sustainability

MDPI

Systematic Review

Increasing City Resilience through Urban Agriculture: Challenges and Solutions in the Global North

Boglarka Z. Gulyas * and Jill L. Edmondson

Department of Animal and Plant Sciences, University of Sheffield, Sheffield S10 2TN, UK; j.edmondson@sheffield.ac.uk
* Correspondence: bgulyas1@sheffield.ac.uk

Abstract: Cities, which now host the majority of the global population, are vulnerable to environmental and socio-economic disturbances, which are likely to increase in number and severity in the near future. Urban agriculture (UA) could help increase the resilience of cities to a range of pressures and acute shocks by improving food security and public health, building social capital, and promoting circular economies. However, comprehensive assessments of its potential are still lacking. Here, we use a systematic review of the literature on UA in the global North to identify factors that determine its success in providing resilience benefits, explore challenges that can limit this, and develop a conceptual model to highlight the ways in which it could be enhanced through research, policy, and practice. We define the success of UA in increasing city resilience as determined by five factors, which in turn depend on the amount of institutional and public support for UA, the presence of a sufficient knowledge base, communication and collaboration among different actors, and resourcefulness in finding alternative ways to use space and other resources efficiently. We close with a discussion of specific directions for research and practice based on the conceptual model developed here.

Keywords: food system; urban horticulture; food security; sustainable urban development; global change; urbanisation; sustainability

Citation: Gulyas, B.Z.; Edmondson, J.L. Increasing City Resilience through Urban Agriculture: Challenges and Solutions in the Global North. *Sustainability* **2021**, *13*, 1465. https://doi.org/10.3390/su13031465

Received: 4 January 2021
Accepted: 27 January 2021
Published: 31 January 2021

1. Introduction

1.1. City Resilience

Hosting the majority of the world's population, today urban areas are facing an unprecedented number of threats, including natural disasters, pandemics, terrorism, water scarcity, poverty, and food insecurity. These risks are exacerbated by climate change, population growth, and continued rapid urbanisation, and are expected to increase in number and severity in the near future [1–4]. In addition, most cities' dependence on global resources has made them highly vulnerable to shocks that can disrupt their current supply systems, the fragility of which has become obvious following the recent outbreak of the Covid-19 pandemic [5–10]. Therefore, to prevent an imminent disaster, cities must take prompt measures to better prepare for future crises.

The term resilience—often defined as "the ability of a system to absorb shocks of all kinds, and its capacity to adapt to changing conditions without losing any of its key functions" [11]—has become a buzzword in urban planning, used to describe cities that can withstand and recover from various disturbances, including those caused by climate change and socio-economic crises [12–14]. Resilient cities are proposed to be reflective, resourceful, flexible, redundant, robust, and integrated, characteristics which make them "safe to fail" (rather than fail-safe) in the face of challenges [15,16]. Since urban areas are complex, dynamic socio-ecological systems, city resilience is a concept that spans multiple dimensions and involves various systems and actors [13,17–19]. Appropriate institutional frameworks with equitable rights and decision-making processes are also argued to be an important aspect of systems resilience [19].

1.2. Urban Agriculture and Resilience

As well as serving to meet basic needs, the food system is a key determinant of the health and wellbeing of society, with poor diets being a main cause of noncommunicable diseases and related deaths worldwide [20–22]. Thus, securing access to sufficient amounts of nutritious food for urban populations in the face of disturbance is a fundamental part of resilience [19,23]. Most cities in the developed world are currently highly dependent on globalised supplies, which are vulnerable to environmental, economic, social, and geopolitical stresses [10,24,25]. As a result, supply disruptions and increasing food prices can severely impact consumers in urban areas, especially the urban poor [9,26,27]. Increasing local production and developing shorter supply chains could decrease the likelihood of disruption to food supplies, enable the development of circular systems, reducing dependency on external inputs, while diversifying sources can provide "back-up" capacity and, thus, improve the ability of food systems to react and adapt to shocks [19,24,26,28–30]. There is growing evidence that urban agriculture can increase city resilience through a number of mechanisms, including, but not only, through increasing the resilience of food systems.

Urban agriculture (UA)—the production of food, mostly fruit and vegetables, within urban areas [31,32]—is increasingly recognized for its multiple social and ecological benefits by city governments around the world [10,33–36]. During World War II, UA played an important role in increasing food security and boosting national morale in Britain and the USA, where household fruit and vegetable production was promoted through the Dig for Victory and Victory Garden campaigns, respectively [7,37]. Following a period of decline in post-war years, urban agriculture is now enjoying a resurgence of interest in the global North, which has recently spiked during the Covid-19 lockdowns [6,38–44]. Today, UA takes various forms, from vegetable plots in private gardens, through allotments and community farms, to rooftop gardens and edible walls using technologically advanced, soil-free cultivation methods [45,46]. While peri-urban agriculture (PUA)—the production of food on the outskirts of cities—is sometimes treated as a separate phenomenon from UA, the distinction between the two is not always clear-cut [32,47]. For the purposes of this study, the term UA will be used to refer to all forms and scales of growing food in both urban and peri-urban areas.

Perhaps the most obvious way in which UA can contribute to city resilience is by increasing household and citywide food security, especially in terms of micronutrient requirements, through the provision of fresh produce locally [6,32,34,35,41,46,48–52]. Own-growing, in particular, can play an important role in supplementing the diets of more disadvantaged groups who have limited physical or financial access to fresh food [9,23,26,27,53]. However, importantly, UA can also increase the sustainability of the food system on a larger level, by enabling the recycling of organic urban wastes as fertiliser and reducing reliance on mineral fertilisers, which have considerable environmental costs globally [26,30,54–56]. In addition, making use of spare space in urban areas can increase food production without devoting more scarce land to agriculture, while certain forms of UA can help protect crops from adverse weather effects and enable stable year-round production [39,48,56].

Several potential resilience benefits of UA also go beyond the food system. For example, promoting public health through improving access to fresh produce and providing a form of regular exercise [34,57] could reduce the incidence of noncommunicable disease within the urban population, making cities better able to cope during crises caused by pandemics, terrorism, or natural disasters. Furthermore, the practice of food growing can play an important role in building social capital, fostering proactive attitudes, and collaboration, which are key determinants of the ability of communities to get through challenging times [15,34,42,52,57–60]. Urban farms can also create jobs and help fight unemployment and poverty [26,61]. Last but not least, vegetation cover provided by urban agricultural sites could improve air quality and decrease the urban heat island effect (UHI), potentially mitigating some of the acute effects of climate change [6,26,62,63].

However, despite growing evidence for UA's various benefits and increasing recognition of its potential to increase city resilience, it is still unclear how UA's success in

providing these benefits could be enhanced. While previous research on UA has predominantly focused on issues in developing countries, the urgent need to increase the resilience of cities in the developed world is now also clear. The aim of this study is, therefore, to assess and conceptualise the success of UA in the global North in order to answer to the following questions:

1. What determines the success of UA in promoting city resilience in the global North?
2. What challenges does it currently face that might limit its contribution?
3. How could its benefits be maximised through research, policy, and practice?

2. Methods

To gain a comprehensive understanding of urban agriculture in the context of city resilience in the global North, a review of the academic literature was carried out. In order to minimise bias and improve replicability, a systematic approach was taken based on predefined criteria for the selection of relevant studies. An overview of the selection process is shown in Figure 1 below. Articles were identified using a combination of keywords connected by Boolean operators (i.e., AND, OR, and NOT), which could appear anywhere in the title, abstract, topic, or keywords of papers. Studies focusing on issues in the developing world and for which full-text was not available in English were excluded. To control for the quality of sources, only publications in peer-reviewed journals were considered. In order to ensure that issues are considered from a range of perspectives, no restrictions on article type, publication date, or journal title were applied.

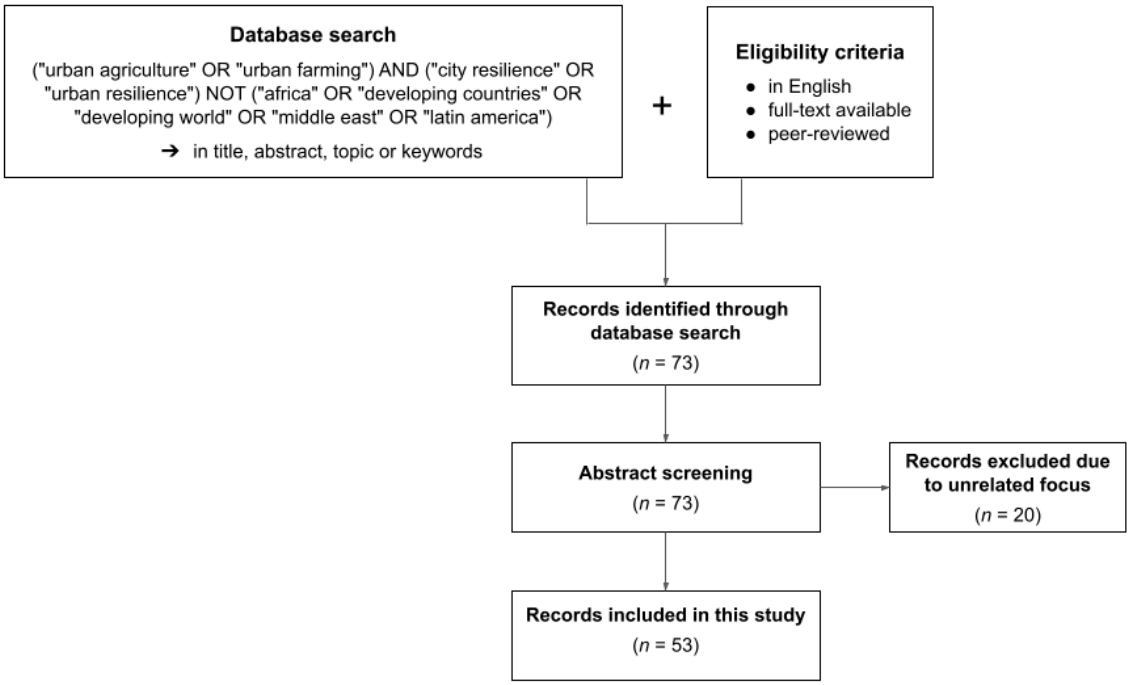

Figure 1. Study selection strategy for the systematic literature review.

The following literature database search was carried out in July 2019 through the University of Sheffield's StarPlus catalogue:

> "urban agriculture" OR "urban farming") AND ("city resilience" OR "urban resilience") NOT ("africa" OR "developing countries" OR "developing world" OR "middle east" OR "latin america"

Abstracts of all 73 returned articles were read and any nonrelevant search hits (i.e., articles not related to the keywords) were manually removed. The remaining 53 papers were read in full and information related to the specific questions addressed by the study (i.e., 1. factors determining the success of UA in providing city resilience benefits; 2.

current challenges for UA; 3. ways in which UA and its benefits could be promoted) was extracted and organised into emerging themes to characterise the success of UA in terms of the amount of resilience benefits it can provide, and was used as the basis for the development of a conceptual framework to illustrate potential pathways through which it could be promoted.

3. Results

3.1. Bibliometrics

Applying all selection criteria and an initial screening of 73 abstracts (see Methods) resulted in 53 papers to be reviewed for this study. All reviewed papers were published after 2010 (most between 2013 and 2018) (Figure 2), in 39 different journals with focal subjects covering a range of topics (mostly related to sustainability, environmental science, and urban planning and policy, but also public health, geography, architecture, and engineering) (Figure 3). This reflects the novelty and inherently multidisciplinary nature of this research area, and also demonstrates the breadth of research that fed into the conceptual model we present in this study.

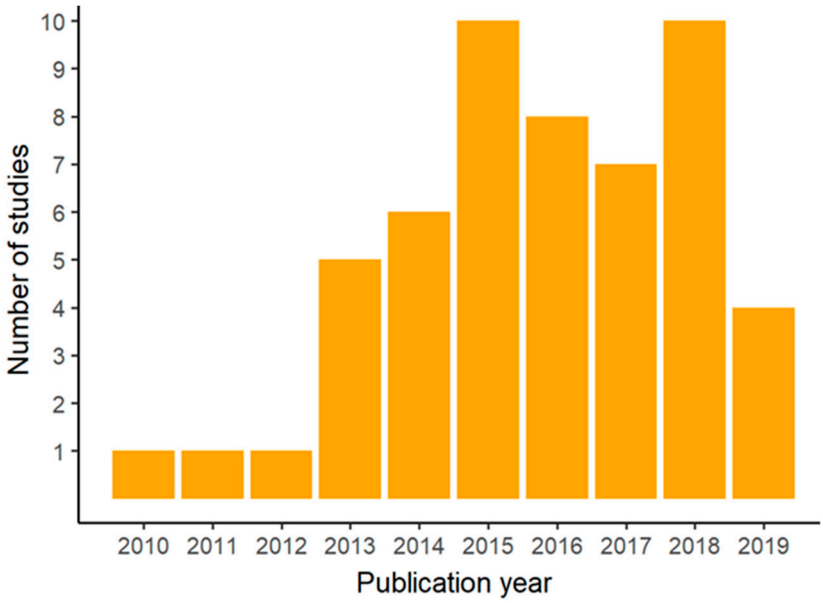

Figure 2. Distribution of reviewed studies by publication date.

3.2. What Makes UA Successful?

Based on the reviewed literature, it is proposed that the provision of resilience benefits by UA in the global North is determined by five factors (Figure 4): its scale (i.e., the amount of space dedicated to, and number of people engaged in food production in a city); the efficiency of production (i.e., crop yields per unit cultivated area and resource input); the extent to which it is integrated into the urban fabric (i.e., links with different urban systems including food, waste, and education), inclusiveness (i.e., equitable access to growing space and other resources needed to engage in UA, and to urban-grow food); and human and environmental safety (i.e., urban-grown produce is safe to consume and practices do not pollute the city's water supplies or cause harm to surrounding ecosystems). A range of potential issues related to the five key aspects of successful UA as proposed here (i.e., Scale, Efficiency, Integration, Inclusiveness, and Safety) was identified. The aim of the following section is not to provide an exhaustive list of these, but rather an overview of the different kinds of challenges that need to be addressed if UA is to play a more significant role in increasing city resilience.

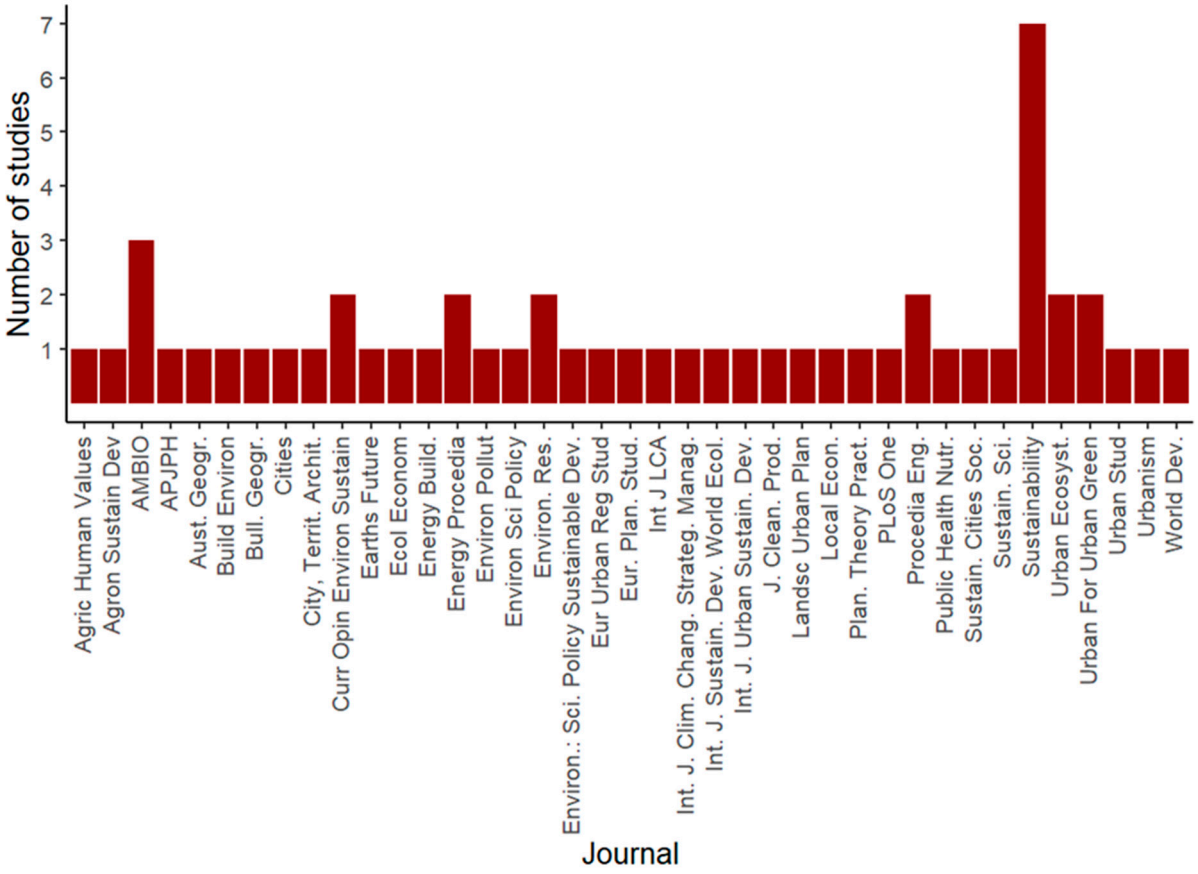

Figure 3. Distribution of reviewed studies by journal.

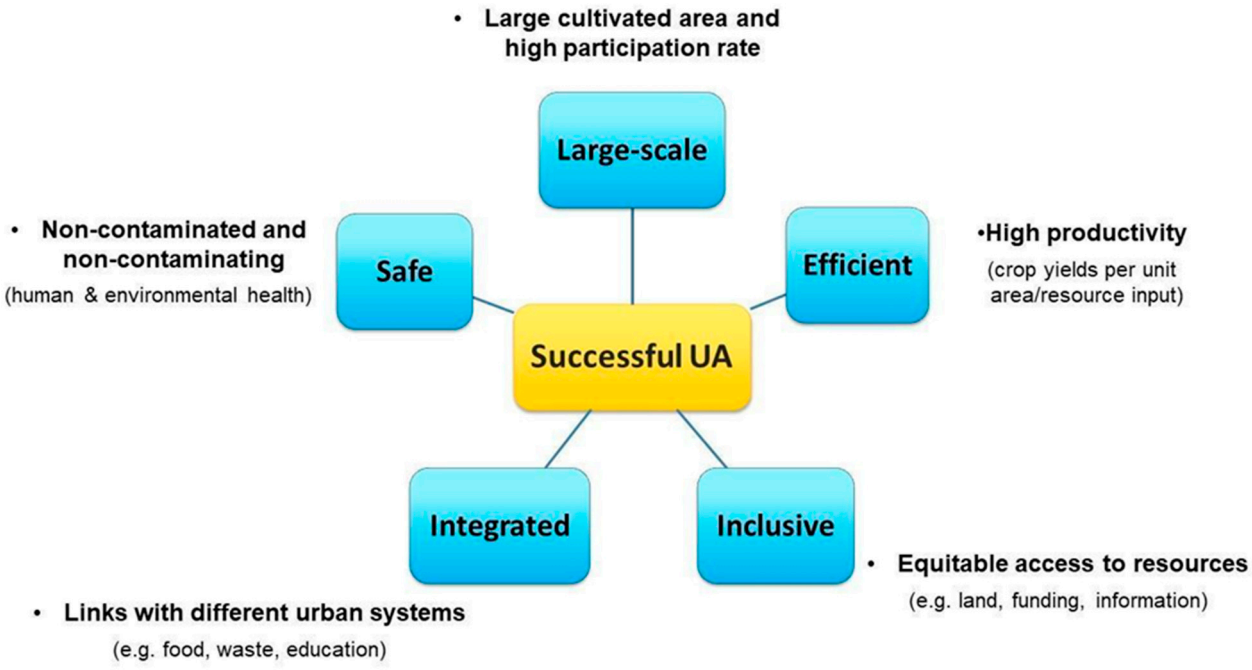

Figure 4. Key characteristics of successful urban agriculture (UA) in the context of promoting city resilience.

3.3. Current Challenges for UA

3.3.1. Scale

Perhaps the most obvious constraint on the scale of UA is the limited availability of space in cities, which is coupled with the fact that both urban and peri-urban land is under severe pressure from different contradicting uses, including housing, industry, infrastructure development, and recreation [38,50,64–67]. Moreover, vacant space in dense urban settings is often found in small patches among built-up areas, which can prevent the development of larger farms [68]. Another issue is that not all available space may be suitable for food production: urban soils can be contaminated [12,18,38], while concrete cover can make some open areas unsuitable for traditional cultivation methods [62,69]. Although suitable rooftops and vertical spaces could be used to expand UA area [12,30,48,50,59,64,69,70], it is estimated that the global availability of these is low compared to the amount of vacant urban land, and, therefore, their contribution may be limited [71], not to mention possible competition from other roof uses, notably photovoltaics [72].

Nevertheless, it can be argued that in many cases the biggest issue is not the lack of space per se, but rather its availability for potential growers—in fact, a recent case study has found that, although there are social and techno-scientific challenges to achieving this in practice, in theory there is enough suitable growing space in a typical UK city to fully meet the fruit and vegetable demands of its inhabitants [73]. Several reviewed studies point to a lack of supportive policies, ownership issues, and prohibitive legal frameworks as being the main constraints on the scale of UA. On the one hand, measures to safeguard agricultural land in urban areas are often absent, or only temporary, allowing the fragmentation and gradual disappearance of farms [13,50,62,74,75]. On the other, expensive land lease and zoning laws defining land use in different areas can limit opportunities to put more land to food production, and can sometimes cause the implementation of UA to outstrip policy and lead to farms being shut down on legal grounds [13,34,39,48,50,58,59,71,76].

Along with the availability of growing space, the level of participation by citizens is a key factor determining the scale of UA. It has been argued that certain forms of urban food production are dying out in some parts of the developed world [38]. For instance, many commercial peri-urban farms in Europe have been abandoned or become inhabited by people with little interest in agriculture, and studies suggest that the majority of active growers in some cities are among the elderly [13,18,38,62,72]. Expensive land lease, lack of security of growing space, potentially high costs of setting up and operating farms in urban areas (e.g., for building materials, water, fertiliser, and electricity for supplementary lighting, or circulating water in some nonconventional methods) and limited demand for urban-grown produce can also be discouraging or prohibitive for those wishing to start a UA business or social enterprise [30,38,39,48,50,56,71]. Nonetheless, other forms of UA are becoming increasingly popular. For example, own-growing is enjoying a recent resurgence of interest in the UK, where higher participation is hindered by dwindling allotment supply [44,77,78].

3.3.2. Efficiency

It has been argued that, in many cities of the global North, the knowledge of how to grow food is being lost [38,39,53,79]. A lack of skills among growers can mean that practices are inefficient [74], which, especially if the availability of growing space is limited, can limit food provision by UA [39,62]. While alternative practices like aquaponics or hydroponics can allow for high yields in restricted spaces, these are still in relatively early stages of development and, thus, not yet well known among the public. In addition, technologically advanced methods can be quite expensive and may require specialist knowledge, which can be an issue for own-growers and small businesses and community initiatives that cannot afford the hiring of professionals [30,48,56,79]. While urban waste water, organic materials, and energy streams could be exploited to decrease costs and improve the efficiency of production, the infrastructure and markets for such products are yet to be developed [30].

3.3.3. Integration

One main challenge in this area is linking urban producers with consumers. Due to high land prices in more central areas, commercial farms and market gardens are often established on the outskirts of cities, which can complicate the logistics of reaching customers [13,50]. Another potential issue for small-scale commercially-oriented projects is that many supermarket chains only accept fruit and vegetables of certain size and appearance, making it difficult for producers to secure contracts with them [74]. Restrictions related to food safety [13] and organic certification of produce (especially when grown using nonconventional methods) can present further obstacles [72]. Although alternative distribution systems and retail outlets (e.g., growers' markets) do exist for urban produce, these are not available everywhere, at least partly due to limited government support [13,80,81]. In addition, it is often difficult for urban-grown produce to compete with the low prices available through globalised markets, especially in lower-income neighbourhoods where people cannot afford the alternative [39]. As well as difficult access, cultural factors might also limit consumer demand for UA produce [72,81].

Another major issue is the widespread lack of comprehensive planning for resilient urban food systems and, in fact, for food in general: in some countries, there is no government department dedicated to food, and even in highly developed European countries like Sweden, Denmark, or Belgium, explicit strategies for urban food production are rare [13,65,71,80,82]. Another related issue is that grey and green areas tend to be treated as distinct systems in urban planning, and so potential synergies that could be achieved through their integrated management (e.g., water and organic waste could be recycled to provide a source of irrigation and nutrients, contributing to more resource- and cost-efficient closed-loop systems, green walls could increase the energy efficiency of buildings while improving air quality and local microclimate [30]) are seldom exploited [52,83].

3.3.4. Inclusiveness

Urban development patterns in many parts of the global North have led to uneven distribution of green space, often favouring more affluent areas, making equitable access to growing space a major issue, especially in urban centres and for low-income or racially segregated communities [13,38,39,62,65,66,75,77,79,81–86]. In addition, the success of UA projects is often dependent on networking, social work, and business skills in addition to horticultural knowledge [13,39,87]. As well as growing space, relevant skills and access to financial and material resources is also distributed unequally, and even where support systems exist many people may be isolated from these geographically or due to socio-economic factors [13,49,79,81,88]. For example, the low-income and the elderly may have limited access or ability to use digital tools that could facilitate knowledge and resource sharing [85], which will be crucial for realizing the potential of urban horticulture [73].

Another crucial factor that can limit the positive impacts of UA is unequal financial and physical access to urban-grown food [64,81]. Many areas lack walkability to urban farms and alternative food shops, and, for various reasons, local produce tends to have higher prices than that grown on larger, commercial farms. As a result, purchasing locally grown fruit and vegetables has become mostly widespread among people in higher-income groups, and producers in lower-income neighbourhoods often struggle to sell their produce, which may force them to raise prices, intensifying issues of unequal access to local food [39,80].

3.3.5. Safety

In some areas, urban soils and groundwater can contain high levels of heavy metals and other toxic chemicals due to industrial activities, current and past emission from vehicles or the use of amendment soil delivered from contaminated sites. This is coupled with a lack of detailed legislation regarding the safety of urban-grown food in some countries (and even where strict controls exist, domestic practices are not regulated), which has given rise to concerns over the health effects of consuming potentially contaminated

produce [12,18,38,72,89,90]. Air pollution near main roads and in urban centres has also been suggested as a potential health risk to people gardening in these areas [38].

Another possible issue is related to potentially inappropriate domestic agrochemical use. It has been argued that, as a result of reduced ecological understanding or in an attempt to enhance yields, some urban growers might use excessive amounts of fertilizers or pesticides, which could cause harm to the environment or introduce agricultural pollutants into the city's water and food supplies—although, due to the lack of monitoring of such residues in waterways or produce, the reality of these concerns is largely unknown [39,74,91].

3.4. Underlying Factors

While there are a variety of potential issues that can limit the success of UA, there seem to be some common themes underlying them. These will be discussed in turn here.

3.4.1. Public Support

In modern societies, there is often a cultural bias towards manicured landscapes, which people might associate with safety and higher quality of life and, thus, may prefer over green areas with a less tidy appearance, like many UA sites [38,59,86]. Urban food gardens might even be seen as a sign of poverty or under-development by some, who might not want to see these near their home or workplace [40]. Part of the reason for this could be what has been described as an "environmental generational amnesia", meaning that many people today fail to reconnect with and understand their dependency on natural ecosystems [40], and as a result may have little interest in and underestimate the benefits that spending time in nature and growing their own food can offer. In addition, research suggests that the concept of urban agriculture—especially its more urban-specific forms, like aqua- and hydroponics—may be little known and understood among the public, and certain practices, such as highly engineered cultivation methods or animal farming, may have low acceptance [72].

Single-family residential gardens take up a significant proportion of open space in many cities and, thus, hold great potential for increasing UA area [53,62,68,91,92]. However, this will require public willingness. A key issue can be that even if they are generally supportive of UA, due to busy schedules characteristic of modern lifestyles, higher levels of engagement may be outside the comfort zone of most people [59,76]. The importance of this factor is shown in the huge increase in interest in 'grow-your-own' in many countries during the lockdowns that followed the outbreak of the Covid-19 pandemic (for example, evidenced by rises in waiting lists for allotment plots in the UK [44,78]), when many people suddenly had more free time. Voluntary contributions to community gardens also tend to be limited and unreliable, and few people are likely to be willing to help with product distribution or provide financial support for projects [72]. The lack of long-term security of growing space, fees for garden use, difficult access to sites, including perceived access (e.g., allotment sites are often fenced off from non-members), and potentially insecure environments (e.g., risk of vandalism or presence of homeless "tramps" near sites) can also discourage people from getting involved in some forms of UA, while insecure funding for projects can make those who want to make a living from horticulture reluctant to start [38–40,50,64,84]. Finally, conflicts amongst users of communal sites—especially if there is high cultural diversity in the group—have also been suggested as a potential issue limiting participation [15,64].

Another important social factor affecting the success of UA is the amount of demand for fresh local produce, which might be limited. Food shopping and consumption patterns in most parts of the developed world have become supermarketised, and many people may not give a high priority to sustainability in their product choices, or have a limited understanding of what constitutes a healthy diet [13,72,80,81]. In addition, reduced choice, difficult access, an absence of an enabling culinary culture, concerns over the safety of consuming urban-grown food, and beliefs that local produce—especially if organic—is always expensive can also make people reluctant to buy such products [48,81].

3.4.2. Institutional Support

Another key factor that can limit the success of UA is the amount of support for it from authorities [64,71,74]. Despite increasing recognition of its benefits and potential importance on various levels of governance [33,36], the fact that food production is rarely considered as an urban issue, and as a result UA tends to receive little attention in local council legislation and city planning, is frequently mentioned in the literature [13,40,50,52,62,65,72,74,80,82,93]. It has been argued that current and potential growing spaces in municipal ownership are often maintained as reserves for urban development, while zoning regulations put constraints on expanding UA area [38,52,74]. Many peri-urban farms might be threatened by urbanisation, and liberalised legislation can sometimes allow anyone to purchase agricultural land and pursue activities other than farming, which poses a further threat to how scarce fertile land is used [13,50,52,59]. Regulations related to producing food in urban areas are also sometimes absent, and in some cases a system of "organised irresponsibility" may be observed around complex issues like pesticide pollution, with multiple relevant agencies all assuming it to be another's responsibility [38,72,74,91]. Furthermore, it has been argued that governments might tend to subsidise export-oriented food production in order to promote broader national development, a strategy that is in contrast with building resilience through increasing local self-sufficiency [74,81]. Some international policies, such as the EU's Common Agriculture Policy (CAP), also promote the globalisation of markets and favour larger rural producers [13]. Although strategic declarations about creating more resilient urban food systems, acknowledging the role of UA in it, have now been made by many cities [33,94], specific targets and action plans are still relatively rare [93]—although not absent (see e.g., [95]).

As a result of a lack of effective measures to facilitate their access to resources, smaller UA businesses may often struggle to compete with larger producers [13,71,74,81,82,86]. While the development of multifunctional UA projects could provide additional income streams (e.g., through tourism or education), it requires additional investment and can still be complicated by banks' reluctance to fund "risky" urban horticulture projects [39] or contradictions in legislation relating to different activities involved [13,74]. City agencies have also been argued to take only a small part in efforts to ensure equitable access to healthy food for more disadvantaged communities—mostly leaving this task to community groups and NGOs—limiting some of the potential benefits of UA [65].

Lastly, limited governmental budgets and plans for green space development (for example, in 2016 only 1% of brownfields in England were proposed to be reused as green space [62]), and the fact that it usually focuses on parks, playgrounds, or urban forests, can also present a problem for UA, which tends to be given lower priority [13,52,64,79]. In addition, in larger-scale municipal-led greening initiatives sometimes the most disadvantaged areas get the least attention, and measures might overlook or even reinforce existing issues of spatial and social inequality [38,62,65,66,75,79,81,86]. Moreover, the ways in which green spaces are increasingly incorporated into private development schemes can lead to "green stealth", a process of spatial exclusion through privatisation of these areas [62]. Finally, while the concept of promoting resilience through ecosystem services and nature-based solutions (including UA) are increasingly well-known, the actual incorporation of these approaches into urban policy and planning is still weak in most parts of the global North [38,53,63,75,83,86], and may be sidelined in favour of hard engineering solutions that might provide more immediate results or direct economic returns [15,59,62,71,79,83,87].

3.4.3. Knowledge Base

A likely reason behind sometimes limited municipal attention and policy support for UA is that, until recently, the quantitative evidence base for its various benefits, including its current and potential contribution to city resilience, was lacking [52,71,83]. One issue is that land cover and use characterisation at high resolution can be difficult and very time consuming, and as a result, such information is often sparse or lacking in sufficient level of detail [68,71,76]. Estimating the area of rooftops and building façades suitable

for alternative production methods is also problematic because many factors need to be taken into consideration (e.g., load-bearing, accessibility, availability of light) [12,71]. In addition, data from different sources is sometimes inconsistent or difficult to integrate, not to mention that some essential information might be proprietary [50,71]. As a result of these factors, data on how much land is, or could be, used for food production in urban areas is often unknown—although recent research suggests considerable potential [73,96].

Another challenge is that a large proportion of food production in cities takes place on private gardens, allotments, and small farms where yields do not normally get recorded [13,50]. Although estimates could be made based on conventional agriculture or mathematical models, these may not reflect ground level realities [76]. In the UK, the actual productivity of allotments and gardens has recently been estimated [73,96,97], but in other countries own-grown crop yields are yet to be quantified adequately to support arguments about possible levels of local self-sufficiency, and the role of different forms of UA in providing food security still requires further research [80,82,98]. The economic characterisation of urban-grown food can also be difficult, as its value is affected by quality, production methods, and supply–demand conditions [82]. In addition, the safety of consuming urban produce is often uncertain as the presence of toxic residues in private growing spaces is seldom monitored. Similarly, the potential risk of agrochemical pollution in cities is largely unknown, with insufficient toxicity data, debated historical accounts, and mathematical ecosystem models, and a lack of consensus on what tests and thresholds should be used complicating its regulation [71,74].

Another potential issue is that cultural services provided by UA are subjective and difficult—and arguably senseless—to translate into quantitative metrics, making it hard to provide evidence for these benefits [58,92]. Moreover, ecosystem service provision by urban food gardens is generally evaluated from the perspective of practitioners only. Very few studies so far have addressed public perceptions on UA, therefore, the extent to which an increase in its scale and its different forms would be supported by global society is not yet clear [72]. In addition, participatory research essential for studying social factors is time-consuming, and effective study designs can be difficult to create. As a result, participatory data sources are relatively rare and seldom have inter-annual continuity [50].

Finally, a fundamental problem is that, despite the growing popularity of the concept, it is still somewhat unclear what resilience actually means for urban planning and policy, let alone UA's role in it [17,79,85]. These uncertainties, combined with the fact that UA sites do not usually provide direct economic benefits to local authorities, can make them reluctant to increase the provision of growing space, and can limit the effectiveness of measures intended to promote UA practice [71,92].

3.4.4. Communication and Collaboration

Another key factor that can limit the success of UA is a lack of communication and collaboration among researchers, policy-makers, and communities. Multiple authors argue that weakened social bonds and a decreased sense of participation, characteristic of modern urbanised societies, have resulted in decreased informal learning and exchange of knowledge among individuals and groups—importantly between generations—making the social memory of UA vulnerable [13,39,75,85,98]. In addition, limited connection and collaboration between individual initiatives and agents working across larger scales can present a barrier to knowledge and resource sharing, and to building a critical mass on debate [13]. The potential reluctance of smaller UA initiatives to work with larger companies or institutions, or accept advice from external experts, can be a problem because a lack of support from stakeholders with better access to information and resources (for example, councils could act as "anchor institutions" to provide security for community-based urban horticulture businesses [73]) can limit the success of projects [13,38,50,52,79,86,99]. In particular, the spread of alternative UA practices can be hindered by a lack of willingness to collaborate, as well as by proprietary control of knowledge and tools for innovation [85,87]. For instance,

most rooftop greenhouse projects currently operate in isolation, which likely limits their success and technological development [48].

A lack of communication between municipalities and communities, and views that scientific knowledge is superior to non-scientific, local knowledge can also mean that the latter is overlooked in making plans and policies related to UA practice and the provision of growing space. Although it could be argued that a synergistic interaction between governments and citizens is sometimes over-idealised [76], the issues of local practitioner groups often cannot be addressed through traditional institutional regulatory instruments [18] and measures devised without a sufficient understanding of the local context might not be well-received by the public, or even have unintended negative consequences, like increasing social or spatial inequalities [64,75,87,99]. For example, top-down approaches to mobilizing citizens can lead to the exclusion of less vocal communities [64,75], and there is evidence that government attempts to make people cultivate abandoned areas may not be effective if these people do not feel attachment to the gardens allocated to them [15,34].

Another issue is that the science and policy of climate change adaptation, environmental protection, agriculture, food systems, and public health tend to be disconnected across a range of institutions and government departments [49,62]. This puts UA in a difficult position, since, due to its multifunctional nature, it is not fully in the domain of any particular agency. Instead, its different aspects concern a number of sectors, in all of which it may be given relatively little attention. Complex issues like city resilience and urban agriculture's role in it can also have different understandings, which, combined with limited information sharing and coordination among different government departments, can result in contradicting policies. Current resilience plans often have multiple contrasting goals, overarching city-wide strategies are rare, and possible synergies between different plans (such as opportunities to link green space development with improving urban health and living conditions) are seldom exploited [49,52,62,74,79,80,85]. In addition, possible opposition grounded in political differences can make it more difficult to reach a consensus between parties and mean that legislation generally emerges slowly [38,76,79,98], whilst dominant policy discourses and entrenched urban planning practices can be inhospitable for new frameworks [52].

Finally, limited knowledge exchange can also be observed within research. For instance, while multi- and interdisciplinary approaches to evaluating ecosystem services are becoming increasingly popular, there is still a shortage of such projects. Multifunctionality is often poorly covered in assessments of urban green spaces (for example, combining green space mapping with related health and wellbeing data), with most studies dealing with only one service from the perspective of one type of stakeholder [71,76,92]. In addition, urban resilience and ecosystem service research rarely involves stakeholders [50], and might not focus on the most deprived areas where increased provision of green space, including UA sites, is most needed [52]. Another important problem is that, in many cases, research findings are not communicated sufficiently to relevant planners, policy-makers, and practitioners, or are not directly transferable to real life settings [53]. City resilience and ecosystem service frameworks might also lack specific guidelines or fail to take existing administrative and governance structures as a starting point, which can make them difficult to operationalise [52].

3.4.5. Contextual Diversity

The last underlying challenge identified is the fact that there can be considerable differences between, and even within, cities in key factors affecting urban agriculture and the types of resilience benefits it can provide [76]. These include geographic constraints on food production (e.g., climate, soil, and groundwater properties) [12,82], landscape features and land cover characteristics (e.g., amount of brown or green vs. grey area, urban built form) [12], land ownership [12,82], costs of key items (e.g., labour, land rent, materials) [71], pressures on land use [82], institutional designs and policies (e.g., tax treatments, subsidies, regulations) [71], cultural factors that affect practice, public perceptions of different forms

of UA, and demand for urban produce [34,50,66,75,84,91]. Such wide contextual diversity can limit the transferability of research and policy approaches between different scales and locations, and makes it difficult to find solutions for promoting UA that are appropriate across space [13,99]. It also means that the cost and effort of implementing certain measures will likely vary between locations. In addition, the development of locally suitable actions may be hindered by the fact that municipal plans need to conform to larger regional, national, and international policies [76].

3.5. Pathways to Promoting UA

Based on the reviewed literature, it is proposed that the overall success of UA in increasing city resilience depends on the amount of institutional and public support for it, the presence of a sufficient knowledge base to guide policy and practice, communication and collaboration among different actors, and resourcefulness in finding locally appropriate solutions and alternative ways to use space and other resources efficiently. Figure 5 shows a conceptual diagram illustrating how these factors could promote key aspects of UA through a number of direct and indirect mechanisms.

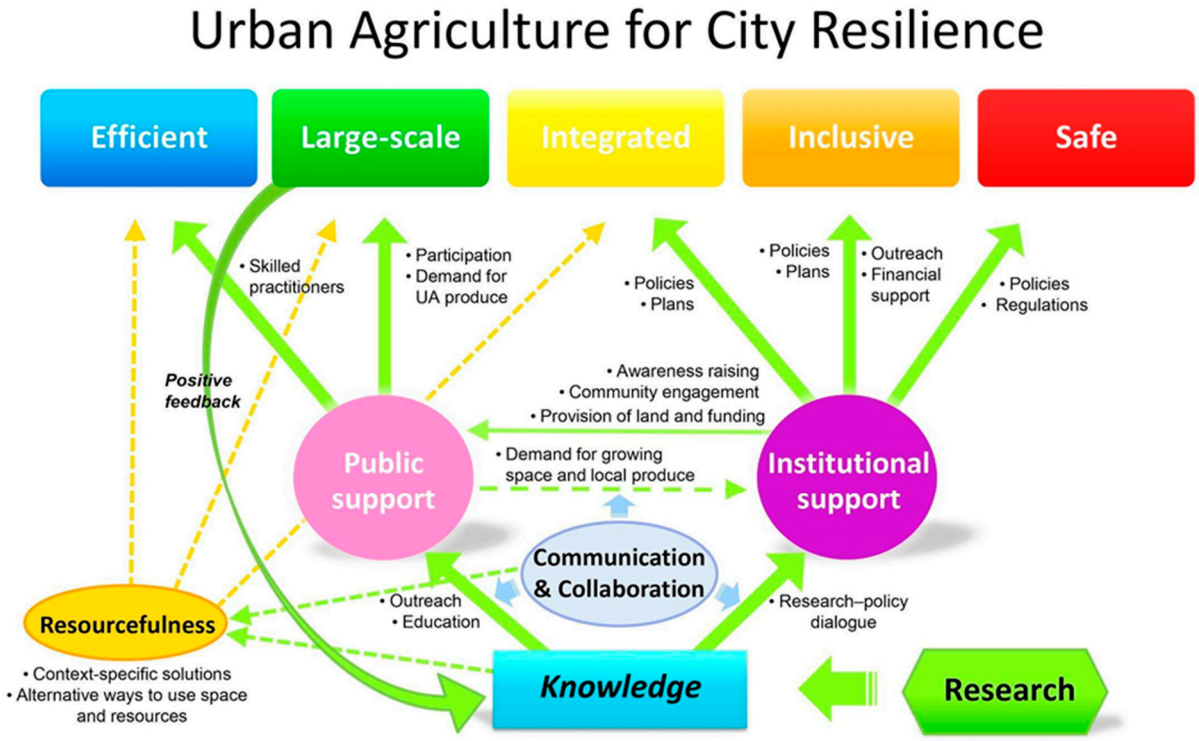

Figure 5. Pathways to promoting urban agriculture (UA) for increased city resilience: five key aspects of successful UA (top of figure), factors that determine UA's success in increasing city resilience (objects below), and main mechanisms through which these can contribute to different aspects of UA (arrows; all represent promoting effects).

People's ability and motivation to engage in UA and related activities is a crucial factor determining its success. In fact, since a significant portion of space in cities is owned or managed by private individuals and local user groups [92], it could be argued that the scale and impact of urban agriculture is ultimately a function of the level of participation from citizens. Nonetheless, the public's contribution is limited without the support of local governments, which have a crucial role in creating enabling policy frameworks and facilitating access to land, funding, and information. It should be noted that there is a bidirectional relationship between public and institutional support for UA. On the one hand, high public demand for growing space and locally grown food can trigger increased attention and support from governments in the form of different policies and urban development plans, which can promote the integration, inclusiveness, and safety of UA.

On the other, awareness raising, community engagement, and provision of growing space can increase public interest and participation in UA-related activities, which in turn can increase the scale of the practice. To facilitate such a synergistic relationship, it is important that effective communication takes place between communities and local governments.

Through generating an evidence base to underlie the amount of both institutional and public support and the effectiveness of policy and practical measures, research plays a fundamental role in determining the success of UA, potentially having downstream positive effects on all of its five key aspects. In order to have a real impact, as well as the creation of knowledge, its communication to government administrators, practitioners, and the general public is also crucial. Researchers have a responsibility in increasing key actors' awareness of issues around urban agriculture and resilience, the importance of actions being taken, and how they can contribute. Thus, outreach, education, and good research–policy dialogue are essential. Last but not least, resourcefulness is important for finding effective and locally appropriate solutions, the success of which is greatly dependent on knowledge exchange and collaboration among practitioners and between researchers and communities [14,40,85]. Finally, there is a positive feedback relationship between the scale of UA and the amount of knowledge potentially available on it, completing a virtuous cycle of research, science communication, and collaborative action.

4. Discussion

The importance of increasing the resilience of our cities has become clearer than ever after the recent global Covid-19 outbreak. Achieving greater resilience is a complex challenge and, while related research and policy often focus on engineering solutions [15,62,87], it is arguably as much a social issue as it is a technological one. Despite growing evidence for its various benefits, urban agriculture's contribution to city resilience is a fairly new concept in academia, and our understanding of its role and potential is still limited. At the intersection of multiple dynamic urban systems, UA faces a number of socio-economic, environmental, and technical issues. Thus, increasing its success requires the support of a range of actors (including governments, nongovernmental organisations, researchers, industry, and the general public), as well as holistic, interdisciplinary, and inter-institutional approaches combining knowledge and insights from different areas [12–15,59,62,66,76,85,86].

4.1. Directions for Policy and Practice

In complex urban systems, planners and policy makers have to address a wide range of issues and prioritise different goals [12,18,30,38,49,52,62,63,65,66,82,85,86]. In order to be able to compete for cities' limited resources, UA must receive enough attention and support from governments. City authorities need to recognise agriculture as an important urban land use, devise appropriate policy frameworks, and incorporate UA into their different agendas (such as green space planning, food, wellbeing, and education), paying particular attention to spatial and socio-economic equality [13,30,59,66,76,86]. There is also a need for better integration among sectors and initiatives and more clarity around the responsibilities of different actors [30,62,66,74,80,88,99], and for strategic declarations to be complemented with action plans that include specific, measurable objectives [64,66,93].

Local governments should improve access to growing space, information, and funding for UA-related projects [13,62,64,80], as well as to local produce (e.g., through promotion of farmers' markets [18]). Since much potential growing space in urban areas is in the private domain, it is also vital that UA be promoted as a business, social enterprise, or recreational activity among various groups and individuals. Therefore, increased support for local stakeholder-led innovation [69], active citizenship and self-organisation [40,58,64,69,75,87], promotion of domestic food production and community farming [40], awareness raising and educational programmes (e.g., on healthy and sustainable diets, horticulture, and the environment) [14,18,62,69,72,80], public engagement (e.g., through hiring "community organisers") [15,62,64,85], and development of multistakeholder communication and collaboration platforms [64,66,76] will be important.

Finally, since the wide contextual diversity that exists between locations may preclude one-size-fits-all solutions, it is important that locally appropriate measures are designed based on a holistic consideration of the environmental, economic, and social setting [18,76,79,82,93]. Green Infrastructures and Nature-based Solutions could be appropriate tools to support integrated planning of urban green space [53,58,62,63,65,66,86], while Strengths, Weaknesses, Opportunities, and Threats (SWOT)-type assessment frameworks [83,100] supported by participatory approaches to planning and management [14,15,53,58,62,64,65,72,76,85,88,98,101] and geospatial information and communication technologies [12,76] could be useful in identifying the specific challenges and opportunities that exist in each city and points where interventions might be the most effective.

4.2. Directions for Research

Greater institutional support for UA and effective enhancement of its resilience benefits require a better understanding of and larger evidence base for its contribution. More research is needed on the current and potential area of UA in different cities, its ecosystem service provision capacity (including food, climate change mitigation and various social benefits) and how this varies with type of practice (e.g., traditional soil-based vs. technological cultivation methods), and environmental and socio-cultural factors (e.g., acceptance of different forms of UA, motivations to participate in UA-related activities, demand for urban-grown produce). In particular, research taking a whole-system perspective and innovative multidisciplinary approaches will be essential [62,76,93]. Examples of research methods suggested in the reviewed literature include GIS-based models (e.g., for land cover, use, ownership, and ecosystem service provision) [62,76,92,100]; life cycle analysis (e.g., of alternative food supply chains) [80]; field surveys (e.g., of soil quality, current cultivated areas, and crop types) [71,89]; computational modelling of different scenarios [39,76]; synthesis of interdisciplinary information [12,86]; place-based research [99]; surveys and interviews (with both practitioners and the general public) [50,66,71,92]; participatory research (including higher education–community partnerships, bottom-up data collection, and online crowd-sourcing, e.g., for mapping unused spaces in urban areas) [15,39,50,76,99]; and development of better indicators and tools for measuring both quantitative and qualitative aspects of resilience [15,92,93].

As well as filling knowledge gaps, it is equally important to create real-world solutions that can help increase the success of urban agriculture. Therefore, research should also focus on developing communication channels (e.g., digital platforms) and affordable and user-friendly tools to facilitate knowledge- and resource-sharing and different practical aspects of UA projects [87], designing alternative solutions for dealing with space and resource constraints (e.g., ponics technologies, green walls and roofs) [71,99], and understanding how institutional actors can best support various initiatives and engage people from different backgrounds in UA-related activities [15,62,85]. Finally, there needs to be a greater emphasis on effective science–policy dialogue and communicating research findings to different audiences [12,15,17,62,66,79,92,99].

4.3. Relevance and Limitations of the Study

The potential role of UA in increasing city resilience in the developing world has been reviewed by de Zeeuw et al. [61]. This study adds to existing knowledge by identifying the factors that determine UA's successful contribution to city resilience in the global North, using a systematic approach. Furthermore, the conceptual model we present highlights some key pathways to enhancing the resilience benefits of UA, and could serve as a basis for the development of (e.g., SWOT-type) assessment frameworks to assist policy-makers and urban planners in devising locally appropriate and effective strategies. The research and policy directions we identified could further contribute to the success of these efforts.

Nonetheless, some limitations of the study are recognised. First, a single literature database was used to identify relevant publications in English, which means that some potentially important work that was only available elsewhere, in other languages, or which

did not include the search terms used here may not have been considered. Second, due to the qualitative nature of the study, some degree of subjectivity might be inevitably present in the interpretation and synthesis of findings.

5. Conclusions

Urban agriculture (UA) could increase city resilience in the global North against various environmental and socio-economic disturbances, which are expected to increase in frequency and severity in the near future. However, its current and potential contribution to this has been little understood. The aim of this study was to conceptualise the success of UA and identify the pathways through which its resilience benefits can be enhanced. It is proposed that the success of UA in increasing city resilience is determined by five factors: its scale, the extent to which it is integrated into the urban fabric, its inclusiveness, the efficiency of food production, and human and environmental safety of practices. These factors in turn depend on the amount of institutional and public support for UA, the presence of a sufficient knowledge base to guide policy and practice, communication and collaboration among different actors, and resourcefulness in finding alternative ways to use space and other resources efficiently. Increasing its contribution to city resilience requires more research on the current and potential area, ecosystem provision capacity and social factors affecting UA, joined-up thinking and collaboration among governments, researchers and communities, and creative, context-specific solutions based on a comprehensive assessment of local conditions. Despite a number of challenges, through innovative solutions, flexible and integrated approaches to urban planning, and taking collective and local ownership of issues, most apparent space and resource constraints could be overcome, and urban agriculture could form an integral part of the resilient cities of our future. By conceptualising this rather complex topic, identifying some key issues that exist, and providing directions for research, policy, and practical courses of action, it is hoped that this study will contribute to these efforts.

Author Contributions: Conceptualization, B.Z.G. and J.L.E.; methodology, B.Z.G.; validation, J.L.E.; formal analysis, B.Z.G.; investigation, B.Z.G.; writing—original draft preparation, B.Z.G.; writing—review and editing, B.Z.G. and J.L.E.; visualization, B.Z.G.; supervision, J.L.E.; project administration, J.L.E.; funding acquisition, J.L.E. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by the Engineering and Physical Sciences Research Council (EPSRC) under grant no. EP/N030095/1 and by an EPSRC PhD studentship.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available in the article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IPCC. *Global Warming of 1.5 °C*; Intergovernmental Panel on Climate Change: Geneva, Switzerland, 2018. Available online: https://www.ipcc.ch/sr15/ (accessed on 4 March 2020).
2. While, A.; Whitehead, M. Cities, Urbanisation and Climate Change. *Urban Stud.* **2013**, *50*, 1325–1331. [CrossRef]
3. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2017 Revision. 2017. Available online: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Jan/un_2017_world_population_prospects-2017_revision_databooklet.pdf (accessed on 14 June 2019).
4. Morton, L.W.; Blanchard, T.C. Starved for access: Life in rural America's food deserts. *Rural Realities* **2007**, *1*, 1–10.
5. Montague-Fuller, A. *The Best Use of UK Agricultural Land*; University of Cambridge: Cambridge, UK, 2014; Available online: https://www.cisl.cam.ac.uk/resources/publication-pdfs/natural-capital-leaders-platform-the-best-use-of-u.pdf (accessed on 6 January 2019).
6. Deelstra, T.; Girardet, H. Urban Agriculture and Sustainable Cities. 2000. Available online: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.168.4991&rep=rep1&type=pdf (accessed on 14 October 2018).

7. Lang, T.; McKee, M. Brexit poses serious threats to the availability and affordability of food in the United Kingdom. *J. Public Health* **2018**, *40*, e608–e610. [CrossRef] [PubMed]
8. de Ruiter, H.; Macdiarmid, J.I.; Matthews, R.B.; Kastner, T.; Smith, P. Global cropland and greenhouse gas impacts of UK food supply are increasingly located overseas. *J. R. Soc. Interface* **2016**, *13*. [CrossRef] [PubMed]
9. Lal, R. Home gardening and urban agriculture for advancing food and nutritional security in response to the COVID-19 pandemic. *Food Secur.* **2020**, *12*, 871–876. [CrossRef] [PubMed]
10. FAO. *Cities and Local Governments at the Forefront in Building Inclusive and Resilient Food Systems: Key Results from the FAO Survey "Urban Food Systems and COVID-19"*; Revised Version; FAO: Rome, Italy, 2020. [CrossRef]
11. Meerow, S.; Newell, J.P.; Stults, M. Defining urban resilience: A review. *Landsc. Urban Plan.* **2016**, *147*, 38–49. [CrossRef]
12. Voskamp, I.M.; Van de Ven, F.H. Planning support system for climate adaptation: Composing effective sets of blue-green measures to reduce urban vulnerability to extreme weather events. *Build. Environ.* **2015**, *83*, 159–167. [CrossRef]
13. Olsson, G.A.; Kerselaers, E.; Kristensen, L.S.; Primdahl, J.; Rogge, E.; Wästfelt, A. Peri-Urban Food Production and Its Relation to Urban Resilience. *Sustainability* **2016**, *8*, 1340. [CrossRef]
14. Lee, T.; Lee, T. Evolutionary urban climate resilience: Assessment of Seoul's policies. *Int. J. Clim. Change Strateg. Manag.* **2016**. Available online: https://www.emerald.com/insight/content/doi/10.1108/IJCCSM-06-2015-0066/full/html (accessed on 1 February 2020). [CrossRef]
15. McMillen, H.; Campbell, L.; Svendsen, E.; Reynolds, R. Recognizing Stewardship Practices as Indicators of Social Resilience: In Living Memorials and in a Community Garden. *Sustainability* **2016**, *8*, 775. [CrossRef]
16. 100 Resilient Cities. 2019. Available online: https://www.100resilientcities.org/resources/ (accessed on 20 February 2020).
17. Sharifi, A.; Yamagata, Y. Resilient Urban Planning: Major Principles and Criteria. *Energy Procedia* **2014**, *61*, 1491–1495. [CrossRef]
18. Dezio, C.; Marino, D. Towards an Impact Evaluation Framework to Measure Urban Resilience in Food Practices. *Sustainability* **2018**, *10*, 2042. [CrossRef]
19. Tendall, D.; Joerin, J.; Kopainsky, B.; Edwards, P.R.; Shreck, A.; Le, Q.; Kruetli, P.; Grant, M.D.; Six, J. Food system resilience: Defining the concept. *Glob. Food Secur.* **2015**, *6*, 17–23. [CrossRef]
20. Di Angelantonio, E.; Bhupathiraju, S.N.; Wormser, D.; Gao, P.; Kaptoge, S.; De Gonzalez, A.B.; Cairns, B.J.; Huxley, R.; Jackson, C.L.; Joshy, G.; et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *Lancet* **2016**, *388*, 776–786. [CrossRef]
21. WHO. Obesity and Overweight. 2020. Available online: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight (accessed on 11 August 2020).
22. FAO; IFAD; UNICEF; WFP; WHO. *The State of Food Security and Nutrition in the World 2020*; FAO; IFAD; UNICEF; WFP; WHO: Rome, Italy, 2020. [CrossRef]
23. Baudoin, W.; Drescher, A. *Urban Agriculture for Sustainable Poverty Alleviation and Food Security*; FAO: Rome, Italy, 2008.
24. Sustainable Food Trust. Building Resilience into our Food Systems. 2020. Available online: https://sustainablefoodtrust.org/articles/building-resilience-into-our-food-systems/ (accessed on 11 August 2020).
25. Ingram, J.; Sykes, R.; Zurek, M.; O'Kane, E. Resilience of the UK Food System in a Global Context. Global Food Security. 2020. Available online: https://www.foodsecurity.ac.uk/research/food-system-resilience/ (accessed on 11 August 2020).
26. Dubbeling, M.; van Veenhuizen, R.; Halliday, J. Urban agriculture as a climate change and disaster risk reduction strategy. *Field Actions Sci. Rep. J. Field Actions* **2019**, *20*, 32–39.
27. Pulighe, G.; Lupia, F. Food First: COVID-19 Outbreak and Cities Lockdown a Booster for a Wider Vision on Urban Agriculture. *Sustainability* **2020**, *12*, 5012. [CrossRef]
28. Ingram, J.; Sykes, R.; Zurek, M.; O'Kane, E. Exploring the Resilience of the UK Food System in a Global Context. Global Food Security. 2020. Available online: https://www.foodsecurity.ac.uk/wp-content/uploads/2009/10/exploring-the-resilience-of-the-uk-food-system-in-a-global-context.pdf (accessed on 11 August 2020).
29. IIED. Building Resilient Food Systems. 14 August 2013. Available online: https://www.iied.org/building-resilient-food-systems (accessed on 11 August 2020).
30. Schuetze, T.; Lee, J.-W.; Lee, T.-G. Sustainable Urban (re-) Development with Building Integrated Energy, Water and Waste Systems. *Improv. Urban Environ.* **2016**, 235–254. [CrossRef]
31. Smit, J.; Nasr, J.; Ratta, A. *Urban Agriculture: Food, Jobs and Sustainable Cities*; United Nations Development Programme: New York, NY, USA, 1996; Volume 2, pp. 35–37.
32. FAO. *FAO's Role in Urban Agriculture*; Food and Agriculture Organization of the United Nations: Roma, Italy, 2018; Available online: http://www.fao.org/urban-agriculture/en/ (accessed on 19 February 2019).
33. Milan Urban Food Policy Pact. 2018. Available online: http://www.milanurbanfoodpolicypact.org/ (accessed on 21 February 2019).
34. Calvet-Mir, L.; March, H. Crisis and post-crisis urban gardening initiatives from a Southern European perspective: The case of Barcelona. *Eur. Urban Reg. Stud.* **2019**, *26*, 97–112. [CrossRef]
35. APA. Urban Agriculture. In American Planning Association. 2019. Available online: https://www.planning.org/knowledgebase/urbanagriculture/ (accessed on 21 February 2019).
36. Morgan, K. Nourishing the city: The rise of the urban food question in the Global North. *Urban Stud.* **2015**, *52*, 1379–1394. [CrossRef]

37. Mok, H.-F.; Williamson, V.G.; Grove, J.R.; Burry, K.; Barker, S.F.; Hamilton, A.J. Strawberry fields forever? Urban agriculture in developed countries: A review. *Agron. Sustain. Dev.* **2014**, *34*, 21–43. [CrossRef]
38. Panagopoulos, T.; Jankovska, I.; Dan, M.B. Urban Green Infrastructure: The Role of Urban Agriculture in City Resilience. Urbanism Arhitectura. 2018. Available online: https://www.ceeol.com/search/article-detail?id=603150 (accessed on 11 June 2019).
39. Chang, M.; Morel, K. Reconciling economic viability and socio-ecological aspirations in London urban microfarms. *Agron. Sustain. Dev.* **2018**, *38*, 9. [CrossRef]
40. Colding, J.; Barthel, S. The potential of "Urban Green Commons" in the resilience building of cities. *Ecol. Econ.* **2013**, *86*, 156–166. [CrossRef]
41. Colasanti, K.J.A.; Hamm, M.W. Assessing the local food supply capacity of Detroit, Michigan. *J. Agric. Food Syst. Community Dev.* **2016**, *1*, 41–58. [CrossRef]
42. Martin, G.; Clift, R.; Christie, I. Urban Cultivation and Its Contributions to Sustainability: Nibbles of Food but Oodles of Social Capital. *Sustainability* **2016**, *8*, 409. [CrossRef]
43. Evans, D.; Davies, J. Urban Farming: Four Reasons It Should Flourish Post-Pandemic. The Conversation. 26 August 2020. Available online: http://theconversation.com/urban-farming-four-reasons-it-should-flourish-post-pandemic-144133 (accessed on 15 October 2020).
44. Royal Horticultural Society. RHS Launches "Grow at Home" to Provide Even More Support to a Growing Number of Gardeners during Lockdown. 2020. Available online: https://www.rhs.org.uk/press/releases/RHS-Launches-Grow-at-Home (accessed on 9 October 2020).
45. Tomkins, M. Edible Urban. 2019. Available online: http://mikeytomkins.co.uk/ (accessed on 28 May 2020).
46. Grewal, S.S.; Grewal, P.S. Can cities become self-reliant in food? *Cities* **2012**, *29*, 1–11. [CrossRef]
47. Opitz, I.; Berges, R.; Piorr, A.; Krikser, T. Contributing to food security in urban areas: Differences between urban agriculture and peri-urban agriculture in the Global North. *Agric. Hum. Values* **2016**, *33*, 341–358. [CrossRef]
48. Sanyé-Mengual, E.; Oliver-Solà, J.; Montero, J.I.; Rieradevall, J. An environmental and economic life cycle assessment of rooftop greenhouse (RTG) implementation in Barcelona, Spain. Assessing new forms of urban agriculture from the greenhouse structure to the final product level. *Int. J. Life Cycle Assess.* **2015**, *20*, 350–366. [CrossRef]
49. Edwards, F.; Dixon, J.; Friel, S.; Hall, G.; Larsen, K.; Lockie, S.; Wood, B.; Lawrence, M.; Hanigan, I.; Hogan, A.; et al. Climate change adaptation at the intersection of food and health. *Asia Pac. J. Public Health* **2011**, *23*, 91S–104S. [CrossRef]
50. Hara, Y.; McPhearson, T.; Sampei, Y.; McGrath, B. Assessing urban agriculture potential: A comparative study of Osaka, Japan and New York City, United States. *Sustain. Sci.* **2018**, *13*, 937–952. [CrossRef]
51. FAO. Food for the Cities. 2001. Available online: http://www.fao.org/tempref/docrep/fao/012/ak824e/ak824e00.pdf (accessed on 19 February 2019).
52. Frantzeskaki, N.; Tilie, N. The Dynamics of Urban Ecosystem Governance in Rotterdam, The Netherlands. *Ambio* **2014**, *43*, 542–555. [CrossRef]
53. Ferreira, A.J.D.; Pardal, J.; Malta, M.; Ferreira, C.S.S.; Soares, D.D.J.; Vilhena, J. Improving Urban Ecosystems Resilience at a City Level the Coimbra Case Study. *Energy Procedia* **2013**, *40*, 6–14. [CrossRef]
54. Cordell, D.; Drangert, J.-O.; White, S. The story of phosphorus: Global food security and food for thought. *Glob. Environ. Chang.* **2009**, *19*, 292–305. [CrossRef]
55. Cameron, D.; Osborne, C.; Sinclair, M.; Horton, P. *A Sustainable Model for Intensive Agriculture*; Grantham Center for Sustainable Futures, University of Sheffield: Sheffield, UK, 2015; Available online: https://static1.squarespace.com/static/58cff61c414fb598d9e947ca/t/5ece686046106e09889699d7/1590585442860/Grantham+2014+Sustainable+Model+for+Intensive+Agriculture.pdf (accessed on 15 November 2018).
56. Winiwarter, W.; Leip, A.; Tuomisto, H.L.; Haastrup, P. A European perspective of innovations towards mitigation of nitrogen-related greenhouse gases. *Curr. Opin. Environ. Sustain.* **2014**, 37–45. [CrossRef]
57. Santo, R.; Palmer, A.; Kim, B. Vacant Lots to Vibrant Plots—A Review of the Benefits and Limitations of Urban Agriculture. John Hopkins Center for a Livable Future. May 2016. Available online: https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-a-livable-future/_pdf/research/clf_reports/urban-ag-literature-review.pdf (accessed on 7 November 2018).
58. Mabon, L. Enhancing post-disaster resilience by 'building back greener': Evaluating the contribution of nature-based solutions to recovery planning in Futaba County, Fukushima Prefecture, Japan. *Landsc. Urban Plan.* **2019**, *187*, 105–118. [CrossRef]
59. Beatley, T.; Newman, P.; Etingoff, K. Biophilic Cities Are Sustainable, Resilient Cities. *Sustain. Cities* **2017**, 3–28. [CrossRef]
60. Barthel, S.; Parker, J.; Ernstson, H. Food and Green Space in Cities: A Resilience Lens on Gardens and Urban Environmental Movements. *Urban Stud.* **2015**, *52*, 1321–1338. [CrossRef]
61. De Zeeuw, H.; Van Veenhuizen, R.; Dubbeling, M. The role of urban agriculture in building resilient cities in developing countries. *J. Agric. Sci.* **2011**, *149*, 153. [CrossRef]

62. Scott, M.; Lennon, M.; Haase, D.; Kazmierczak, A.; Clabby, G.; Beatley, T. Nature-based solutions for the contemporary city/Re-naturing the city/Reflections on urban landscapes, ecosystems services and nature-based solutions in cities/Multifunctional green infrastructure and climate change adaptation: Brownfield greening as an adaptation strategy for vulnerable communities?/Delivering green infrastructure through planning: Insights from practice in Fingal, Ireland/Planning for biophilic cities: From theory to practice. *Plan. Theory Pr.* **2016**, *17*, 267–300. [CrossRef]
63. De la Sota, C.; Ruffato-Ferreira, V.J.; Ruiz-García, L.; Alvarez, S. Urban green infrastructure as a strategy of climate change mitigation. A case study in northern Spain. *Urban For. Urban Green.* **2019**, *40*, 145–151. [CrossRef]
64. Van Der Jagt, A.P.; Szaraz, L.R.; Delshammar, T.; Cvejić, R.; Santos, A.; Goodness, J.; Buijs, A. Cultivating nature-based solutions: The governance of communal urban gardens in the European Union. *Environ. Res.* **2017**, *159*, 264–275. [CrossRef]
65. McPhearson, T.; Hamstead, Z.; Kremer, P. Urban Ecosystem Services for Resilience Planning and Management in New York City. *Ambio* **2014**, *43*, 502–515. [CrossRef] [PubMed]
66. Faivre, N.; Fritz, M.; Freitas, T.; De Boissezon, B.; Vandewoestijne, S. Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges. *Environ. Res.* **2017**, *159*, 509–518. [CrossRef] [PubMed]
67. Ling, T.-Y.; Chiang, Y.-C. Well-being, health and urban coherence-advancing vertical greening approach toward resilience: A design practice consideration. *J. Clean. Prod.* **2018**, *182*, 187–197. [CrossRef]
68. Privitera, R.; Palermo, V.; Martinico, F.; Fichera, A.; La Rosa, D. Towards lower carbon cities: urban morphology contribution in climate change adaptation strategies. *Eur. Plan. Stud.* **2018**, *26*, 812–837. [CrossRef]
69. Dennis, M.; Armitage, R.P.; James, P. Social-ecological innovation: adaptive responses to urban environmental conditions. *Urban Ecosyst.* **2016**, *19*, 1063–1082. [CrossRef]
70. Beatley, T. *Biophilic Cities: Integrating Nature into Urban Design and Planning*; Island Press: Washington, DC, USA, 2011.
71. Clinton, N.; Stuhlmacher, M.; Miles, A.; Aragon, N.U.; Wagner, M.; Georgescu, M.; Herwig, C.; Gong, P. A Global Geospatial Ecosystem Services Estimate of Urban Agriculture. *Earth's Futur.* **2018**, *6*, 40–60. [CrossRef]
72. Sanyé-Mengual, E.; Specht, K.; Krikser, T.; Vanni, C.; Pennisi, G.; Orsini, F.; Gianquinto, G.P. Social acceptance and perceived ecosystem services of urban agriculture in Southern Europe: The case of Bologna, Italy. *PLoS ONE* **2018**, *13*, e0200993. [CrossRef]
73. Edmondson, J.L.; Cunningham, H.; Tingley, D.O.D.; Dobson, M.C.; Grafius, D.R.; Leake, J.R.; McHugh, N.; Nickles, J.; Phoenix, G.K.; Ryan, A.J.; et al. The hidden potential of urban horticulture. *Nat. Food* **2020**, *1*, 155–159. [CrossRef]
74. Plant, R.; Walker, J.; Rayburg, S.; Gothe, J.; Leung, T. The Wild Life of Pesticides: urban agriculture, institutional responsibility, and the future of biodiversity in Sydney's Hawkesbury-Nepean River. *Aust. Geogr.* **2012**, *43*, 75–91. [CrossRef]
75. Buijs, A.; Mattijssen, T.J.M.; Van Der Jagt, A.P.; Ambrose-Oji, B.; Andersson, E.; Elands, B.H.; Møller, M.S. Active citizenship for urban green infrastructure: Fostering the diversity and dynamics of citizen contributions through mosaic governance. *Curr. Opin. Environ. Sustain.* **2016**, *22*, 1–6. [CrossRef]
76. Collier, M.J.; Nedovic-Budic, Z.; Aerts, J.; Connop, S.; Foley, D.; Foley, K.; Newport, D.; McQuaid, S.; Slaev, A.; Verburg, P. Transitioning to resilience and sustainability in urban communities. *Cities* **2013**, *32*, S21–S28. [CrossRef]
77. Dobson, M.C.; Edmondson, J.L.; Warren, P.H. Urban food cultivation in the United Kingdom: Quantifying loss of allotment land and identifying potential for restoration. *Landsc. Urban Plan.* **2020**, *199*, 103803. [CrossRef]
78. Wicked Leeks. Coronavirus Causes Spike in Demand for Allotments. 2020. Available online: https://wickedleeks.riverford.co.uk/news/local-sourcing-grow-your-own/coronavirus-causes-spike-demand-allotments (accessed on 9 October 2020).
79. Mabon, L.; Shih, W.-Y. What might "just green enough" urban development mean in the context of climate change adaptation? The case of urban greenspace planning in Taipei Metropolis, Taiwan. *World Dev.* **2018**, *107*, 224–238. [CrossRef]
80. James, S.W.; Friel, S. An integrated approach to identifying and characterising resilient urban food systems to promote population health in a changing climate. *Public Health Nutr.* **2015**, *18*, 2498–2508. [CrossRef]
81. Dixon, J.; Richards, C. On food security and alternative food networks: Understanding and performing food security in the context of urban bias. *Agric. Hum. Values* **2016**, *33*, 191–202. [CrossRef]
82. Monaco, F.; Zasada, I.; Wascher, D.; Glavan, M.; Pintar, M.; Schmutz, U.; Mazzocchi, C.; Corsi, S.; Sali, G. Food Production and Consumption: City Regions between Localism, Agricultural Land Displacement, and Economic Competitiveness. *Sustainable* **2017**, *9*, 96. [CrossRef]
83. Berte, E.; Panagopoulos, T. Enhancing city resilience to climate change by means of ecosystem services improvement: A SWOT analysis for the city of Faro, Portugal. *Int. J. Urban Sustain. Dev.* **2014**, *6*, 241–253. [CrossRef]
84. Speak, A.; Mizgajski, A.; Borysiak, J. Allotment gardens and parks: Provision of ecosystem services with an emphasis on biodiversity. *Urban For. Urban Green.* **2015**, *14*, 772–781. [CrossRef]
85. Crowe, P.R.; Foley, K.; Collier, M.J. Operationalizing urban resilience through a framework for adaptive co-management and design: Five experiments in urban planning practice and policy. *Environ. Sci. Policy* **2016**, *62*, 112–119. [CrossRef]
86. Draus, P.; Lovall, S.; Formby, T.; Baldwin, L.; Lowe-Anderson, W. A green space vision in Southeast Michigan's most heavily industrialized area. *Urban Ecosyst.* **2019**, *22*, 91–102. [CrossRef]
87. Baibarac, C.; Petrescu, D. Open-source Resilience: A Connected Commons-based Proposition for Urban Transformation. *Procedia Eng.* **2017**, *198*, 227–239. [CrossRef]
88. Olsson, E.G.A. Urban food systems as vehicles for sustainability transitions. *Bull. Geogr. Socio-Econ. Ser.* **2018**, *40*, 133–144. [CrossRef]

89. Schlecht, M.T.; Säumel, I. Wild growing mushrooms for the Edible City? Cadmium and lead content in edible mushrooms harvested within the urban agglomeration of Berlin, Germany. *Environ. Pollut.* **2015**, *204*, 298–305. [CrossRef] [PubMed]
90. Entwistle, J.A.; Amaibi, P.M.; Dean, J.R.; Deary, M.E.; Medock, D.; Morton, J.; Rodushkin, I.; Bramwell, L. An apple a day? Assessing gardeners' lead exposure in urban agriculture sites to improve the derivation of soil assessment criteria. *Environ. Int.* **2019**, *122*, 130–141. [CrossRef]
91. Kosanović, S.; Fikfak, A. Development of criteria for ecological evaluation of private residential lots in urban areas. *Energy Build.* **2016**, *115*, 69–77. [CrossRef]
92. Haase, D.; Larondelle, N.; Andersson, E.; Artmann, M.; Borgström, S.; Breuste, J.; Gomez-Baggethun, E.; Gren, Å.; Hamstead, Z.; Hansen, R.; et al. A quantitative review of urban ecosystem service assessments: Concepts, models, and implementation. *Ambio* **2014**, *43*, 413–433. [CrossRef]
93. Coppo, G.; Stempfle, S.; Reho, M. Urban food strategies and plans: Considerations on the assessment construction. *City Territ. Arch.* **2017**, *4*, 8. [CrossRef]
94. C40. C40 Cities. 2020. Available online: https://www.c40.org/networks/food_systems (accessed on 11 August 2020).
95. Sonnino, R. The new geography of food security: Exploring the potential of urban food strategies. *Geogr. J.* **2016**, *182*, 190–200. [CrossRef]
96. Edmondson, J.L.; Childs, D.Z.; Dobson, M.C.; Gaston, K.J.; Warren, P.H.; Leake, J.R. Feeding a city—Leicester as a case study of the importance of allotments for horticultural production in the UK. *Sci. Total Environ.* **2020**, *705*, 135930. [CrossRef]
97. Edmondson, J.L.; Blevins, R.S.; Cunningham, H.; Dobson, M.C.; Leake, J.R.; Grafius, D.R. Grow your own food security? Integrating science and citizen science to estimate the contribution of own growing to UK food production. *Plants People Planet* **2019**, *1*, 93–97. [CrossRef]
98. McGrail, S.; Gaziulusoy, A.I.; Twomey, P. Framing Processes in the Envisioning of Low-Carbon, Resilient Cities: Results from Two Visioning Exercises. *Sustainability* **2015**, *7*, 8649–8683. [CrossRef]
99. Molnar, C.; Ritz, T.; Heller, B.; Solecki, W. Using Higher Education-Community Partnerships to Promote Urban Sustainability. *Environ. Sci. Policy Sustain. Dev.* **2010**, *53*, 18–28. [CrossRef]
100. Sieber, J.; Pons, M. Assessment of Urban Ecosystem Services using Ecosystem Services Reviews and GIS-based Tools. *Procedia Eng.* **2015**, *115*, 53–60. [CrossRef]
101. Alvarez, L.; Borsi, K.; Rodrigues, L. The role of social network analysis on participation and placemaking. *Sustain. Cities Soc.* **2017**, *28*, 118–126. [CrossRef]