

2018

## Agroecology for the Shrinking City

Dustin L. Herrmann

*Oak Ridge Institute for Science and Education Research Participant Program with the United States Environmental Protection Agency, herrmann.dustin@epa.gov*

Wen-Ching Chuang

*USEPA, chuang.wen-ching@epa.gov*

Kristen Schawrz

*Northern Kentucky University, schwarzk1@nku.edu*

Timothy M. Bowles

*University of California - Berkeley, timothy.bowles@berkeley.edu*

Ahjond S. Garmestani

*U.S. Environmental Protection Agency, garmestani.ahjond@epa.gov*

*See next page for additional authors*

Follow this and additional works at: <http://digitalcommons.unl.edu/ncfwrustaff>

 Part of the [Aquaculture and Fisheries Commons](#), [Environmental Indicators and Impact Assessment Commons](#), [Environmental Monitoring Commons](#), [Natural Resource Economics Commons](#), [Natural Resources and Conservation Commons](#), and the [Water Resource Management Commons](#)

Herrmann, Dustin L.; Chuang, Wen-Ching; Schawrz, Kristen; Bowles, Timothy M.; Garmestani, Ahjond S.; Shuster, William D.; Eason, Tarsha; Hopton, Matthew E.; and Allen, Craig R., "Agroecology for the Shrinking City" (2018). *Nebraska Cooperative Fish & Wildlife Research Unit -- Staff Publications*. 259.  
<http://digitalcommons.unl.edu/ncfwrustaff/259>

This Article is brought to you for free and open access by the Nebraska Cooperative Fish & Wildlife Research Unit at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Nebraska Cooperative Fish & Wildlife Research Unit -- Staff Publications by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.





---

**Authors**

Dustin L. Herrmann, Wen-Ching Chuang, Kristen Schawrz, Timothy M. Bowles, Ahjond S. Garmestani, William D. Shuster, Tarsha Eason, Matthew E. Hopton, and Craig R. Allen

Article

# Agroecology for the Shrinking City

Dustin L. Herrmann <sup>1</sup> , Wen-Ching Chuang <sup>2</sup>, Kirsten Schwarz <sup>3</sup>, Timothy M. Bowles <sup>4</sup> , Ahjond S. Garmestani <sup>2</sup>, William D. Shuster <sup>2</sup> , Tarsha Eason <sup>5</sup>, Matthew E. Hopton <sup>2,\*</sup>  and Craig R. Allen <sup>6</sup>

<sup>1</sup> ORISE Postdoctoral Fellow at U.S. Environmental Protection Agency, Cincinnati, OH 45268, USA; herrmann.dustin@epa.gov

<sup>2</sup> Office of Research and Development, United States Environmental Protection Agency, Cincinnati, OH 45268, USA; chuang.wen-ching@epa.gov (W.-C.C.); garmestani.ahjond@epa.gov (A.S.G.); shuster.william@epa.gov (W.D.S.)

<sup>3</sup> Department of Biological Sciences, Northern Kentucky University, Highland Heights, KY 41099, USA; schwarzk1@nku.edu

<sup>4</sup> Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA 94720, USA; timothy.bowles@berkeley.edu

<sup>5</sup> Office of Research and Development, United States Environmental Protection Agency, Durham, NC 27711, USA; eason.tarsha@epa.gov

<sup>6</sup> U.S. Geological Survey-Nebraska Cooperative Fish and Wildlife Research Unit and School of Natural Resources, University of Nebraska, Lincoln, NE 68583, USA; callen3@unl.edu

\* Correspondence: hopton.matthew@epa.gov; Tel.: +1-513-569-7718

Received: 26 January 2018; Accepted: 1 March 2018; Published: 2 March 2018

**Abstract:** Many cities are experiencing long-term declines in population and economic activity. As a result, frameworks for urban sustainability need to address the unique challenges and opportunities of such shrinking cities. Shrinking, particularly in the U.S., has led to extensive vacant land. The abundance of vacant land reflects a loss of traditional urban amenities, economic opportunity, neighbors, businesses, and even basic city services and often occurs in neighborhoods with socially and economically vulnerable or underserved populations. However, vacant land also provides opportunities, including the space to invest in green infrastructure that can provide ecosystem services and support urban sustainability. Achieving desirable amenities that provide ecosystem services from vacant land is the central tenet of a recent urban sustainability framework termed *ecology for the shrinking city*. An agroecological approach could operationalize ecology for the shrinking city to both manage vacancy and address ecosystem service goals. Developing an agroecology in shrinking cities not only secures provisioning services that use an active and participatory approach of vacant land management but also transforms and enhances regulating and supporting services. The human and cultural dimensions of agroecology create the potential for social-ecological innovations that can support sustainable transformations in shrinking cities. Overall, the strength of agroecological principles guiding a green infrastructure strategy stems from its explicit focus on how individuals and communities can shape their environment at multiple scales to produce outcomes that reflect their social and cultural context. Specifically, the shaping of the environment provides a pathway for communities to build agency and manage for resilience in urban social-ecological systems. Agroecology for the shrinking city can support desirable transformations, but to be meaningful, we recognize that it must be part of a greater strategy that addresses larger systemic issues facing shrinking cities and their residents.

**Keywords:** ecology for the city; urban sustainability; urban agriculture; ecosystem services; urban amenities; vacant lot

## 1. Shrinking Cities: An Opportunity for Agroecological Transitions

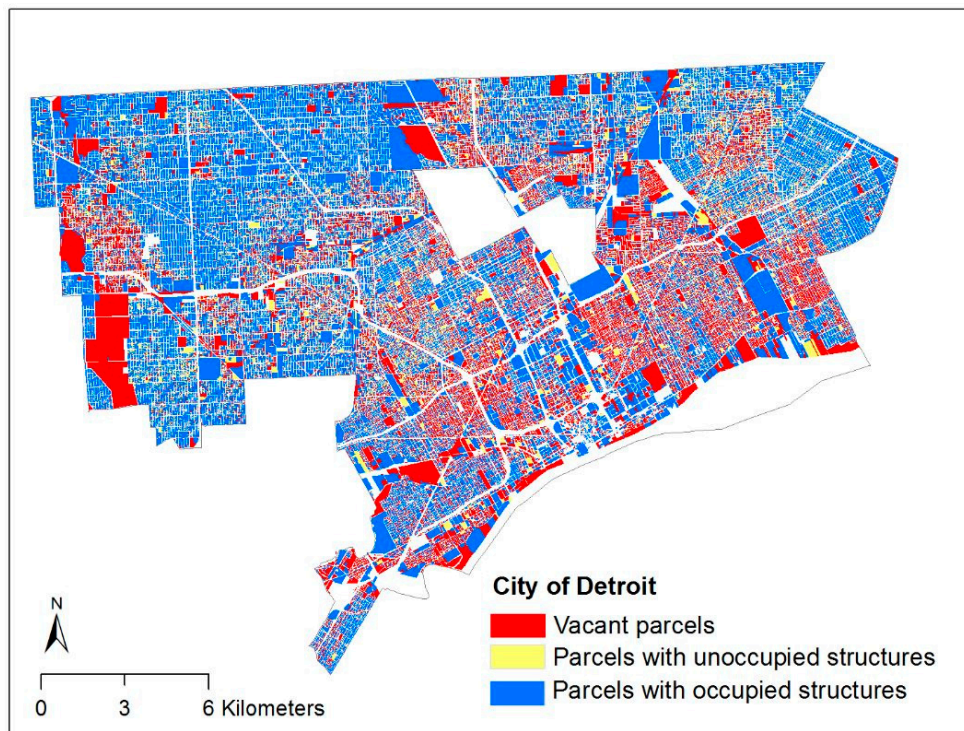
Shrinking is a general term used to describe cities that have faced long-term population decline and loss of economic activity [1]. While urban growth predominates globally, examples of shrinking cities can be found across the world [2]. Concentrated examples can be found in regions such as the Great Lakes area of the U.S.A. and Canada [1], where shrinking cities are so common, in part due to loss of manufacturing employment, that the region has taken on the moniker Rust Belt. Shrinking in the case of Rust Belt cities is both multi-decadal and entrenched [1]. Initially, population loss and decline in economic activity were considered to be a trend that could be countered through urban renewal projects. In many cases, these projects were unsuccessful in spurring revitalization and widely damaging to physical and social connections that had existed [3]. The failure to address the problems of shrinking cities through urban renewal programs points to the need for new approaches that embrace the reality of smaller populations.

The emergence of abandoned buildings and vacant land in shrinking cities strains traditional government, as it is associated with lower tax revenues and greater management burdens. In the current era, with widespread abandonment and disrepair of buildings, shrinking cities use demolition to manage risk to the city and residents, and to mitigate real or perceived blight [4]. Cities throughout the Rust Belt have used demolition as an urban management tool since the 1970s and have increased its use in the last decade [4]. In Detroit, Michigan, USA, the city is actively demolishing >5000 buildings per year with a goal of 40,000 demolitions using the current round of federal funding from the Hardest Hit Funds program [5]. People in affected shrinking city neighborhoods also disproportionately represent marginalized or socially vulnerable groups [6].

Although shrinking cities pose social, economic, and environmental challenges, they provide a scarce resource in urbanized landscapes: land (Figure 1). Despite having access to the coveted resource of space, vacant land in shrinking cities often functions as blight or a management burden rather than a beneficial resource for the community or city (Figure 2). Accordingly, theory and praxis for the transformation of this land into a resource that builds sustainability are needed. This paper is part of a progression of work we are developing toward that end. Initially, Herrmann et al. [7,8] developed a general framework called *ecology for the shrinking city* (discussed below). Here we present agroecology as a pathway to advance sustainability in shrinking cities by maximizing both ecosystem services and amenities, and engaging communities in the shaping of place. Specifically, agroecology is a framework that can address the need and desire for food security and sovereignty, support livelihoods generally, and drive neighborhood and city level transformations to sustainable pathways.

This article integrates ecology for the shrinking city framework with agroecology science and practice theory. It first reviews ecology for the shrinking city [7] and presents a short agroecology primer. We then demonstrate the potential of agroecology to support sustainability outcomes through two case studies, an example of agroecology in Minas Gerais, Brazil that demonstrates agroecology in a rural case and one from Detroit, Michigan, that specifically demonstrates the benefits of agroecology in a shrinking city. Lessons for how an agroecology would be compared in a shrinking city to a rural practice are examined. We then discuss how agroecology facilitates managing for resilience and operationalizes ecology for the shrinking city. Finally, we consider if an agroecology for the shrinking city should be about more than food in order to manage multiple ecosystem services in urban landscapes.





**Figure 1.** The City of Detroit has a large amount of vacant parcels (i.e., parcels without structures) and vacant buildings (i.e., parcels with structures that are not occupied). As of 2013, 30% of Detroit’s parcels were vacant, and 18% of parcels with structures were unoccupied. Data source: “Motor City Mapping, Winter 2013–2014 Certified Results” via Data Driven Detroit (<http://portal.datadrivendetroit.org/>).



**Figure 2.** Detroit street where structures no longer exist because of demolition; evidence of neglect (e.g., unmanaged vegetation growth) and undesirable uses (e.g., refuse dumping) persist after demolition. Vacant urban land in shrinking cities is extensive and presents an opportunity for natural resource management for social and environmental benefits.

## 2. Ecology for the Shrinking City: A Framework for Informing Urban Transitions

Ecology for the shrinking city is a new framework that has the potential to offer solutions to social and environmental issues faced by shrinking cities and their residents [7]. The science of urban ecology is a relatively young discipline with origins as recent as the 1990s for the contemporary science as practiced in the U.S. [9], but it has rapidly evolved multiple and complementary paradigms for research and practice [10]. Three recognized urban ecology paradigms are ecology *in*, ecology *of*, and ecology *for* the city [10–12]. Ecology *in* the city uses traditional ecological approaches that typically focus on the green spaces of cities. Ecology *of* the city uses both ecological and social dimensions to build an understanding of urban ecosystems. These paradigms have been used to inform and shape applications of ecological understanding to urban form and function. Ecology *for* the city is the co-production of knowledge and action by scientists, urban practitioners, government officials, and urban residents, among others [9].

The knowledge created and actions taken through ecology for the city are intended to promote sustainability goals, including equity, justice, and resilience of desirable regimes of city functioning [10–12]. However, cities (or neighborhoods within cities), despite potentially strong similarities in form and function across differing social, political, and environmental contexts [13], likely differ significantly in their ability to transform towards sustainable trajectories while preserving the dominant political economy. Large cities (e.g., New York City, London) that attract a great share of investment and talent can redirect billions of dollars to building justice, sustainability, and resilience [14]. Intermediate but stable or growing cities can work toward sustainability transitions with moderate shifts in strategy [15]. Arguably, though, shrinking cities are a case of failure in city building, associated economies, and governance. In these cases, an alternative is likely necessary to achieve desirable outcomes of justice, sustainability, and resilience.

In shrinking cities, loss of amenities that are the basis of a desirable and thriving urban community coupled with the emergence of blight can reinforce a low amenity state for cities. Lost amenities can include, for example, businesses and commerce, neighbors, reliable city services, and suitable transportation options. Blight includes abandoned structures and land that experiences insufficient beneficial use by the community or insufficient management by individuals and government agencies to handle vegetation growth, dumping, or other undesirable uses. Blight management, such as demolition of structures and mowing, has been employed largely based on the broken windows hypothesis that a neighborhood without visible evidence of neglect will be able to remain stable or improve. However, blight mitigation has not been transformative in shrinking cities vis-à-vis the restoration of traditional urban amenities [16].

Co-arising with the loss of amenities and the need for blight management in shrinking cities is the potential to enhance ecosystem services through available green space. Vacant lots have been demonstrated to provide multiple ecosystem services (e.g., habitat for wildlife, regulation of urban hydrology), which indicates the potential for ecosystem services in high vacancy shrinking city neighborhoods [17,18]. However, ecosystem services provided by vacant lands are not necessarily amenities to the immediate neighborhood and residents affected by the vacancy. Examples include those benefits that arise from regulation of the water cycle and greenhouse gases or the provision of a wildlife habitat that residents do not necessarily value or directly benefit from. Instead, many of the benefits accrue at different levels of organization or to individuals outside the neighborhood (e.g., city, watershed, and region). Ecosystem services that are realized are not necessarily managed as amenities, indicating that the potential ecosystem services of shrinking cities are greater than what is generally recognized.

Amenities and ecosystem services are key dimensions of ecology for the shrinking city, where the goal is transformation of blight and vacancy to a high amenity-high ecosystem service landscape [7]. For example, the potential for amenities and ecosystem services can be realized by vacant lots that are co-designed by communities and managers to support stormwater retention and desired community use of the space (e.g., public parks). Herrmann et al. [7] synthesized and advanced a general vision for



urban sustainability that recognizes the need to maximize ecosystem services and amenities, but its operationalization is needed to realize desired outcomes. Agroecology presents a potential pathway for realizing high amenity-high ecosystem service landscapes for just and sustainable outcomes in shrinking cities.

### 3. Agroecology Primer

Agroecology is a holistic, dynamic, and evolving approach to developing sustainable agricultural food systems. As a scientific discipline, agroecology emerged as a counterpoint to reductionist views of agriculture and as a means of understanding the ecology of traditional and biologically-based farming, thereby responding to environmental and social problems that result from industrialized food systems [19,20]. Agroecology considers agricultural systems to be complex ecosystems and management of ecological processes and linkages to be the key to productive and functional systems. The core ecological concept underpinning agroecological thought is that biodiversity at multiple temporal and spatial scales, from crop genetic diversity to incorporation of natural vegetation across landscapes, is the basis of ecosystem functioning and resilience [21]. Agroecological systems also emphasize soil development and the recycling of nutrients and energy as the basis for continuing productivity and environmental quality, as opposed to external chemical inputs. These concepts are operationalized through various techniques, based on local resource opportunities and constraints, traditions, knowledge, and markets. Because the means of productivity are biologically-based and can be tailored to site-specific situations, these guiding concepts may better meet the needs of resource-poor farmers and farmers in marginal environments than those based on purchased inputs [22].

Like the discipline of urban ecology, the focus of agroecology has shifted over time. Since its roots as a scientific discipline that informs the design and management of sustainable agricultural systems [19], agroecology has evolved into a broader framework that “seeks to integrate transdisciplinary, participatory, and action-oriented approaches” [23] to transform agricultural food systems [24]. In agroecology, transdisciplinarity manifests as a dialectic between natural and social sciences and experiential knowledge [25], out of which emerge appropriate agricultural practices for specific contexts. This appreciation for practitioner-generated knowledge stands in contrast to typical modes of knowledge production and policymaking in agricultural research, which tend to be one-way flows of information from scientists to stakeholders [26]. By emphasizing partnerships with farmers and other stakeholders in knowledge production and action-oriented research, an agroecological approach also shares attributes with participatory action research. Participatory action research and participatory approaches in agroecology each emphasize the importance of the research *process*, not just outcomes, to co-define research questions, methodology, and interpretation, and ultimately to empower stakeholder communities [23].

As the focus of agroecology expanded to include broader definitions of food systems that specifically include the people that grow and distribute food, issues of equity and social justice have also emerged as relevant, along with sets of guiding principles [27]. In particular, the concept of food sovereignty, in concert with agroecology, has been pushed by a transnational peasants’ social movement, La Vía Campesina [28]. Food sovereignty is defined broadly as the “call for peoples’ rights to shape and craft food policy” [29]. It is distinct from food security, which is primarily concerned with sufficient food supply, and instead centers on issues of power in food systems, in particular regaining local control over food-related issues that are increasingly controlled by global markets [29]. In this way, agroecology is already in line with the motivations of many urban gardening efforts that focus on securing food access and developing food sovereignty to address issues of equity and justice [30].

Agroecology, in its ideal, thus provides not only the ecological principles that underpin the study, design, and management of sustainable agroecosystems, but it also is explicitly concerned with transforming the broader agricultural food system to be more just and equitable and the institutional and economic barriers to doing so [31,32]. Yet, integrating all these elements is still a work in progress, and the agroecological literature is still weighted toward natural science perspectives on ecological

phenomena [33], illustrating the challenge of a truly transdisciplinary, transformative approach. However, examples do exist of integrating the science and practice of agroecology for agroecological transformation through tight collaboration of researchers, farmers, and connected organizations, including one from a transition to an agroecology program in Brazil. We provide the following example as a demonstration of the benefits of adopting a participatory farming model and then use an additional case study to demonstrate how that participatory farming model can be adapted to a shrinking city.

#### 4. A Rural Example of Agroecology in Practice

In the early 1990s, smallholder coffee farmers and researchers, aided by NGOs, developed an agroecology program in the Atlantic rainforest biome in the hilly Zona da Mata region of Minas Gerais, Brazil [34,35]. Recent historical farming practices in the region had primarily been to remove the forest and plant commodity crops in full sun, coffee in particular. Farmers had identified erosion and decline in soil quality as major issues that stemmed from these practices. As a result, farmers in these sun-grown coffee fields had to use large amounts of external inputs such as fertilizer, lime (to increase pH), and pesticides to maintain coffee production.

Farmers groups, several NGOs, and university researchers identified agroforestry as a potential pathway to mitigate soil erosion, improve soil quality, and protect against extreme temperatures that negatively impact coffee growth, and possibly to improve livelihoods simultaneously. Agroforestry is an agroecological scheme that interplants trees with commodity crops [36]. The trees regulate air temperature, provide habitat for other plants and animals beneficial to crop production and of conservation concern, build soil quality through litter inputs, prevent soil erosion, and provide timber products such as wood fuel. In addition to farm management benefits, long-term goals of the transition to agroforestry were to increase the value placed on women's work and local knowledge, restoration of nature, stronger smallholder farmer organizations, and improved quality of life [34].

Baseline understanding of agroforestry practices was achieved through a participatory approach with a small group of innovative farmers who were already experimenting with intercropping trees with cash crops [34]. Based on this initial survey, scientists, NGOs, and farmer groups worked in concert to develop strategies for implementing agroforestry in dozens of small-scale, on-farm experiments, and co-developed goals and metrics to be used in monitoring successes and shortcomings of the program. Participating farmers were the most important actors in shaping and implementing the program. Workshops and visits to existing agroforestry operations in the region helped farmers' to acquire the knowledge and skills that are required to adopt agroforestry. Researchers and farmers co-monitored the effectiveness of the agroforestry regimes based on social-ecological indicators (e.g., percent of soil covered, days of labor, fertilizer used).

Several years after transitioning to the agroforestry system, ecological improvements were manifest, but at the cost of increased labor and without expected reductions in fertilizer usage. However, benefits were substantial enough for farmers experimenting with agroforestry that additional farmers joined, attributed in part to the participatory process that made farmers equal partners in the program. A big lesson was that long-term success would require an adaptive process, with continued monitoring, learning, and adaptation [34].

Over a decade after the program was initiated, agroforestry-based coffee systems were clearly different from full sun systems; coffee agroforestry contributed to native tree and wildlife conservation, moderated the microclimate to benefit coffee production, and protected against soil erosion and improved soil quality (e.g., soil carbon levels and nutrient cycling) [35,37]. Moreover, coffee production in the agroforestry systems matched that of the full sun systems while creating a higher quality bean with a greater market value [35,37]. The existence of very high performing agroforestry operations indicates that the potential is greater than what is seen on average; on-going research and development, as well as more farmer-to-farmer knowledge sharing, is expected to improve the agroforestry system over time [35].



## 5. Translating an Agroecology Approach to Shrinking Cities

Some of the lessons from the agroforestry program in Zona da Mata may translate to the development of agroecology in shrinking cities, especially the collaboration among researchers, relevant organizations, and urban farmers. Of course, there are meaningful differences between shrinking cities and the example from Brazil that must be considered. In particular, coffee farmers in Zona da Mata were operating on land over which they had enough confidence in their tenure to transition to a farming practice that would take multiple years to realize sufficiently its benefits. In the case of shrinking cities, residents most likely do not have legal access to or control over land. There are, though, efforts in the both the private [38] and public [39] sectors to address this need. Land tenure in shrinking cities is a broad issue and one that requires study and development to advance an agroecology for the shrinking city. In order to create land tenure policies to support agroecology, it may be necessary to form a long-term strategy for land management, which is an objective that this article intends to help address.

The legal and cultural identity of land in shrinking cities also differs from the coffee farms. Urban land is typically governed by local land use regulation; agroecology can be a complex land use to codify, but some cities are attempting to deal with this issue [40]. Detroit, for example, has introduced two new land uses, Innovation Agricultural and Innovation Ecological [41], which could allow the legal conversion of land to an agroecological land management regime. Culturally, agroecological uses are not necessarily legitimate or currently desired land uses in neighborhoods whose identities have been shaped by homes, businesses, and more traditional urban activities [42]. However, if shrinking cities and residents begin to view the loss of traditional urban land uses as long-term or permanent, there is an opportunity for moving in new directions [42].

The agroforestry example from Brazil, and what agroecology in shrinking cities might be, share two key similarities. Both would (1) operate on marginal land and (2) require operations that use small amounts of financial capital. These are two of the core elements of agroecology as a practice that are meant to benefit smallholder farmers that do not have access to a lot of financial capital [22]. Marginal land is land that is difficult to farm using industrial farming technologies [22]. In the case of Brazil, the hilly, erosion-prone landscape created the marginal land that was available to smallholder coffee farmers. In a shrinking city, the complex urban landscape—many parcels of land under a mix of land covers and land uses extensively intersected with physical infrastructures, such as roads and water supply lines—creates marginal lands for farming and natural resource management generally. Urban soils may also contain both modern and legacy pollutants [43,44]. Brazilian coffee farmers needed to limit the financial and labor costs of adopting agroforestry, and to build fiscal security, while agroecology practices were intended to replace expensive external inputs (e.g., fertilizer) with on-farm ecological processes, but may have required more labor, at least early on. Because the neighborhoods and individuals most affected by economic and population declines in shrinking cities are also part of low-income groups, a low financial capital strategy like agroecology (i.e., without expensive external inputs) is needed to build fiscal security into a natural resource management regime. This is especially the case if an agroecology for the shrinking city is driven by disadvantaged communities. Translating these similarities into lessons for building an agroecology practitioner community in shrinking cities will require an understanding of social and cultural differences in shrinking cities, and how motivations for becoming agroecology practitioners would differ for shrinking city residents compared to rural farmers. To build knowledge for that translation, we next present an example of the motivations and experiences of a group of urban farmers in Detroit, Michigan.

## 6. Food Security and Community Building in Detroit

In 2006, Detroit residents formed a communally-run organization called Detroit Black Community Food Security Network (DBCFSN) to address food insecurity in Detroit (<http://detroitblackfoodsecurity.org/>). The organization was a response to the limited availability and access to healthy food choices created by distance, mobility, economic, and cultural hurdles [30]. The use of 'black community' in the

group's name is not because the group is focused on being exclusively black; rather, the community saw the need for leadership to come from within the community of people that were experiencing food insecurity [30]. This strategy is meant to facilitate self-reliance in the community and address historic and contemporary barriers to food security by market and governance failures.

A major initiative of DBCFSN is their D-Town Farm. D-Town Farm is on ~2 ha of leased land within a City of Detroit park. The farm is oriented toward staples for traditional food preparation, including annual and perennial row crops, orchard fruits, and mushroom production. Season extension is accomplished through the use of greenhouse and hoop houses; nutrient cycling and soil building is supported by an on-site composting operation. Food is grown for consumption by the farmers, as well as to sell at markets on the farm and in other venues within the City of Detroit (e.g., Eastern Market). Community building, personal development, and connections to the land are also central to the work [45].

D-Town Farm demonstrates how urban farming builds agency to transform a community [30,45,46]. Due to the historical failures of working through governmental channels for change, farming is an approach to empower a community to take on responsibility and control of their food supply (i.e., food sovereignty), as well as to foster community development [46]. Empowerment that is focused inward on the community is contrasted with fighting for justice by, for example, petitioning for change in government policy. Growing food also reduces vulnerability to the choices private food businesses make about what, where, and how much to sell. It furthermore means taking control over a group's culture as it is created and maintained through food. D-Town Farm growers see food as forming a connection to African and African American agricultural traditions and culture [30].

By farming, D-Town Farm growers can provide healthy foods, thereby exercising agency over their nourishment. The activities and the farming space can also build agency in other ways. In the absence of now-shuttered local community centers, the farm serves as a stable gathering space where inter- and intra-generational relationships are built. Additionally, the act of working the land builds a relationship between the farmers and the earth. The D-Town farmers connect taking command of food access through tending the land with part of a process of shaping other aspects of their lives and community services that currently are lacking (e.g., affordable drinking water, housing, education, and public safety). Thus, agency over the food system can translate into support of their community in general. Through the act of tending the land, they are not only supporting the foundations of food (e.g., the soil system) but also the foundation for community transformations. Most involved see the reuse of vacant land as a resource for improving their own lives and transforming Detroit. The participants also see themselves as earth stewards and that the vacant land can be greened to the benefit of the environment and to the benefit of the community. Therefore, the food system is a start, but it can be broadened to address land use, water, pollution, conservation, and waste management. D-Town Farm and urban farming offer a positive pathway for improving Detroit at a time when few good options exist.

## 7. Synthesis

*Agroecology offers strategies for enhancing community empowerment and natural resource management in shrinking cities.*

The Brazil example demonstrates how expert knowledge and project co-development successfully helped smallholder coffee farmers to transition to agroforestry. Long-term co-monitoring played a key role in promoting the program by providing evidence of changes to ecosystem function (e.g., reduced soil erosion) and farm management factors (e.g., productivity of labor hours), and by keeping farmers actively engaged. In this case, the on-going researcher-farmer partnership and farmer-to-farmer sharing have gradually transformed agricultural and environmental governance systems in the region. Co-monitoring is a critical component of co-learning and adaptive management [47]. Adaptive management further offers approaches to understanding the provisioning of ecosystem services

and, more importantly, the explicit and implicit tradeoffs that occur between services and between spatiotemporal scales [48].

D-Town centers on individual agency and community building in the context of undesirable social, economic, and ecological outcomes in a shrinking city neighborhood. It especially emphasizes food security and sovereignty. There is significant common ground between both cases; they both have goals of empowering smallholder farmers and residents and increasing their capacity to adapt to a changing environment. Specifically, for the D-Town case, the co-benefit from the farming program is increasing the accessibility of healthy, affordable food to marginalized populations. The program in D-Town also demonstrates how a powerful mediating organization like DBCFSN is critical in terms of land acquisition and community participation. This “bridging” organization also plays an important role in linking different levels of the governance system (residents/farmers/NGOs/land owners/municipal resource managers/officials) through building the partnerships with different agencies and institutions [17]. This was particularly evident in acquiring land and engaging community.

Taken together, the two case studies envision “agroecology for the shrinking city” as an emerging focus of urban ecology that integrates social (i.e., community building, food sovereignty, empowerment of marginalized populations), economic (i.e., livelihood building), and environmental (i.e., ecosystem services) dimensions. The agroecological approach provides a framework that transforms the mode of environmental governance and natural resource management in shrinking cities. Promoting agroecology in shrinking cities not only provides a framework to effectively manage vacant land and ecosystems but also safeguards the well-being of socio-economically disadvantaged populations (Figure 3) [49]. The Brazil case showed how elements of a successful transformation include long-term monitoring, collaboration, and learning. Without the collaboration between farmers and scientists to co-develop the program, the program may not have created an influence (which attracts more farmers to participate) at a regional level. Given the uniqueness of the shrinking city context to agroecology and research, a long-term supported research program like the Long-Term Ecological Research sites (<https://lternet.edu/>) or the emerging Long-Term Agroecosystem Research network (<https://ltar.nal.usda.gov/>) is needed to develop the knowledge and social-ecological innovations to scale up agroecology in shrinking cities and translate it across cities and neighborhoods. A long-term researcher-practitioner partnership would help build the many forms of capital required to have a viable shrinking city agroecology practice. Specific examples of needs relate to farmer knowledge of agroecology, managing labor costs, and the development of markets.



**Figure 3.** Farm landscape in Detroit that demonstrates growing food in the city with a mural of an urban agrarian landscape on the side of a boarded structure that depicts themes of social activation (home/farm buildings), food security (baskets of produce), ecosystem services (pollinator), and hope (large rays of light emanating from a sun). (Photo credit: Stephanie Held, Detroit Daily).

## 8. Managing for Resilience through the Community's Shaping of Environment

We propose that an emergent lesson of the agroecology examples and a framing for an agroecology for the shrinking city going forward is *managing for resilience through the communities' shaping of environment*, which we refer to as tending. To tend, according to the Merriam-Webster Dictionary, means "to apply oneself to the care of" or "to manage the operations of." Tending is a term we use here to describe the actions of natural resource managers engaged in co-creating benefits in partnership with natural systems (i.e., partnering with the land). At its core, these benefits are ecosystem services but extend beyond food production and can create broader-based livelihood and cultural sovereignties. Residents of shrinking cities that gain tenure of land and tend it for ecosystem services build agency [30,50,51]. Specifically, individuals take control over food systems and the ability to nourish themselves, their family, and their community. As discussed in the Detroit example, the farm as a community endeavor and gathering space facilitated cultural benefits greater than tending the land for food production only. The ability to change one's circumstances and to be empowered to act on that ability is individual agency. The agency of individuals in a social-ecological system is a key factor in the capacity to transform the system towards desirable states or along desired trajectories [52]. Agroecology can be a part of the basis for transformation in the management of ecosystem services in shrinking cities.

## 9. Agroecology as a Pathway to Operationalize Ecology for the Shrinking City

Ecology for the shrinking city is a general concept that requires specific actions or mechanisms for realization. We contend here that agroecology is a scheme for operationalizing ecology for the shrinking city. Specifically, agroecology can be a strategy for realizing the three objectives of ecology for the shrinking city: (1) creation of and governance by community members of both (2) high amenity and (3) high ecosystem service land uses [7]. Importantly, we consider the social dimensions of agroecology to be as relevant as the ecological dimensions for realizing these objectives. Socially, agroecology emphasizes the capacity of smallholder farmers and farming communities to gain food sovereignty and build knowledge and skills to leverage ecosystem functions, thereby ideally reducing reliance on external inputs and managing for resilience at multiple scales (e.g., plot, farm, community, region). Agroecology for the shrinking city should also be about cultivating the capacity of smallholder land management. This cultivation will require the co-creation of an agroecology scheme for shrinking cities by communities, scientists, and other stakeholders.

By being farmer- and community-centric, the co-creation of an agroecology scheme can facilitate the emergence of desired land uses from the perspective of the communities impacted by shrinking. In the language of ecology for the shrinking city, the vacant land is transformed from an undesired or underutilized part of a neighborhood into an amenity as defined by neighborhood residents. An amenity in this case could be a formerly vacant lot that now provides a livelihood to a neighbor, a place of active use, a green space that visually reflects on-going tending rather than neglect, or a local spot to buy healthy food. In a research context, an ecology for the city approach means that advances in scientific understanding relate to community-desired applications and basic science research shaped to be meaningful to those applications [10–12].

Ecosystem service outcomes are an intentional and necessary component of agroecology in practice. Ecosystem services in an agroecology for the shrinking city differ sharply from both those provided by industrial agriculture and shrinking city neighborhoods that are experiencing extensive vacancy. Agroecology, in contrast to industrialized agriculture, relies on regulating and supporting ecosystem services as part of a larger strategy of managing for provisioning services. Developing an agroecology in shrinking cities would transform and bolster regulating and supporting services that are already emerging from increasing vacancy to manage for provisioning services as well. Agroecological approaches can also grow cultural ecosystem services such as facilitating community relationships, culturally appropriate food systems, or recreational and aesthetic benefits from neighborhood greenspace amenities.



## 10. Should It Be about More Than Food?

Regulating and supporting ecosystem services in an agroecological scheme are foremost concerns when maintaining the food production system and the independence of producers from the need for external inputs. In the Brazilian agroforestry example, the tree canopy regulated the microclimate to conditions better suited for coffee bean production than what is experienced in full sun [34]. However, the emphasis in agroecology on increasing ecosystem services broadly could be applied to non-food services as a primary or organizing objective. Agroecology for the shrinking city could, for example, consider addressing regulation of urban hydrology or creating habitat to support species conservation. By expanding the focus, there is potential to grow partnerships and markets for shrinking city agroecology practices and products. While this route seems logical, it is a route for which agroecologists and farmers have demonstrated concern.

The importance of food sovereignty is increasingly recognized as a central tenet of agroecology [29]. Under this lens, it would be possible to erode the social outcomes of an agroecological approach by creating markets for ecosystem services beyond food production. For example, one contested expansion is payment for soil carbon storage as a means of regulating climate change [53]. The international peasant organization La Vía Campesina resists the notion of farmers being paid to store carbon in their soil, because it does not address the problem of having carbon-intensive industry; in this case, agroecology is being used to clean up the pollution of industrial systems. Furthermore, a carbon market could enmesh smallholders in volatile global markets and increase competition for land with heavily capitalized organizations. Another critique is that being part of a soil carbon market incentivizes managing for soil carbon, with potential trade-offs for food sovereignty and security. The requirements of such a program could also be at odds with the localized nature of agroecology.

The same scenario could occur for payment for soil carbon storage and other ecosystem services as part of an agroecology for the shrinking city. For example, many cities are under a mandate to reduce pollution, such as excessive nutrient loadings, to waterways. Cities could pay urban smallholders to regulate storm flows as a means of meeting city-wide pollution reduction targets [54]. However, by creating exploitable markets, shrinking city residents would be in competition with highly financially capitalized individuals or organizations. As a result, non-food foci of agroecology could marginalize and exclude the populations that an agroecology for the shrinking city would ideally benefit. Therefore, when developing an agroecology for the shrinking city one needs to approach the expansion from food production to other ecosystem services with grounding in the principles of agroecology, including fidelity to its core social and environmental objectives. One avenue for this may be to ground any widening of the scope in its support of producer and producer communities' sovereignty and securities, such as water, livelihood, and cultural sovereignty and security.

## 11. Conclusions

Regardless of its scope, lessons from agroecology are appropriate and potentially transformative for shrinking cities. Shrinking cities on many fronts are failing to provide basic needs and quality of life for many residents, and new strategies are needed to realize sustainability. Agroecology is instructive for shrinking cities, as it is a model of land management for producing environmental goods. The human and cultural aspects of agroecology also make it suited to identifying social-ecological innovations for sustainable transformations in shrinking cities.

Broadly, alternative economic and governance models with a focus on natural resource management are likely necessary conditions for transformations to sustainability in shrinking cities. An important parameter in shrinking cities is the mosaic of vacant parcels and traditional urban land uses that divide the urban landscape into many small management units. Site-specific management by smallholders—a hallmark of agroecology—may be a good strategy for land management in the shrinking city land mosaic, one that utilizes pockets of land while supporting the urban land uses with which they co-exist. Finally, the innovations required to achieve successful agroecology programs

in shrinking cities necessitate a deep-investment process with science and community working in partnership, i.e., an agroecology for the shrinking city.

**Acknowledgments:** Dustin L. Herrmann was supported in part by an appointment to the Postdoctoral Research Program at the (Laboratory Office of Research and Development, National Risk Management Research Laboratory) administered by the Oak Ridge Institute for Science and Education through Interagency Agreement No. (DW-8992433001) between the U.S. Department of Energy and the U.S. Environmental Protection Agency and Wen-Ching Chuang held a National Research Council Research Associateship appointment at the National Risk Management Research Laboratory within the Office of Research and Development of the U.S. Environmental Protection Agency. The views expressed in this paper are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency. Nebraska Cooperative Fish and Wildlife Research Unit is jointly supported by a cooperative agreement between the U.S. Geological Survey, the Nebraska Game and Parks Commission, the University of Nebraska-Lincoln, the United States Fish and Wildlife Service, and the Wildlife Management Institute.

**Author Contributions:** All authors contributed to the writing of the paper.

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

## References

1. Beauregard, R.A. Urban population loss in historical perspective: United States, 1820–2000. *Environ. Plan. A* **2009**, *41*, 514–528. [[CrossRef](#)]
2. Rieniets, T. Shrinking cities: Causes and effects of urban population losses in the twentieth century. *Nat. Cult.* **2009**, *4*. [[CrossRef](#)]
3. Ryan, B.D. *Design After Decline: How America Rebuilds Shrinking Cities*; University of Pennsylvania Press: Philadelphia, PA, USA, 2012; ISBN 9780812223040.
4. Hackworth, J. Demolition as urban policy in the American Rust Belt. *Environ. Plan. A* **2016**, *48*, 2201–2222. [[CrossRef](#)]
5. City of Detroit Detroit Demolition Program. Available online: <http://www.detroitmi.gov/demolition> (accessed on 25 January 2018).
6. Sugrue, T.J. *The Origins of the Urban Crisis: Race and Inequality in Postwar Detroit*; Princeton University Press: Princeton, NJ, USA, 1996.
7. Herrmann, D.L.; Schwarz, K.; Shuster, W.D.; Berland, A.; Chaffin, B.C.; Garmestani, A.S.; Hopton, M.E. Ecology for the shrinking city. *Bioscience* **2016**, *66*, 965–973. [[CrossRef](#)]
8. Herrmann, D.L.; Shuster, W.D.; Mayer, A.L.; Garmestani, A.S. Sustainability for shrinking cities. *Sustain. Sci. Pract. Policy* **2016**, *8*, 911. [[CrossRef](#)]
9. Grove, J.M.; Childers, D.L.; Galvin, M.; Hines, S.; Muñoz-Erickson, T.; Svendsen, E.S. Linking science and decision making to promote an ecology for the city: Practices and opportunities. *Ecosyst. Health Sustain.* **2016**, *2*. [[CrossRef](#)]
10. Pickett, S.T.A.; Cadenasso, M.L.; Childers, D.L.; McDonnell, M.J.; Zhou, W. Evolution and future of urban ecological science: Ecology in, of, and for the city. *Ecosyst. Health Sustain.* **2016**, *2*, e01229. [[CrossRef](#)]
11. Childers, D.L.; Cadenasso, M.L.; Grove, J.M.; Marshall, V.; McGrath, B.; Pickett, S.T.A. An ecology for cities: A transformational nexus of design and ecology to advance climate change resilience and urban sustainability. *Sustainability* **2015**, *7*, 3774–3791. [[CrossRef](#)]
12. Schwarz, K.; Herrmann, D.L. The subtle, yet radical, shift to ecology for cities. *Front. Ecol. Environ.* **2016**, *14*, 296–297. [[CrossRef](#)]
13. Groffman, P.M.; Cavender-Bares, J.; Bettez, N.D.; Morgan Grove, J.; Hall, S.J.; Heffernan, J.B.; Hobbie, S.E.; Larson, K.L.; Morse, J.L.; Neill, C.; et al. Ecological homogenization of urban USA. *Front. Ecol. Environ.* **2014**, *12*, 74–81. [[CrossRef](#)]
14. The City of New York. *PlaNYC: A Stronger, More Resilient New York*; NYC Office of the Mayor: New York, NY, USA, 2013.
15. Allen, C.R.; Birge, H.E.; Bartelt-Hunt, S.; Bevans, R.A.; Burnett, J.L.; Cosens, B.A.; Cai, X.; Garmestani, A.S.; Linkov, I.; Scott, E.A.; et al. Avoiding decline: Fostering resilience and sustainability in midsize cities. *Sustainability* **2016**, *8*, 844. [[CrossRef](#)]
16. Lind, K.J.; Schilling, J. Abating neighborhood blight with collaborative policy networks—Where have we been? Where are we going? *Univ. Memphis Law Rev.* **2016**, *46*, 803–855.

17. Green, O.O.; Garmestani, A.S.; Albro, S.; Ban, N.C.; Berland, A.; Burkman, C.E.; Gardiner, M.M.; Gunderson, L.; Hopton, M.E.; Schoon, M.L.; et al. Adaptive governance to promote ecosystem services in urban green spaces. *Urban Ecosyst.* **2016**, *19*, 77–93. [[CrossRef](#)]
18. Herrmann, D.L.; Shuster, W.D.; Garmestani, A.S. Vacant urban lot soils and their potential to support ecosystem services. *Plant Soil* **2017**, *413*, 45–57. [[CrossRef](#)]
19. Altieri, M.A. *Agroecology: The Science of Sustainable Agriculture*, 2nd ed.; Westview Press: Boulder, CA, USA, 1995.
20. Wezel, A.; Bellon, S.; Doré, T.; Francis, C.; Vallod, D.; David, C. Agroecology as a science, a movement and a practice. A review. *Agron. Sustain. Dev.* **2009**, *29*, 503–515. [[CrossRef](#)]
21. Kremen, C.; Iles, A.; Bacon, C. Diversified farming systems: An agroecological, systems-based alternative to modern industrial agriculture. *Ecol. Soc.* **2012**, *17*, 44. [[CrossRef](#)]
22. Altieri, M.A. Agroecology: The science of natural resource management for poor farmers in marginal environments. *Agric. Ecosyst. Environ.* **2002**, *93*, 1–24. [[CrossRef](#)]
23. Méndez, V.E.; Bacon, C.M.; Cohen, R. Agroecology as a transdisciplinary, participatory, and action-oriented approach. *Agroecol. Sustain. Food Syst.* **2013**, *37*, 3–18.
24. Francis, C.; Lieblein, G.; Gliessman, S.; Breland, T.A.; Creamer, N.; Harwood, R.; Salomonsson, L.; Helenius, J.; Rickerl, D.; Salvador, R.; et al. Agroecology: The ecology of food systems. *J. Sustain. Agric.* **2003**, *22*, 99–118. [[CrossRef](#)]
25. Vandermeer, J.; Perfecto, I. Syndromes of production in agriculture: Prospects for social-ecological regime change. *Ecol. Soc.* **2012**, *17*, 39. [[CrossRef](#)]
26. Lubell, M.; Niles, M.; Hoffman, M. Extension 3.0: Managing agricultural knowledge systems in the network age. *Soc. Nat. Resour.* **2014**, *27*, 1089–1103. [[CrossRef](#)]
27. Dumont, A.M.; Vanloqueren, G.; Stassart, P.M.; Baret, P.V. Clarifying the socioeconomic dimensions of agroecology: Between principles and practices. *Agroecol. Sustain. Food Syst.* **2016**, *40*, 24–47. [[CrossRef](#)]
28. Martínez-Torres, M.E.; Rosset, P.M. La Vía Campesina: The birth and evolution of a transnational social movement. *J. Peasant Stud.* **2010**, *37*, 149–175. [[CrossRef](#)]
29. Patel, R. Food sovereignty. *J. Peasant Stud.* **2009**, *36*, 663–706. [[CrossRef](#)]
30. White, M.M. D-Town Farm: African American resistance to food insecurity and the transformation of Detroit. *Environ. Pract.* **2011**, *13*, 406–417. [[CrossRef](#)]
31. Iles, A.; Marsh, R. Nurturing diversified farming systems in industrialized countries: How public policy can contribute. *Ecol. Soc.* **2012**, *17*, 42. [[CrossRef](#)]
32. Bowman, M.; Zilberman, D. Economic factors affecting diversified farming systems. *Ecol. Soc.* **2013**, *18*, 33. [[CrossRef](#)]
33. Tomich, T.P.; Brodt, S.; Ferris, H.; Galt, R.; Horwath, W.R.; Kebreab, E.; Leveau, J.H.J.; Liptzin, D.; Lubell, M.; Merel, P. Agroecology: A review from a global-change perspective. *Annu. Rev. Environ. Resour.* **2011**, *36*, 193–222. [[CrossRef](#)]
34. Cardoso, I.M.; Guijt, I.; Franco, F.S.; Carvalho, A.F.; Ferreira Neto, P.S. Continual learning for agroforestry system design: University, NGO and farmer partnership in Minas Gerais, Brazil. *Agric. Syst.* **2001**, *69*, 235–257. [[CrossRef](#)]
35. De Souza, H.N.; de Goede, R.G.M.; Brussaard, L.; Cardoso, I.M.; Duarte, E.M.G.; Fernandes, R.B.A.; Gomes, L.C.; Pulleman, M.M. Protective shade, tree diversity and soil properties in coffee agroforestry systems in the Atlantic Rainforest biome. *Agric. Ecosyst. Environ.* **2012**, *146*, 179–196. [[CrossRef](#)]
36. Tschardtke, T.; Clough, Y.; Bhagwat, S.A.; Buchori, D.; Faust, H.; Hertel, D.; Hölscher, D.; Jührbandt, J.; Kessler, M.; Perfecto, I.; et al. Multifunctional shade-tree management in tropical agroforestry landscapes—A review. *J. Appl. Ecol.* **2011**, *48*, 619–629. [[CrossRef](#)]
37. De Carvalho Gomes, L.; Cardoso, I.M.; de Sá Mendonça, E.; Fernandes, R.B.A.; Lopes, V.S.; Oliveira, T.S. Trees modify the dynamics of soil CO<sub>2</sub> efflux in coffee agroforestry systems. *Agric. For. Meteorol.* **2016**, *224*, 30–39. [[CrossRef](#)]
38. Equity Trust. *Secure Land for Urban Agriculture: Developing Models for Secure Tenure of Urban Community Farms and Gardens*; Equity Trust: Amherst, MA, USA, 2014.
39. United States Department of Agriculture Small Farm Funding Resources. Available online: <https://www.nal.usda.gov/ric/small-farm-funding-resources> (accessed on 25 January 2018).

40. Paddeu, F. Legalising urban agriculture in Detroit: A contested way of planning for decline. **2017**, *88*, 109–129. [[CrossRef](#)]
41. Detroit Future City. *2012 Detroit Strategic Framework Plan*; Inland Press: Detroit, MI, USA, 2012.
42. Mallach, A. What we talk about when we talk about shrinking cities: The ambiguity of discourse and policy response in the United States. *Cities* **2017**. [[CrossRef](#)]
43. Pouyat, R.V.; Szlavecz, K.; Yesilonis, I.D.; Groffman, P.M.; Schwarz, K. Chemical, physical, and biological characteristics of urban soils. In *Urban Ecosystem Ecology*; Agronomy Monograph; American Society of Agronomy, Crop Science Society of America, Soil Science Society of America: Madison, WI, USA, 2010; Volume 55, pp. 119–152, ISBN 9780891181811.
44. Schwarz, K.; Pickett, S.T.A.; Lathrop, R.G.; Weathers, K.C.; Pouyat, R.V.; Cadenasso, M.L. The effects of the urban built environment on the spatial distribution of lead in residential soils. *Environ. Pollut.* **2012**, *163*, 32–39. [[CrossRef](#)] [[PubMed](#)]
45. White, M.M. Sisters of the soil: Urban gardening as resistance in Detroit. *Race Ethn. Multidiscip. Glob. Contexts* **2011**, *5*, 13–28. [[CrossRef](#)]
46. White, M.M. Shouldering responsibility for the delivery of human rights: A case study of the D-Town farmers of Detroit. *Race Ethn. Multidiscip. Glob. Contexts* **2010**, *3*, 189–211.
47. Allen, C.R.; Fontaine, J.J.; Pope, K.L.; Garmestani, A.S. Adaptive management for a turbulent future. *J. Environ. Manag.* **2011**, *92*, 1339–1345. [[CrossRef](#)] [[PubMed](#)]
48. Birgé, H.E.; Allen, C.R.; Garmestani, A.S.; Pope, K.L. Adaptive management for ecosystem services. *J. Environ. Manag.* **2016**, *183*, 343–352. [[CrossRef](#)] [[PubMed](#)]
49. Walker, S. Urban agriculture and the sustainability fix in Vancouver and Detroit. *Urban Geogr.* **2016**, *37*, 163–182. [[CrossRef](#)]
50. Glover, T.D.; Parry, D.C.; Shinew, K.J. Building relationships, accessing resources: Mobilizing social capital in community garden contexts. *J. Leis. Res.* **2005**, *37*, 450–474. [[CrossRef](#)]
51. Wakefield, S.; Yeudall, F.; Taron, C.; Reynolds, J.; Skinner, A. Growing urban health: Community gardening in South-East Toronto. *Health Promot. Int.* **2007**, *22*, 92–101. [[CrossRef](#)] [[PubMed](#)]
52. Olsson, P.; Galaz, V. Social-ecological innovation and transformation. In *Social Innovation: Blurring Boundaries to Reconfigure Markets*; Nicholls, A., Murdock, A., Eds.; Palgrave Macmillan: New York, NY, USA, 2012; pp. 223–247.
53. Campesina, L.V. Call to Durban. 2011. Available online: <https://viacampesina.org/en/la-via-campesina-call-to-durban/> (accessed on 1 March 2018).
54. Punam, P.; Taylor, M.A.; Hoagland, T.; Thurston, H.; Shuster, W.D. Application of market mechanisms and incentives to reduce stormwater runoff: An integrated hydrologic, economic, and legal approach. *Environ. Sci. Policy* **2005**, *8*, 133–144.



© 2018 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).