jones, 2017). In the MMGBD, however, urban food riots did not take place. Paradoxically, over the same period, relative purchasing power remained stable, even among the urban poor (Keck and Etzold, 2013). One explanation for the difference in response and vulnerability is that in the MMBGD self-organized circular food systems substituted dependence on commodified foodstuffs subject to price fluctuations on the global market. The vast and complex agro-urban landscape of the MMGBD, its cities and integrated delta wetlands, forms an integrated resource of UPA infrastructure to recycle and produce food. Organic urban waste is collected and applied to fertilize horticultural gardens, paddy fields, and aquaculture in city peripheries. Food for consumption is brought back to hub-markets and distributed by street vendors in informal urban settlements. An informal transport infrastructure of canals through marshes, wetlands, and paddy fields connects with major rivers and links waste, produce, people, and distribution nodes in circular food system networks. These food system networks transport c. 80% of the rice and ensure that c. 60% of the fish is produced in areas less than 100km from any street vendor, thus providing a back-up food security option for a significant proportion of the poor (Keck and Etzold, 2013; Mukherjee, 2015; Rhaman et al., 2013). This means that, while the global market-based food system failed to provide food security, a self-organized local network of food producers in areas not hit by the natural catastrophe safeguarded proximate residents. Food traders, waste handlers, boaters, street vendors, and poor urban consumers had generated a resilient circular food economy that succeeded to keep local food prices stable during the 2007–2008 global food crisis (Keck and Etzold, 2013; Mukherjee, 2015).

While Havana and the cities of the Ganges-Brahmaputra Delta are located in fertile tropical regions and therefore could be considered ‘outliers’, in a global perspective, cities are in fact most frequently located in landscapes that are highly suitable for food production (Bren d’Amour et al. 2017). In a majority of such urban landscapes UPA can contribute to building relatively higher levels of food security for the urban poor. Obviously, there are exceptions where UPA may never play an important role, for instance where climatic and environmental conditions make investments to produce sufficient amounts of food locally much higher than the costs of importing. Generally, however, a global advisory land use policy aligned with regional planning to preserve urban croplands, maintain and restore soil quality through protecting and facilitating UPA. Such interventions simultaneously facilitate regional circular economies, which may impact on unfair social-ecological teleconnections by building a resilient urban food security (figure 3).

4. Conclusion

Global urbanization and food production are in direct competition for land as urban expansion often occurs in peri- and ex-urban landscapes. Since urban and peri-urban soils on average are approximately twice as productive as the global mean 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. Unfair social-ecological teleconnections are potential consequences of such displacement, leaving the urban poor of the Global South in increasingly vulnerable and food insecure situations. In combination, these processes involve a series of cascading effects that interact to accelerate towards Earth System tipping points that in turn feedback with detrimental effects on the global food system. Therefore, preserving croplands and managing long-term soil health in urban landscapes that are, or recently have been, in agricultural food production is a key leverage place to battle food insecurity.

To counteract negative patterns of Anthropocene there is, as we have shown here, arguments for declaring urban and peri-urban lands with fertile soils as one global commons. However, stand-alone global regulation is likely to fail due to the political complexities involved, that international negotiations are inert, and out-comes uncertain. To advance towards halting the global process of croplands in the direct proximity of cities being converted for urban development we conclude that a viable multi-level strategy must include an advisory global policy. An advisory global policy need to be informed by the global sustainability implications of urban form, with the specific aim to discourage urban encroachment onto potential croplands and to restore and maintain soil quality. The policy will lend support to both regional zoning regulations and to social movements engaged in UPA that embody stable and long-term common property regimes, such as cooperatives and community land trusts.

Involving social and political movements engaged in UPA is critical, not least in geographies where urbanization processes cause seemingly uncontrolled encroachment onto croplands. UPA is a global phenomenon and there is overwhelming archaeological, historical, and contemporary evidence of UPA practices mitigating local food insecurity. Nonetheless, in many contexts there remains an unrealized capacity to multiply, facilitate, and protect UPA, rather than upscale and intensify agricultural production, which is counter-productive to community involvement and can introduce new dependencies on brittle and unfair food value chains. Regional policy tools, for instance biosphere reserves, involving UPA institutions may be particularly effective since such multi-level policies also will enhance the livability of cities. Future research need to assess in further detail if the outcomes of our proposal are efficient to curb urban encroachment onto urban lands with fertile soils, and quantitatively model if these effects promote SDG2: enhancing food security for all. There is also a need for quantitative integrated social-ecological modeling to test if the leverage places identified herein are in line with calls for a shift in governance trajectory towards a stabilized Earth System (Steffen et al., 2018).

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