The Routledge Handbook of Sustainable Cities and Landscapes in The Pacific Rim

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First published 2022

ISBN: 978-0-367-47114-9 (hbk)
ISBN: 978-1-032-18994-9 (pbk)
ISBN: 978-1-003-03353-0 (ebk)

Chapter 11

Introduction to Section 2

Food and nutrition security

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DOI: 10.4324/9781003033530-13

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

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INTRODUCTION TO SECTION 2
Food and nutrition security

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Section introduction

From the perspective of food and nutrition security, the history of the rise and fall of cities is a history of their changing relationships with the landscapes upon which they depend and with the rural workers who manipulate those landscapes in order for them to grow food. For the majority of that history, the size, wealth, complexity, and stability of cities depended upon the productivity of those landscapes, including any capacity to augment their yields through inputs such as labor, water, or nutrients (Mazoyer & Roudart, 2006). Strategies such as trade, conquest, and colonization served to extend the area from which the city drew resources, often at the expense of other communities who had been using those same resources for themselves (Fraser & Rimas, 2010). These landscape-productivity-based organic economies are ultimately constrained by the rate at which solar energy is photosynthesized into biomatter. Labor energy input from humans and animals could manipulate what grew where in what volumes, and to maximize the yield of biomatter the community deemed useful, but the system as a whole is zero-sum rate-limited by the regeneration time of those resources (Sieferle, 2001). Over-taxing the ecological basis of an organic economy, such that its capacity to regenerate the resources into the future is eroded, leads to overshoot and collapse (Fraser & Rimas, 2010; Mazoyer & Roudart, 2006; Zeunert, 2018).

Commencing in the late seventeenth century onward, but with an explosion of use from the mid-twentieth century, energy derived from fossil fuels lifted the solar energy limit on landscapes' capacity to provision cities. Those with access to these energy sources, and the technologies to harness them, transformed food systems around the globe. Fertilizer application, indicated by volumes of nitrogen, phosphorus, and potassium (as potash), is predicted to reach 189.67 million tonnes in 2020 (FAO, 2017), a 650% increase from 1960. The global land area devoted to cultivation only increased by 12% between 1960 and 2010 but the percentage of land under irrigation more than doubled (FAO, 2011). Synthetic chemical pesticide application to agriculture commenced in the mid-twentieth century to reach 3.5 million tonnes a year in 2020 (Sharma et al., 2019). A consequence of this intensification is that land area needed to feed one person has halved during this period (FAO, 2011). World cereal production has risen from around 750 million tonnes in 1960 to three billion in

DOI: 10.4324/9781003033530-13

2020 – a 400% increase in a period where the global population rose 250% from three billion to over 7.6 billion (The World Bank, 2020).

Despite these impressive increases in total volumes and average yields per hectare that fossil fuel-enhanced industrial agriculture has brought, it has come at significant and concerning costs. The environmental impacts of agriculture are well documented (for a summary, see Campbell et al., 2017). For example, 40% of ice-free land has been converted to crops and pastures, which is a much higher percentage if considered as biologically productive land, and has a significant impact on biodiversity; 70% of freshwater diversion is for irrigation; artificially manufactured nitrogen fertilizers are extremely energy-intensive and accessible terrestrial reserves of phosphorus are dwindling, and its excessive application can lead to eutrophication of waterways; agriculture is both a significant contributor to climate change and at the same time is highly vulnerable to its effects (Deutsch et al., 2013).

Socially, primary producers and other workers in the food processing systems are typically disadvantaged. For example, across much of Asia, smallholder farmers and fishers are among the poorest and most disadvantaged groups in their countries (Wahlqvist et al., 2012). Even in more affluent nations, producers are increasingly price takers who have to compete in an often global bidding market for supply contracts, leading to declining income per kilogram of product and often high levels of debt exposure as they are driven to farm more intensively for an equivalent return (Swain et al., 2003). Issues of indebtedness, risk exposure, declining landscape productivity, and other sources of stress and anxiety manifest in higher than national average figures for rural suicide and other mental health issues (Hirsch & Cukrowicz, 2014). Many other jobs in the food system, including pickers, processers, and meat workers, are low paid, insecure, seasonal, and typically without welfare safety nets (Petetin, 2020).

Given the environmental and social harms caused by dominant food systems, it is highly problematic that about one-third of the food produced is wasted. In developing nations, this wastage typically occurs on farm or in transit to markets. In a developed nation context, the wastage typically occurs at point of retail or post-retail. If these wastages could be averted, the environmental pressures of food production could be reduced, or the world's undernourished could be fed, or both (Ingram et al., 2016). Profligate consumption of inherently environmentally burdensome food choices, notably industrially produced meats and dairy, can also be considered wasteful, and invariably cruel for the animals involved. It can certainly be acknowledged that in wealthy countries, far too much meat is consumed and the individual and environmental health benefits of a lower meat-content diet are acknowledged (Schiermeier, 2019; WHO, 2020a).

The industrial productivist approach to food production will have to change (Lang & Heasman, 2015). The underlying linear throughput model is unsustainable and if nutrients cannot be recovered and recycled within an energy budget, it will eventually exhaust available reserves and production based on its further application will cease. In this regard, phosphorus is of particular concern, as terrestrial reserves are limited, difficult to estimate, and overwhelmingly concentrated in one place (Edixhoven et al., 2014). Similarly, the currently dominant food system is vulnerable to over-dependence on cheap and abundant fossil fuels to produce and apply the inputs it depends on, and to globally distribute, process, and retail food commodities. Ethically, it needs to address the poor, harsh, and unjust conditions many producers and food systems workers endure. Many would include the welfare of livestock as subjects of ethical concern as well. An urban consumer unconcerned by such ethics should at least concern themselves that producers are sufficiently well rewarded to be incentivized to continue to produce healthy food in sustainable a fashion, since that consumer depends upon those producers for their sustenance.

The final motivation for change is that the productivist food system is not doing its job very well as it is. The Food and Agriculture Organization (FAO) defines food security as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996). Latest available WHO (WHO, 2020c) statistics suggest that over 820 million people are undernourished, meaning that they lack sufficient daily food energy intake. A further two billion suffer from hidden hunger, meaning that they might get sufficient food energy, but their diet lacks sufficient nutritional content for it to be healthy, leading to micronutrient deficiency. Another two billion people globally are obese, with an excess of energy intake: a significant number of whom may also suffer micronutrient deficiency, where the foods they consume are high in fats and sugars but low in nutrient content. Overconsumption of high-fructose corn syrup is particularly implicated (Johnson et al., 2017); a 375 ml can of soda is mostly corn syrup and has no nutrient value at all; yet, it is 10% of recommended daily calorie intake. Although some of these figures overlap (i.e. a person can be in both the micronutrient-deficient and obese categories), as measured by its ability to regularly and reliably deliver adequate, culturally appropriate, healthy, and nutritious food to the world's population, then industrial productivist food retail systems are failing about five billion people – around two-thirds of the world's population.

With this critique of dominant global food production and retail systems in mind, the chapters in this section explore alternatives. The overarching question is, can we redesign the relationships between cities and their landscapes so that they function as sustainable and culturally rich systems delivering health and well-being outcomes for all that participate in them, including producers, transformers, and consumers? To achieve this, as the chapters argue, we need new food systems that operate within a new paradigm, and which have new design goals. The chapters that follow develop principles of ethical and sustainable food systems, and a material stocks and flows-based framework for critically assessing alternatives. We then consider a range of food systems, current and emerging, operating at different scales.

Chapters in this section

Chapter 12: ecosystem services and food security

This chapter frames food security in terms of the fundamental dependency all humans have on the carrying capacity set by the ecosystem services provided by healthy landscapes. The advent of urban settlements has done nothing to change this dependency other than make the pathways by which cities obtain those services become more complex and material- and energy-intensive. All human food comes ultimately from plants through photosynthesis, with humans eating either plants or animals that have fed on plants. Plant and animal co-dependencies have evolved over billions of years as part of the biodiverse landscapes on which all life depends. Core to biodiversity functionality is that material flows of nutrients are constantly being recycled and are in long-term homeostasis, meaning that they neither significantly accumulate nor decline. In their current form, cities do not respect this principle, and draw nutrients in from the landscapes upon which they depend, transform them as food within the city, and then export them as waste, often to sinks from which they are difficult to recover. It is this energy-intensive linear flow of nutrients from source to sink that threatens the food security of cities. The chapter then offers material flows' analysis as a design tool for measuring and assessing local carrying capacities and the long-term sustainability of urban food supplies. The chapter argues that urban sustainability can only be achieved by shifting to a circular economy.

Chapter 13: agricultures – re-evaluating agriculture as a mode of engagement toward sustainable urban futures

This chapter looks at the contribution urban agriculture can make to a city's food security. Until recent times, urban agriculture has been relatively unexplored as an urban planning modality. This chapter argues that urban agriculture, considered as a planning instrument, is critical to the construction of future sustainable cities and the improvement of existing green urban infrastructures. It has the potential to not just amplify food networks, but to be a carrier of a host of other social, economic, and cultural benefits. This exploration of urban agriculture's potential augments and expands the notion of productivity within the framework of multi-functional green infrastructures. Benefits range from improved social networks, mental well-being, and broader economic opportunities, to the wholesale re-imagining of public spaces. Because of this polyvalence, urban agriculture is catalytic and foundational to re-investment and renewal of existing urban fabrics, as well as the development of sustainable urban futures. In summary, the chapter argues that these broader social and cultural aspects urban agriculture can provide to a city need to be considered over and above any assessment of the total volumes of food the city might be producing to contribute to its own food security.

Chapter 14: novel horticultural practices

This chapter discusses how the industrial agricultural and agribusiness global food complex is increasingly geared to standardization and uniformity in production, supply chains, and retailing. Across the globe, agricultural practices and their landscapes are homogenizing, resulting in regions that lack identifiable character. Despite this dominant trajectory, distinctive agricultural landscapes can be identified which defy global agribusiness trends of uniformity. These novel landscapes have emerged from specific sociocultural, economic, and environmental conditions resulting in landscapes readily identifiable to a particular region. Landscape modifications and agricultural practices have developed that are unmistakably representative of a unique location. This demonstrated capacity to innovate in response to place-specific conditions is likely to become an essential capacity to develop as we face increasing climatic and resource challenges. It also marks a shift in values that recognizes diversity in agricultural practice as both an environmentally practical and culturally significant good. This chapter explores this potential, presenting case examples that illustrate novel horticultural landscapes from ancient vineyard practices to climate-controlled and artificially lit contemporary greenhouses.

Chapter 15: a framework for urban food security and nutrition across scales

Chapter 5 describes a human ecological framework based on system dynamics, which can help planners and policy makers identify trade-offs and synergies when designing approaches to ensure urban food security and nutrition outcomes. The chapter demonstrates the application of this visual framework to the APRU SCL scales and boundaries model, showing the multiple levels of determinants of food and nutrition security, as well as the recursive relationships and feedback processes that connect them. The chapter highlights the various ways that food systems can influence the breadth of human health beyond diet and nutrition, and makes the case for food policies to include broader consideration of the psychosocial and cultural well-being of individuals and populations across the urban-rural continuum and across the spectrum of food system activities from co-production of food and meals, through to post-consumption management of nutrients

Chapter 16: food systems security across scales

This final chapter in the section draws on frameworks and concepts developed across the previous chapters and looks at food systems security challenges and opportunities at various scales. At the intra-urban scale, the contribution of relatively low technology open space production is considered against more high-tech industrial and artificial environments. Both systems at least offer the possibility of nutrient recovery, although most are not currently designed or operated as circular economies. Open space systems provide a range of social benefits at the cost of being relatively insignificant in their production volumes. Conversely, high-tech systems tend to be efficient in volumes of food production but energy-intensive and low in other ecosystem service provision, including any cultural services. Beyond producing a small percentage of the city's vegetable requirements, local systems do not contribute much to the carbohydrates and proteins portions of a nutritionally balanced diet. The next scale looked at is the city's regional landscapes, and for many cities this scale offers the prospect for nutrient cycling, trustworthy and reliable information pathways, and mutual care and support between producers and consumers. However, for many cities, dependency on regional produce is either not possible or not desirable, in cases where regional landscapes lack the capacity to provide adequate year-round volumes of culturally appropriate and diverse nutritionally adequate diets. Consequently, the third scale of cities telecoupled to remote landscapes, including internationally, is likely to be a necessary component of many cities' food and nutrition security. The chapter then discusses the energy, material, and information pathways and their challenges for just and sustainable food system at these telecoupled scales. In closing, the chapter argues that whatever scale or combination of scales a city's food system operates at, a core determinant of its sustainability is how food is perceived and valued, either as a retail commodity valued solely in economic terms, or as sustenance that supports the well-being of humans involved across the food system.

Connections to handbook themes

Sustainable development goals

The theme of food and nutrition security speaks most directly to the United Nations' sustainable development goal (SDG) 2 *Zero Hunger.* A number of sub-targets within that headline make it clear that zero hunger is not merely to be understood as provision of sufficient food for all, although that is included (all references to targets are from United Nations, 2017). Target 2.1 is that by 2030 all people have access to "safe, nutritious, and sufficient food all year round," while target 2.2 is that by this date all forms of malnutrition are ended. The World Health Organization defines malnutrition as encompassing "undernutrition (wasting, stunting, underweight), inadequate vitamins or minerals, overweight, obesity, and resulting diet-related noncommunicable diseases" (WHO, 2020b). The goal then is that underweight people regularly and reliably consume more food, while overweight and obese people consume less food, while micronutrient intake is adequate, and people no longer suffer from diseases stemming from these conditions. Target 2.3 requires these food provisioning goals to respect issues of justice and fairness, specifically singling out minority and marginalized groups, such as women, indigenous peoples, and small-scale farmers and fishers. It also demands that all producers have secure and equal access to land and other resources, including knowledge, finances, market, and value-adding opportunities. Target 2.4 requires that provisioning is done sustainably, creating resilient agroecosystems in the face of climate change and other extreme events, strengthening adaptive capacity, and regenerating land and soil quality.

The sub-targets of SDG 2 cross-relate to most of the other SDGs. SDG 1 *No Poverty* requires that where food is accessed financially, all people, including producers themselves, have sufficient income to regularly and reliably access healthy food. Similarly, SDG 11 *Reduced Inequality* demands that all socio-economic groups within and between nations have access to food and that eating well is not a special privilege enjoyed by an elite minority. SDG 3 *Good Health and Wellbeing* includes the direct health outcomes from a balanced diet, and that the mental and physical health of food producers and processors is considered. Addressing gender equity (SDG 5) reflects the need to support the role women play throughout food systems, especially in lesser developed country contexts. Where development programs target women in agriculture, a greater percentage of income is spent on community and family improvements, including children's education (SDG 4) (Akter et al., 2017). The benefits or harms flowing from agriculture and fisheries are central to SDG 6 *Clean Water*, SDG 14 *Life Below Water*, and SDG 15 *Life on Land*. Food systems' relations to SDG 13 *Climate Action* and to SDG 11 *Sustainable Cities and Communities* are discussed separately below. In all cases, SDG 12 *Responsible Production and Consumption* is a significant consideration. Whether food systems beneficially or negatively affect the health and well-being of all involved in it depends largely on the broader social and cultural contexts that constrain and influence how those systems operate. The same is true of the environmental impacts of food systems and whether they degrade or regenerate landscapes and whether the nutrients they deliver to the human economy are wasted or recycled. These issues are addressed in the chapters that follow in this section.

Climate change

As was discussed in the introductory comments, food systems significantly drive, and are affected by, climate change. On-farm cropping and livestock production accounts for between 9% and 14% of total global greenhouse gas emissions and a further 5% to 14% from land use change, such as land clearing and deforestation. Activities in the food system beyond the farm gate, including food waste and decomposition, account for between 5% and 10%, for a total greenhouse gas contribution from the food system as a whole of 21% to 37% (IPCC, 2019).

The direct effects of climate change on food systems are mixed and depend on aspects like latitude. Reported benefits from processes such as CO_2 fertilization and extended growing season in higher latitudes are offset by variability to heat, drought, and rainfall patterns elsewhere (Porter et al., 2014). Direct climate effects on maize, soybean, wheat, and rice suggest losses of between 8% and 24%, even if CO_2 fertilization is assumed (Ingram et al., 2016). Government policy and corporate responses to such changes in supply, such as to stockpile, trade, or gamble on future price increases, further compound likely problems in reliability of supply. Exacerbating existing global and regional food system inequities, the burden of these changes will fall disproportionately on the poor, marginalized, and vulnerable as wealthier and more powerful consumers outbid them for supply (IPCC, 2019). Climate change effects are felt beyond production, as extreme weather events come to disrupt other aspects of the food system, such as transport, storage, and distribution networks.

Despite food systems' contributions to worsening climate change issues, they also hold great promise to make significant remediating contributions.[1] As discussed with examples in some of the chapters in this section, well-managed agroecosystems have the potential to sequester large amounts of carbon in the soil; better fertilizer use can reduce nitrous oxide emission (N_2O), a greenhouse gas with 300 times the warming potential of CO_2; alternate management regimes can reduce methane from rice paddies and from livestock (IPCC, 2019). Beyond the farm gate, opportunities exist to limit factory emissions in processing and packaging food, from transport and refrigeration, and at point of consumption (Ingram et al., 2016). Food waste occurs all along the food system, either through spoilage or because parts of the material are inedible and recovering that organic material for reuse as a nutrient input is crucial. Some of these measures bring direct benefits to the land managers themselves, for example, soils with higher organic matter also retain more moisture, and so are less vulnerable to drought. However, for most, there needs to be some kind of incentive to reward the time and effort that changing management regimes require. In some contexts, this hinges on security of land tenure, since there is little incentive to labor to build up soil health on landscapes you do not have secure rights to (Davila, 2018). Properly designed schemes that provide financial rewards for carbon sequestration and banking could also help (Verschuuren, 2017). Within economic market-based food systems, a strong financial signal would be sent by processors, retailers, and individuals if they preferentially purchased foodstuffs with a low carbon footprint. For this to be feasible, it is necessary to rethink and redesign the relationship between producers and consumers. This largely involves redesigning the relationship between cities and the landscapes upon which they depend, as discussed in the next section.

Sustainable cities and landscapes

Throughout history, cities have developed mechanisms to grow beyond the limitations of the productive capacity of their immediate hinterlands. The changing nature of the relationship between a city and the landscapes that provision it is of central concern to this entire handbook. The chapters in this section look at how secure are the food systems of cities and their hinterlands, and what are some of the environmental and human health and well-being consequences of their current arrangements. These environmental and well-being concerns extend to all actors in the food system, from producers, processors, retailers, consumers, and issues in post-consumption, wherever they may be located.

The food and nutrition security section of this handbook explores current and potential alternative food production and distribution systems at a range of scales, from the very local, including urban agriculture, to regional food catchments, to national and international distribution systems, including telecoupled relationships between producers and consumers in distant places (Seto et al., 2012). At any scale, food systems can be assessed against their material and energy costs and outputs, including the sustainability of terrestrial and aquatic methods of production, and the transmission of information, including finance, values, and trust relationships between actors. From the perspective of sustainability, it is crucial that the flows of nutrients that the food system mobilizes at whatever scale are recycled in a closed system circular economy and within a carbon-neutral energy budget.

Beyond studying processes that make food physically available, the chapters are concerned with issues of equity and justice for all agents in the food system. They are also concerned with the health and well-being implications of different food system arrangements for primary producers, process workers, and for consumers accessing foods with differing degrees of processing and differing energy and nutrient densities. Overarching questions concern the exposure of cities and their landscapes to different levels of risks and vulnerabilities and how they might be reconfigured to reduce those vulnerabilities, while improving measures of health, justice, and sustainability.

The chapters in the section that follow develop a holistic, comprehensive systems-based perspective. Within this framework, cities and landscapes are viewed as aspects of an inseparable whole, across the various scales at which they operate. Given this mutual co-dependence between rural and urban communities, the often-hostile stereotype each has of the other is strange and unhelpful. The two need each other and could not exist alone (Stuart, 2014). A key challenge then is to bring producers and consumers into closer political alignment that recognizes their mutual interdependence, and to re-situate food economies within their ecological reality. Ultimately, the chapters in this section present this challenge as one of designs and the political will to set the goal or purpose of that design.

Note

1 A rich set of updated resources on this topic can be found at TABLE (formally the Food Climate Research Network) (https://www.tabledebates.org/)

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