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From Industrial Production to Biosensitivity: The Need for a Food System Paradigm Shift

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Abstract:

Urban consumers in affluent cities are typically divorced from the landscapes and farmers that produce their food. Most food is made available to these consumers via global retail systems, operating within an overarching paradigm of industrial commodity production. This paradigm induces one way flows of resources from rural hinterlands to cities, with farmers undercompensated for their services-a process which is inherently unsustainable and unjust. By unwittingly eroding processes upon which they are utterly dependent, urban consumers are making themselves vulnerable. Potentially, this vulnerability could be reduced if urban food consumption was linked to regional production, but for many cities the volumes of food required does not match regional output. Framed using a human ecological systems-based template, this paper presents case studies of three cities that have contrasting relationships with their regional food producing landscapes. Canberra, Australia, could not consume all its regional production and so is in food surplus. Tokyo, Japan, could not meet its consumption needs from its region and so is in food deficit. Copenhagen, Denmark, could probably meet its needs from its region but chooses to reduce its food producing land area and focus production on high-value meat products from pigs fed on imported low-value grains. Despite their differing food procurement strategies, producers and consumers in all three cases remain co-dependent upon each other and vulnerable to the processes being driven by the industrial paradigm. Consequently a shift to a new 'biosensitive' paradigm is required, within which the social and environmental aspects of food production and consumption would be respected. This paradigm shift would reduce food choice and convenience, and likely increase cost, so what would motivate consumers to support it? The answer suggested is that consumers could embrace the new food system if it had features that they valued sufficiently to compensate for the forgone values of the old system. Features that consumers could positively value include personal skills in the creation of meals, knowledge of the provenance and production standards of ingredients, and convivial relationships with producers. Pragmatically, these values are most likely to arise from consumers interacting with local food systems. Hence, it is argued, the primary value of local food systems lies not in the absolute volumes of food that they produce but in their educative capacity to foster a shift to a biosensitive paradigm. This new paradigm could extend concern to all food producing landscapes and farmers, wherever on the planet they were located.

Introduction

Central to the health and wellbeing of an urban community is regular and reliable access to a safe, nutritious, and culturally appropriate diet (Deutsch et al. 2013; Hammelman and Hayes-Conroy 2015). The availability of adequate stocks of the foodstuffs underpinning this diet in turn depends upon the resilience of the systems that produce, import, and distribute a city's food. Much of the history of urbanization can be seen as a struggle by cities to overcome the constraints that local environmental productive capacity placed on the size of their populations and their average per capita levels of consumption (Elmqvist et al. 2013). The development of extensive food networks to provision urban consumers is a typical mechanism to overcome these limitations (Evan and Rimas 2010). The consequence is for cities to become increasingly dependent on ever more remote rural hinterlands for their food supply, and for urban consumers to become alienated from the social and environmental processes upon which they depend.

With the advent of essentially capitalist systems of exchange, this 'rift' between producers and consumers grew ever larger. Central to the emerging paradigm of industrial commodity production is the fundamental principle of unequal exchange between the primary producer of resources and the manufacturer of the commodities retailed to the end consumer. Consequently, the flow of materials is from the hinterlands to the centres, with an under-compensated return flow of wealth back to the hinterlands (Foster et al. 2010; Hornborg 2009; Jorgenson and Clark 2009). Partly driven by this new relationship between producer and consumer is a rapid increase in urbanization. The percentage of the population living in cities has risen from around two percent a hundred years ago to over fifty percent today, and increasing (WHO 2014). We have entered an 'Urban Age' in which, for the first time in human history, the majority of people take no part in the fundamental life-sustaining process of producing the food that they eat (LSE 2014). For many urban consumers, especially in affluent cities in the developed world, their primary connection with the food system is as an economic agent purchasing a commodity (Kneafsey et al. 2013). These food systems are largely dominated by a relatively few large corporate retailers, who access the commodities they need from producers scattered across a nation and reaching over almost the entire world. These retail enterprises are driven by a central rational of enhancing efficiency of production (understood narrowly to mean any steps to reduce economic cost of inputs) and to maximising market share and profits on outputs (Princen 2005). An outcome is, in the affluent nations that are the primary beneficiaries of this system, consumers are presented with an unprecedented range of choices of cheap, relatively high quality food consumption items that are constantly and conveniently available. It would be naïve to suggest that, by-and-large, these consumers do not enjoy cheap access to this wide range of convenient food products. Yet, despite this, urban communities need to rediscover that they and the national and international producers of their food are co-dependent on each other, and that both are vulnerable to systems of production that treat food merely as an industrial commodity.

The concept of 'teleconnections' has been used to capture the sense in which urban centres and distant landscapes connected via complex processes that drive the flows of resources from one place to the other both within and between nations (Seto et al. 2012). In a similar vein, this paper draws on the work of Porter et al (2014) to demonstrates that it is likely that affluent cities will continue to source much of their

foodstuffs from globally teleconnected food systems for at least the medium-term future. Three cities are presented as case examples: Canberra, Australia; Tokyo, Japan; and Copenhagen, Denmark. For each, the productive capacities of their local landscapes is estimated, where 'local' is defined by the immediate regional administrative zone for which the city is prime. The analysis shows that each city links to globally extended food systems in different ways. The population of Canberra, could not consume all its local produce, even if it chose to limit itself to its regional output. The great majority of its regional produce is traded internationally and consumed overseas. The population of Tokyo could consume all its local produce, but would fall far short of satisfying its food requirements if it did. It depends on international imports to secure its food. The population of Copenhagen could satisfy its demands from its regional landscapes. However, it chooses not to do that because of the relative value it places on ecosystem services other than only productive services.

These examples demonstrate that the resilience of the systems by which a city secures its food needs ultimately depend upon the social and environmental sustainability of the management of the agricultural landscapes of origin, wherever on the planet they may be. This sustainability is unlikely to be supported if urban consumers in affluent cities only engage with their food systems as economic agents. Where food is treated merely as an industrialized commodity it will necessarily be produced, distributed, and consumed subject to narrow economically motivated choices, leading to the unequal material and economic exchange described by Hornborg (Hornborg 1992; Hornborg 1999; Hornborg 2009). With its inability to give adequate consideration to aspects of justice and sustainability, primary producers providing the raw commodities into this system of industrial production are caught in commodity traps. With their global reach, food manufacturers can source commodities at the cheapest unit cost for a given grade of produce, forcing producers to compete with each other both within and between nations. As price per unit falls as each producer tries to retain access to markets, producers have to increase yields to secure an equivalent return on sales. The net result of many producers doing this is the volume of commodity available goes up, driving the unit cost further down and trapping the producer in a unsustainable feedback system of intensifying commodity output for decreasing return (Sawin et al. 2003).

Despite benefiting from the cheap end product that this system delivers, first-world urban consumers need to develop a sensitivity to the means by which their food is made available to them, and to extend that concern to all farmers and their environments that are producing that food. No individual consumer could possibly base their consumption choices on an exhaustive knowledge of the social and environmental status of the extended food systems upon which they depend. Furthermore, as writers such as Dawson (2003) have argued, the capacity for individual consumer 'sovereign' choices to influence the system are exceedingly limited. Fragmenting to create new market niches to assimilate consumer preferences is key to expanding retail markets. For any such consumer movement to offer a genuine transformative threat to existing systems of production it would need to manifest as a fundamentally political process to transform the dominate belief systems about how food systems should function. The new belief system would be 'biosensitive', as described by Boyden (2011). The characteristics of a biosensitive society, in regards to food, would be to recognize, and positively support, the fundamental role that food plays in the physical health of the consumer as well as the

psychosocial health of producers. A biosensitive society would also recognize that this first characteristic can only be achieved if at the same time the health of the ecosystems that are yielding the food is also supported.

The motivation for this social change is most likely to stem from individuals and communities who engage with local-scale food production and distribution systems that are small and immediate enough for them to comprehend and appreciate. This does not imply that local production systems are necessarily more just, sustainable, and resilient than their remote counterparts. The suggestion is that the prospect of future just and sustainable global food systems depend upon a political transformation in consumer attitudes to food that is most likely to arise from care and concern for local food systems. Challenging though this may seem, the long term resilience of urban food systems depends upon this transformation in attitudes and associated political support.

This paper proceeds by setting out a generic framework for exploring the structure of human-environmental systems before applying that framework to the three case cities. Although the context of the cities differ from one to the other, a central issue is the direction of change in key variables of concern that is being driven by the dominant industrial commodity paradigm. This sets the ground for arguing that it is this paradigm that must shift if the structure of the food system is to change and so drive towards the goal of maintaining the health and wellbeing of people and environments, rather than merely the economic interests of global food retailers.

Comprehensive understanding of global food systems

A central challenge in understanding the complex global food teleconnections between landscapes of origins and their points of consumption is to have some means of capturing key processes so that they can be understood. This is a crucial first step to the identification of key leverage points to intervene and change behaviour (Meadows and Wright 2009; Seto et al. 2012). Newell has developed a systems-based template as a means of developing dynamic hypotheses about important variables and processes operating in complex systems which account for the behaviour of the system as a whole (Dyball and Newell 2015; Chapter 7). The template (Figure 1) is a generic framework designed to draw attention to the highest order classes of variables present in any social-environmental system and to the processes operating to drive change in the values of those variables. It is designed as a response to the 'complexity dilemma' which often follows from any attempt to comprehend something like the global food system (Newell and Proust 2012). Because comprehensive understanding of such systems can be overwhelming, a typical response is to retreat to studying just a few sub-components, often as narrow cause-and-effect relationship. Yet, trying to understand the behaviour of certain parts of the system in isolation of the greater whole, inevitably leads to missing important feedback processes that are acting between the parts and constraining their behaviour. It is the behaviour of the system that is of concern, as the term 'sustainability', like 'health', is a description of the characteristic pattern of behaviour of the whole system over time. This behaviour is an emergent property of the system, and cannot be reduced to its individual parts in isolation.

A classic example of the failure of an intervention that was blind to feedback processes is the application of broad-spectrum herbicides to control ragweed *(Ambrosia artemisiifolia)*. As Rachel Carson documented in *Silent Spring* (1962),

spraying herbicides to control ragweed actually leads to more ragweed. This is because the herbicides, although effective at killing ragweed, also kill a range of perennial plants. The resulting exposed ground provides the conditions that the prolific seed-setting ragweed has evolved to colonize. Acting on the simple cause-and-effect relationship between herbicides and ragweed, and ignoring the broader ecosystem context, leads to actions that result in outcomes opposite to those intended (Dyball and Newell 2015: 74-76).

>Insert Figure 1 near here<

The four elements in the cultural adaptation template are high order labels for key variables present in any social-environmental system. They are names for things that can be present in greater or lesser amounts. 'State of Community' describes the institutional arrangements a society may have. These are all the formal and informal institutions and institutional practices, such as collective economic, political, legal, or civil societal arrangements. Individuals are here considered as social actors within these community arrangements. 'State of Human Health and Wellbeing' is a high order variable for all the various indicators of the physical and psycho-social health of the community members. It includes all those elements that determine the members of a given community's levels of wellbeing, such as the extent of disease, fitness, comfort, conviviality, mental health, and stress. Many variables in this category have minimum requirements for an individual to access in order that they enjoy a dignified existence, and so issues of justice and fairness are associated with the extent to which these benefits and burdens are distributed within and between the community's members (Raworth 2012). 'State of Ecosystem' captures all the bio-physical elements of a social-environment system, including humans themselves as living entities and the various physical artefacts that they construct, like roads, buildings, and machines. It also houses all those elements typically considered to be the 'natural' environment, like water, air, plants, and non-human animals. As these physical variables affect the material, energy, and information flows of ecosystems to a greater or lesser extent, the capacity of ecosystems to sustain them can be estimated (Odum 1997). The final high order variable is 'State of Cultural Paradigm'. This refers to all the culturally dominant worldviews, knowledge, beliefs, and assumptions held by the community in question. Aspects of the cultural paradigm may not be shared equally by all members of the community—for example the percentage of the population who believe in the reality of climate change may or may not be greater than the percentage who are climate change sceptics. However, as paradigms strongly influence what community members judge to be 'normal', 'rational' or 'prudent' behaviour, these paradigms are key to understanding why a community does what it does. Ultimately, it is this cultural paradigm variable that will need to change if the behaviour of the food system is to change.

The arrows linking the four elements in the template are all processes which drive change in the amounts of the variables. Links numbered one, three, and five are all individual or collective human activities which directly affect the variable that they point to through some action, practice or behaviour of the community. Links two, four, and six are also human activities, but are in the form of observation and learning about the changes in the variables that they point away from. Each of these process links point to 'State of Cultural Paradigm', indicating that if the observation and learning link is present, and if it is strong enough, it can either change or reinforce the

dominant paradigm. Link seven captures how processes derived from environmental conditions directly affect human physiological and psycho-social conditions.

The template is powerful in that it is simple yet generic and so can draw our attention to categories of things that demand our attention in any social-environmental system, and to the presence or absence of processes that change or maintain the amounts of those things over time. The feedback processes operating via the links determine whether the value of key variables are being amplified or eroded over time, or whether they are essentially being maintained within a steady range. At this level of abstraction it is not possible to assign polarities to the processes. Whether or not change in one variable positively or negatively affects another can only be known in a more specific context. The resilience of the system as a whole can be understood as the capacity for it to regularly and reliably maintain the values of key variables at levels at least minimally necessary for the community's health and wellbeing. This will inevitably require that the state of the ecosystem is itself maintained at levels at which it can provide the key resources and services upon which the community's wellbeing depends. The system is vulnerable to processes that drive the value of any key variable or variables beyond the thresholds at which they can continue to provide these services, or to the absence of learning and adapting processes capable of triggering correcting action that ensures such thresholds are not transgressed. However, to be applied to a specific issue of concern, such as urban food security, the adaptation template must be converted into a 'problem-space diagram' (Newell and Proust 2012), as shown in Figure 2.

>Insert Figure 2 near here<

In Figure 2 the generic variables present in Figure 1 have been reworded to apply more specifically to variables relating to food security. The new variables are sub-categories of the generic level variables and nest under them. Here, the relevant aspect of the 'State of Community' is the percentage of local to imported food that the community consumes. The level of 'Health and Wellbeing' here is measured by the extent of security of access that the community has to a safe, nutritious, and culturally appropriate diet. The relevant 'State of Ecosystem' is the health of the community's agricultural soils. In Figure 2 the assumption is that if the community recognized its direct dependence on its agricultural hinterlands it would act in ways to enhance their health if it could. Finally, the relevant 'State of Cultural Paradigms' is 'Belief in the Global Market'. This is the fraction of the community that believes that access to global markets is the best way to participate in food systems. The fraction of the population that hold this view can shift depending on the strength of the learning and adaptation derived from observing changes to one or more of the other variables. As before, in all cases the arrows represent processes that can change the values of the variables. Links one, three, five are human activities that change the values of variables in the categories that they point to. Links two, four, and six are observation and learning processes which could, if acted upon, change aspects of the dominant belief system. Link seven represents the direct effect the level of soil health has for the health and wellbeing of the community through its capacity to provision food and other services. At this level of abstraction, the direction that the processes drive

change in the variables cannot be determined, and so the process arrows merely indicate that a causal influence exists between the two linked variables.

The food security problem space is able to be applied to a number of specific cases, as is done below. In some cases the 'specific system of interest' (Newell and Proust 2012) will have further refinement of a variable's label to show the specific context of that city's relationship to its food security. However, the food security problems space allows the cases to be compared as examples of problems that share a common structure and to look to what processes are driving or inhibiting change in each example. At this specific level, all process arrows' polarities can now be added, indicating what direction of change is being driven between variables that affect each other.

Urban food security: three contrasting systems of interest

The food security problem space can be applied to three contrasting systems of interest. The three examples are intended to broadly capture three different ways that an affluent city can secure its food. A specific system of interest could be developed from the food security problem space for a city that was not able to secure its food. However, the examples here are for cities that are affluent enough to ensure that the majority of their population has access via economic exchange to a wide range of cheap food options. The three examples are Canberra, Australia; Copenhagen, Denmark; and Tokyo, Japan. In the original study by Porter et al, for each city a range of commodity staples for that nation's dietary preferences wase selected. Local consumption of those commodities was determined from actual data for that capital region, if it was available, or by scaling national data to the region's population if not. Local primary production of those commodities was likewise obtained from actual data, if available, or from the relevant agricultural data collection agency for that nation, and from data gathered by FAO. In all cases, foods processed or derived from primary products were converted back to the land area required for the primary product, including feedstock for animals where that was employed. The capital region for each city was set as the administrative region for which the city is prime. For Canberra and Tokyo this is a formally recognized regional administration, while for Copenhagen it is the island of Zealand. The three cities and their respective capital regions are shown in Figure 3. Further details of data sources, calculation methods, and analysis can be found in Porter et al (2014).

>Insert Figure 3 near here<

Canberra, Australia: net food exporter

The surface area of Australia is slightly larger than the contiguous United States of America, although at 23.5 million its population is considerably smaller. Its soils are generally of low fertility and subject to low and unreliable rainfall patterns. Large land areas are incapable of being farmed, or only suitable for very low density grazing. Despite this, Australia is largely food self-sufficient, capable of feeding its domestic population and producing surplus for around another 40 million consumers offshore (Lawrence et al. 2013). For a range of reasons, Australian export production focuses largely on bulk commodities, like beef, lamb, dairy, wheat, rice and other grains, and sugar. The consequence is that most Australian primary producers are far

more dependent on prices in, and access to, export markets than they are on the preferences of domestic consumers, since this is where the majority of the community who consume their products reside (National Farmers Federation 2012). Australian policy at a national and state level reflects this export oriented attitude.

The demographic of the nation's capital, Canberra, is not significantly different from the nation as a whole, although on average it has marginally higher levels of income and education (Australian Capital Territory Government 2010). The city has a population of about 380,000 and is the dominant urban centre to a quasi-official Australian Capital Region (ACR). The ACR comprises about 5.86 million hectares, and its total population is 550,000, so the average population density is 0.1 person per hectare, most of which is concentrated in the city of Canberra. The climate is generally cool-temperate. Much of the ACR is in agricultural production, with some forestry. Like Australia more generally, the dominate activity is grazing sheep and cattle on pastures. Where soils are suitable, they can be sown to wheat, canola, and other grains. There is also some horticulture and some dairy.

Estimation of local consumption to local production conducted in Porter et al (2014) shows that local production of key commodities is more than sufficient to meet local demand (see Figure 4). For items such as apples, beef, and cheese, local consumption could account for only half of local production. For sheep meat the figure is less than a quarter. It follows that the city could, in principle, be food self-sufficient if it switched to a diet focussed on these basic commodities. This diet would be nutritionally adequate but less diverse than that currently enjoyed, and it is doubtful the majority of consumers would willingly accept it. However, even if consumers were to limit their consumption only to that which was regionally produced, the total amount that they consumed would only account for between half and a quarter of the commodities produced in the region. The balance regional of production is exported to consumers outside of the region, the majority of whom are overseas.

>Insert Figure 4 near here<

This dynamics of this relationship is illustrated in Figure 5, with the processes driving change explained in Table 1.

>Insert fig 5 near here<

Table 1: Influence Links in the Canberra System-of-Interest (Figure 5)	
Link	**Actions/Processes/Mechanisms Represented in Figure 5**
1	This is a positive link. Belief in the economic benefit of producing surplus food for export to global markets leads to policy action aimed at maintaining and expanding free-trade agreements. Institutional priorities are oriented towards building capacity in export-oriented bulk commodity processing and distributing infrastructure.

2	This is a positive link. Income from export earnings override any other concerns the community may have. The Canberra community may take action to increase regional consumption but this will still leave the majority of regional agriculture dependent on export markets. Government and community initiatives to promote regional produce are small scale and do not significantly affect the dominant belief in the value of global markets (Turner et al. 2012).
3	This is negative link. Competing in global bulk commodity markets drives down terms of trade for regional farmers (Sawin et al. 2003). Consequently, the viability of rural farming deteriorates, eroding food security for all consumers, both local and overseas, who depend on the food produced in the region.
4	This is a positive link. Levels of food security positively reinforce confidence in global markets. As a 'food rich' nation, Australians show little concern for food security, so there is little pressure to question the belief in global markets (Prime Minister's Science Engineering and Innovation Council 2010). There is no process of feedback raising concern that decisions affecting food security are taken by international food corporations which are outside of ACR's jurisdiction or control.
5	This is a negative link. Declining prices per unit output drive farmers to increase yields per hectare for an equivalent economic return. Landscapes are worked harder drawing down soil nutrient reserves. As the bulk of produce is exported there is little scope for recovering these nutrients. Lost nutrients are partially replaced with artificial fertilizers, but nutrient stocks decline over time, eroding the health of regional agricultural soils.
6	This is a negative link, but weak. Declines in soil health are noted, but the influence of this concern is not strong enough to alter the belief in global markets. The prevailing belief is that economic return on the sale of the commodity can be exchanged for replacement fertilizers, if necessary.
7	This is a positive link. The health of agricultural soils is directly correlated with levels of food security. As soil health declines food security declines. The key to raising food security is to raise the health of agricultural soil. This would require a learning feedback and action link from those overseas consumers most responsible for affecting regional agricultural landscapes and the dominant farming methods.

Because the Canberra region produces more than its population can consume, many of the drivers of change to the health of agricultural soils are from the demands of consumers outside of the region. Local consumers certainly could demand sustainably and ethically produced local food products, and farmers and business could respond to satisfy that demand. However, even if all local consumers demanded such produce, it would still leave the majority of local producers servicing the demands of others. If these other demands are mediated to producers only through economic exchange they are likely to drive high-input - high output conventional agricultural methods. Such methods tend to erode soil nutrients over time by not paying the economic cost of

fully replacing exported nutrients. Regional farmers attempting to practice alternative farming methods must contend with the fact that the food system is geared towards conventional farming. Ultimately, if the national approach to food security is focussed on production of bulk commodities for export to global markets, non-conventional regional food production will tend to struggle to defy the logic of the system. For these considerations, the food security of consumers in Canberra is intimately entwined with the food preferences of consumers overseas.

Copenhagen: food transformer

The Danish capital city, Copenhagen, is the central city in the Danish Capital Region (DCR). The DCR comprises the city of Copenhagen itself and the adjoining islands of Amager, Sjælland, Lolland and Falster. In total the DCR has a population of 2.91 million in a land area of 0.70 million hectares giving a population density of 4.1 persons per hectare. Generally speaking, soils are deep and fertile and rainfall is reliable. Winters are cold, with the growing season limited to between April and October. About 0.68 million hectares are used for food production of which about 0.06 million hectares are used for grazing to yield milk, cheese and pork products; the rest of the food production area is used for crops (Porter et al. 2014).

Until as recently as the 1950s a quarter of the Danish population was employed in agricultural production (Jesperson 2004). However, for a range of reasons the importance of agriculture to the Danish economy has been declining through the latter half of last century. What products it does continue to produce are up-market, notably pork, cheese, and dairy, especially for export (Danish Agriculture and Food Council 2012). Overall self-sufficiency across all main commodities is stable at around 40% (Porter et al. 2014). Drivers include changes to the relative economic importance of agriculture in the Danish economy, the impact of the European Commission's common agricultural policy, and the cheapness of imported food relative to the cost of Danish products. One consequence of Denmark securing much of its food from non-Danish landscapes is the re-afforestation of Danish land areas now retired from food production. From near total clearance a century ago, Denmark has embarked on a program of restoring forest cover and has a target of around 20% to 25% forest cover by the end of the twenty-first century (FAO 2010).

The community of Copenhagen now could not meet its food requirements from its regional landscape for any of its major commodities except pork and potatoes (see Figure 4). These two items feature very prominently in national dietary preferences, and it is understandable that the Danish would want to produce them themselves. However, in reality the pork that the DCR produces is increasingly reliant on feed, such as soya cake, that is imported. This is one reason why the area of Danish landscapes devoted to agriculture can be shrinking yet the percentage of food self-sufficiency remain the same. The site of primary production of feed for pigs is increasingly being displaced off shore. Economically, this makes sense. The value of the pork product is far greater than the value of the feed. In regards to pork, the Danish can be seen as value-added 'transformers' of cheap South American soya to expensive Danish bacon. The pigs, and the resulting pork products, are 'Danish' only insofar as they stand on Danish soil while eating imported energy and nutrients.

The food security of the community of Copenhagen, including for pork, largely depends on the social and environmental sustainability on landscapes outside of the

DCR. This relationship is illustrated in Figure 6, with the processes driving change explained in Table 2.

>Insert Figure 6 near here<

Table 2: Influence Links in the Copenhagen System-of-Interest (Figure 6)	
Link	**Actions/Processes/Mechanisms Represented in Figure 6**
1	This is a positive link. The dominant belief is in the benefit of sourcing low value commodities from the global market and selling high value refined niche-products into it. Policies encourage this goal, leading to a focus on raising high-value pork products from pigs increasingly dependent on imported pig feed.
2	This is a positive link. High value returns from transforming cheap, largely imported grain to high value pork for export reinforces the belief in the effectiveness of global markets.
3	This is a negative link. Focussing on a narrow range of niche products drives down regional food security. The community of Copenhagen is self-sufficient only for pork and potatoes, and in the case of pork only because of displaced sites of primary production of feed. Focussing on niche production leaves Copenhagen dependent on access to remote markets for all other food types.
4	This is a positive link. Despite a fairly significant market share for local, low input regional produce, at the broader scale few major problems with food security are seen. As a result there is little pressure to change the belief in the value of access to global markets.
5	This is a positive link. Importing food allows landscapes previously cleared for regional food production to be regenerated as forests. This action increases the extent of native forest ecosystems. However, a link equivalent to five potentially reduces the health of those overseas ecosystems to which the production of animal feed, like soya cake, is displaced.
6	This is a positive link. Observed increases in the extent of native forests is seen as a desirable outcome. To the extent that this process is made possible by displacing the site of primary production of input commodities offshore it reinforces the belief in global markets. Damage done in the overseas sites of primary production does not generate concern in the local community that reaps the benefits. Economic exchange, although unequal, is presumed to compensate for the imported commodities.
7	This is a negative link. Increased extent of native forest decreases the amount of food secured from regional landscapes by decreasing the extent of land devoted to food production. Food security could be increased again, but at the expense of converting forested landscapes back into agricultural production.

The demand for organic produce in Denmark has grown in the past decades to the point where over 6 per cent of Danish farms are organic (Landbrugsinfo 2014), indicating a high level of concern for safe and healthy food. However, the capacity of Danish landscapes to meet Danish consumers' food preferences is limited, unless a much greater land area is converted back into primary production. Assuming that this is not what the community of Denmark desires, the alternative would seem to be to remain import-dependent, but support monitoring that ensured minimum quality food production standards in the landscapes of origin.

Tokyo: food importer

Tokyo, the Japanese capital, is in the centre of the Japanese Capital Region (JCR) in the Kanto plains. The JCR is comprised of Tokyo and six prefectures in the Kanto region (Saitama, Chiba, Kanagawa, Ibaraki, Tochigi, and Gunma). In all, the JCR has a population of 41.4 million in a land area of 3.24 million hectares giving a population density of 13.1 persons per hectare, with 80% of this population centred on and around Tokyo. Various agricultural production systems dominate non-urban land use in the JCR, including rice, dairy, and vegetables. The extraordinary productivity of the Japanese landscape is evidenced by its fairly constant capacity to provision around 3.5 persons per hectare—a figure 35 times that of the ACR and almost twice that of DCR. Despite this the JCR simply cannot meet the consumption demands of its very high-density population. Food self- provisioning has fallen from 41% in 1965 to 27% in 2005. The change is largely due to a population increase of 158% (from 26,200,000 to 41,500,000) across this period (all figures from Porter et al. 2014).

Until recently, a consistent Japanese government policy position was to maintain food self-sufficiency in the nation's basic carbohydrate staple of rice. This policy has been largely successful, with around 95 percent of rice consumed by the Japanese being locally produced. However, the importance of rice in the Japanese diet has been progressively falling over the last fifty years, from 126 kilograms consumed per capita in 1960 to just 67.4 kilograms per capita by 2010. The balance of food intake has been met by a rise in percent consumption of non-traditional 'western' food stuffs, such as wheat and grain-fed beef. Japanese farms are very small, typically less than two hectares, and most farmers are small independent operators who do not derive their primary income from farming. These features of the Japanese rice-oriented farming system restrict its ability to meet the changing food choices made by Japanese consumers. Rising imports with falling food self-sufficiency result.

There is an argument that government support for rice production should be dropped and these small-time farmers allowed to go out of business. The predicted outcome would be for Japanese food to be secured through larger-scale domestic agricultural business capable of responding to changing domestic demands. International imports would account for those food products that are more efficiently produced offshore. Those who disagree with this argument hold to the general belief that a high-level of dependence on imported food is inherently risky. Their position is often also accompanied by an appeal to the traditional role of farmers and farmed landscapes in the Japanese national psyche. These traditional '*satoyama*' farming communities typically involve mosaics of small villages and farms among sustainably managed wooded landscapes with rice paddies and other small-scale activities (Takeuchi et al. 2003). Moving to a food production system based on free economic exchange would, in this view, entail the loss of aspects of Japanese culture that have very high non-monetary value (Kohsaka et al. 2013). Whether or not traditional *satoyama*

landscapes can be preserved depends upon whether enough of the community believe that it is worth resisting unfettered access to global markets and maintaining some support of self-sufficiency in traditional foods. However, any such commitment needs to acknowledge that it is currently not possible for Japanese farming landscapes to satisfy Japanese consumption demands. This relationship is illustrated in Figure 7, with the processes driving change explained in Table 3.

>Insert figure 7 near here<

Table 3: Influence Links in the Tokyo System-of-Interest (Figure 7)	
Link	**Actions/Processes/Mechanisms Represented in Figure 7.**
1	This link is positive. The belief in the importance of being self-sufficient in rice as a traditional food prompts actions to protect domestic rice production. This belief also drives suspicion of the global market as being inherently risky and of inferior quality.
2	This link is positive, although the fraction of the community who support it is declining. As a result, the paradigm of self-sufficiency in traditional foods is under pressure to change from that fraction of the community that want to consume a non-traditional diet for which commodities, such as wheat and beef, must be imported.
3	This link is negative. Food security for rice is increased by support for traditional food and reduced dependence on imported foods, but security for non-traditional foods is decreased. As food habits move away from traditional consumption overall food security declines.
4	This link is positive, but is driving belief in the value of traditional food down. As food preferences shift, self-sufficiency declines as Japan cannot produce the new commodities from traditional farming systems. Consequently, the fraction of non-Japanese produce securing Japanese consumption increases, eroding commitment to maintain regional production of traditional food.
5	This link is positive. Adherence to traditional diets is closely associated with a determination to maintain traditional *satoyama* farming landscapes. Action is taken to prevent abandonment of the traditional farming landscapes, and their reversion to natural forests. However, as the fraction of the community consuming traditionally declines so too does the extent of *satoyama* landscapes.
6	This link is positive. Observations that *satoyama* landscapes are declining results in concern to take action to preserve them. Support for this action involves appealing to their environmental and cultural value rather than narrow measures of their economic worth or productive output.

7	This link is negative. As *satoyama* farming systems are not as productive in terms of volumes of food produced per hectare as more intensive practices, the more *satoyama* farming there is the less food secure Japan becomes. In fact *satoyama* landscapes are declining in extent as farmers age and are not replaced by younger generations. Initiatives to replace these old farming systems with larger scale higher input systems have only mixed results, partly due to Japanese climate and landscapes being poorly suited to producing the new food preferences. Other elements that *satoyama* farming landscapes contribute to community wellbeing, such as aesthetic and cultural values, are also at risk.

Japanese consumers are generally concerned about the safety of the food that they consume. One reason for the fairly widespread political support for costly subsidies to Japanese farmers is that Japanese generally believe Japanese products are of high quality and safe to eat. However, the Tokyo region simply cannot supply the volumes of food required to meet the consumption needs of Tokyo, even if the decline in farming could be arrested or reversed. It is inevitable for at least the medium-term future that Tokyo, like the rest of Japan, will have to rely on imports for the difference between what it produces itself and what it needs to consume. Concern that the citizens of Tokyo have for food safety and quality that leads them to support regional farmers would need to be extended to support, and preferentially purchase from, overseas farmers who are producing wholesome food that is as safe to eat as its domestic equivalent. A Japanese consumer may not be concerned for the health and wellbeing of an Australian farmer or of the condition of the Australian landscape that is being farmed. However, they are at this time dependent on the food that is being exported to them from landscapes like these. Consequently, it is in their ultimate self-interest to see that for them the relevant link L7 is that which exists between the remote Australian landscape of origin and their own health and wellbeing, as it is these Australian landscapes that are primarily providing them with security of access to safe wholesome food. This concern could see a modified paradigm, in which traditional farmers domestically were supported for the production of traditional foods while international farmers were supported at least sufficiently for them to not be caught in the commodity trap of chasing ever greater volumes of food produce for export at the expense of quality, safety, nutritional value, and long-term sustainability.

The case studies demonstrate the feedback process operating between urban communities and the food producing landscapes. Demands for food originating in cities drive changes in the state of the landscapes of origin and in the wellbeing of the rural communities that manage them for food production (Seto et al. 2012). The capacity of these lands and their managers to continue to provision food to cities requires that their respective health and wellbeing is maintained (Deutsch et al. 2013). Dominant industrial food systems are characterised by one way flows of resources from these sites of production to their points of consumption in places like cities (Hornborg 2009). Over time this process results in the transfer of key resources, such as nutrients, from rural hinterlands to cities, and then on to their waste-streams, and so erodes the hinterland's provisioning capacity. The next section argues that a shift to a biosensitive paradigm will be necessary if urban consumers are to adequately understand their agricultural dependency and to learn to politically support a food system that functions to maintain the capacity of agriculture to provision them with food. For the medium term at least, affluent cities will likely continue to be

provisioned from a combination of both regional and global landscapes. However, the next section also argues that regional food production systems have a particular educative role to foster that biosensitive paradigm.

Shifting paradigms

Under currently dominant industrial food production systems the costs of a number of social and environmental harms are externalized (Lang and Heasman 2004). As more ethically and sustainably produced food might be expected to internalize such costs, it is unlikely that they would be cheaper. Food regimes with lower overall environmental impact would likely see fewer convenience products, with fewer pre-prepared and ready-to-eat dinner options, due to the energy and resource costs of their manufacture (Ingram et al. 2010). It is also unlikely that food systems favouring low inputs, less processing, and shorter, including seasonal, supply chains would be able to provide a greater variety of foodstuffs. For these reasons, a more just, sustainable, and resilient food system is unlikely to be cheaper, more convenient, and offer more choice than the industrialized system it would replace. Yet a transition to a biosensitive society would seem to demand consumers embrace these apparent discomforts. The question then is, what would compel consumers to willingly make this change?

Rather than trying to 'sell the unsaleable', by promoting cost, inconvenience, and narrowness of choice as a virtue to consumers, proponents of alternate systems might do well to focus on the benefits that they offer (Lakoff 2004). For example, consuming less meat in total, but ensuring what was consumed was from livestock that was humanely reared, free-range, and organic could lead to a variety of meat and vegetarian food options. In this case, rather than the consumer being told to 'give up' the meat that they presumably enjoyed eating, the message could promote desirability of cheap, flavoursome, and healthy options that they had not considered when they insisted on cheap meat being central to every meal. This is potentially a more attractive message that the consumer can positively relate to–a crucial element in winning support for the proposed change (Futerra Sustainability Communications 2014). As a result of eating less meat consumers could discover a whole range of benefits to themselves that they had not previously thought of. Examples would be the satisfaction of mastering new low-meat or meat-free recipes; discovering interesting cuisines in which meat features less prominently; impressing friends and relations with new cooking skills; improved diets and personal health; and a reduced food bill. In this way, rather than 'giving up' something previously enjoyed in the consumption of meat-based dishes, a positive commitment to the alternative can lead change the consumer's belief about what constitutes their self-interest (Christensen 2014). This is a crucial step towards a situation where people might willingly and politically support just and sustainable food systems.

Focussing on the positive aspects of sustainable food systems can encourage urban consumers to re-engage with the process of accessing food as far more active agents than they could ever be as merely purchasers of commodities. For example, direct procurement of food by fishing or hunting; as a member of an urban or backyard gardening initiative; by person to person interaction with food producers at farmer's markets and other outlets of local production; by reinvigorating the social values of preparing and sharing meals, as promoted by Slow Food and similar movements. Versions of such individual efforts can be adopted by cafes and restaurants, such as

those that promote the use of regional, organic, and free range products. Central to whatever mode of food production employed is the celebration of the culture values of meals. By engaging with these local systems, urban consumers can come to place a positive value on these aspects of engagement, conviviality, and solidarity with producers, which they can set against a moderate decline in the convenience and variety offered by the conventional system. In this way, the very understanding consumers have of what it is to live well can be shifted to the point where they recognize they can contest industrial commodification of food systems as active ecological citizens without having to somehow become enthusiastic about campaigning against their own self-interest. Only if consumers' understandings of their own self-interest—in effect, their expectations of cost, convenience, and choice—can be shifted can one expect consumers to move beyond a private concern for their own desire or satisfaction to a genuinely public and political concern for rights and responsibilities implicated in food systems.

Conclusion

As the case studies above demonstrate, it is implausible that consumers could limit themselves solely to locally sourced food. In cases where there is not enough local produce to meet local demands it is simply impossible—which is of course why communities that do not have access to alternatives starve when local production volumes are insufficient. In cases where it is technically possible to sustain the community on local seasonal produce, but the dietary restrictions and inconvenience would be excessive, the desired acceptance of biosensitivity would be lost. Furthermore, for some product types the local option may be less sustainable than its imported alternative—a tomato grown in a local heated greenhouse, for example, may have greater environmental impacts than a tomato grown outside in a warm climate and imported. As the case studies demonstrate, many urban communities are likely to secure their food from a range of local and more remote landscapes, with the question of 'which is better' dependent on a range of social and environmental contexts specific to the city in question. There is rarely, if ever, a 'one size fits all' solution to human-environmental problems.

Despite the likely ongoing global dependency for food in affluent cities, there are grounds for advocating engagement with, and support for, local food production and retail systems. These grounds are irrespective of local production's total capacity to provision the local urban community, or even if by some measure they were 'less sustainable' than a remotely imported alternative. Engaging with local food systems, including urban gardens, regional farmers' markets, and farm-to-home distribution systems, can have an educative role, especially among the young, including through both formal and informal programs of education (Davila Cisneros and Dyball 2015). By fostering consumer awareness of their relationship with, and concern for, local food systems political support can be generated for minimum social and environmental standards. This political support can then be extended to all the food-producing landscapes and producers, wherever these landscapes and producers are. With a shift to a biosensitive paradigm, citizens would come to value their active engagement with food systems that they cared about and would expect as normal everyday practice that their food systems were just and sustainable. With such a shift the priority values of the old industrial paradigm, emphasising cheapness, convenience, and choice, would be dissipated. From within a biosensitive paradigm, people can potentially come to see that what they took to be in their self-interest from

the perspective of the old paradigm was actually at a cost to a broader range of values. This suggests the possibility of more just and sustainable food systems where communities will be as or more content with low-impact modes of consumption as they previously were with modes of consumption that had high levels of social and environmental impact.

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Figs

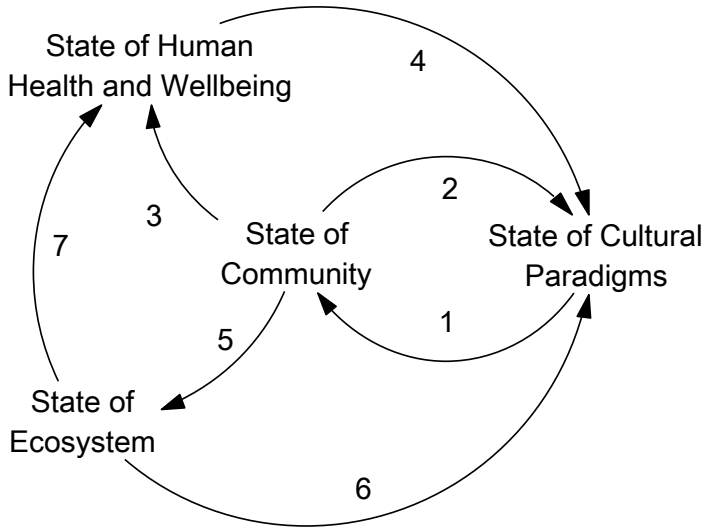

Figure 1: A Cultural Adaptation Template (CAT) (adapted from Dyball and Newell 2015).

Figs

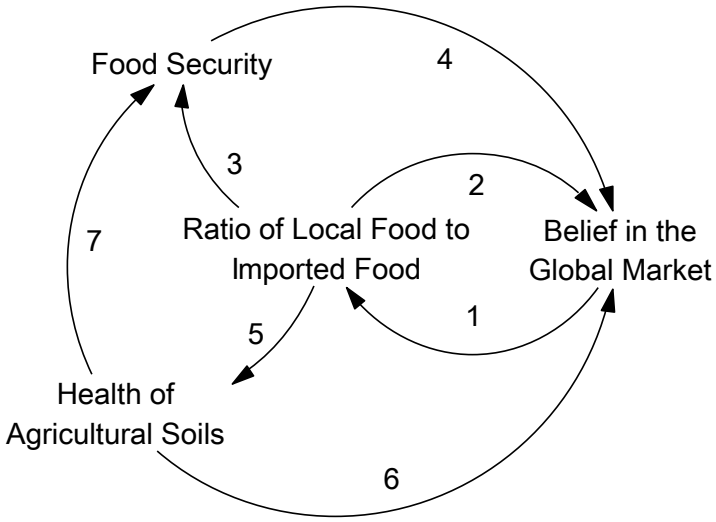

Figure 2: The Cultural Adaptation Template (Figure 1) translated to a Food Security 'problem space' (adapted from Dyball and Newell 2015).

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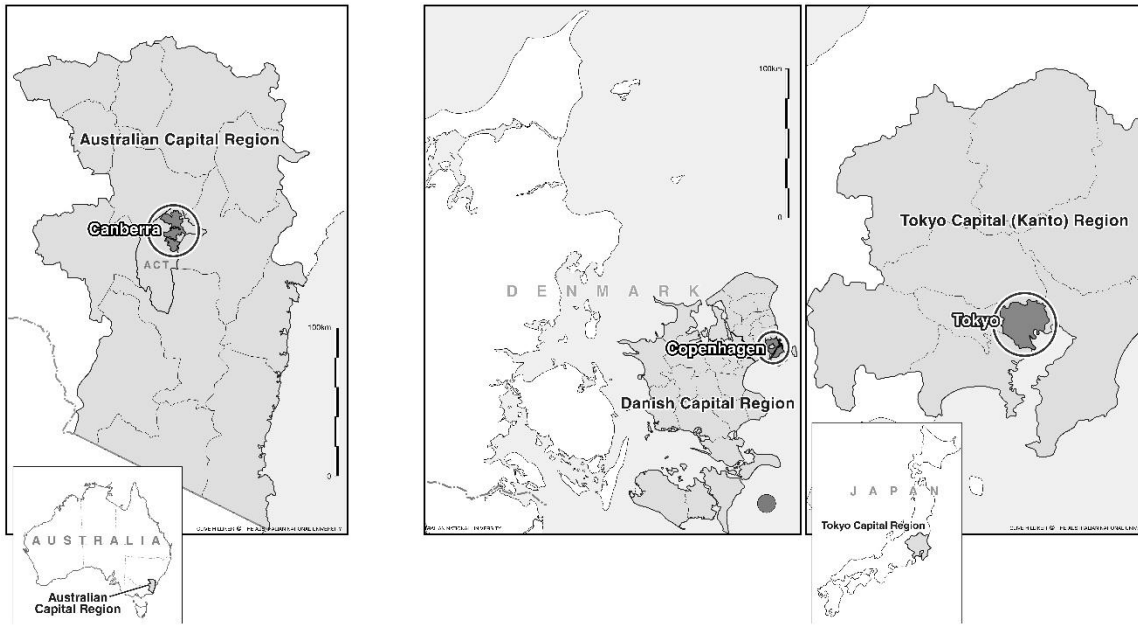

Figure 3: The location of the three case studies (adapted from Porter et al. 2014).

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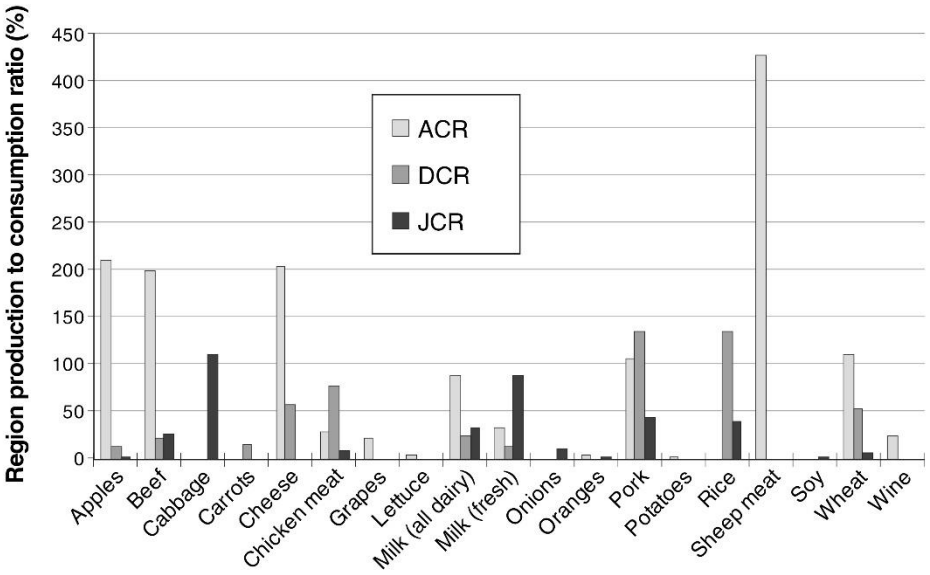

Figure 4: The relative food security of the three cities, Australian Capital Region (ACR), Danish Capital Region (DCR), and Japanese Capital Region (JCR). Graph shows regional production as a percentage of total regional consumption. 100% is total regional consumption of that commodity (adapted from Porter et al. 2014).

Figs

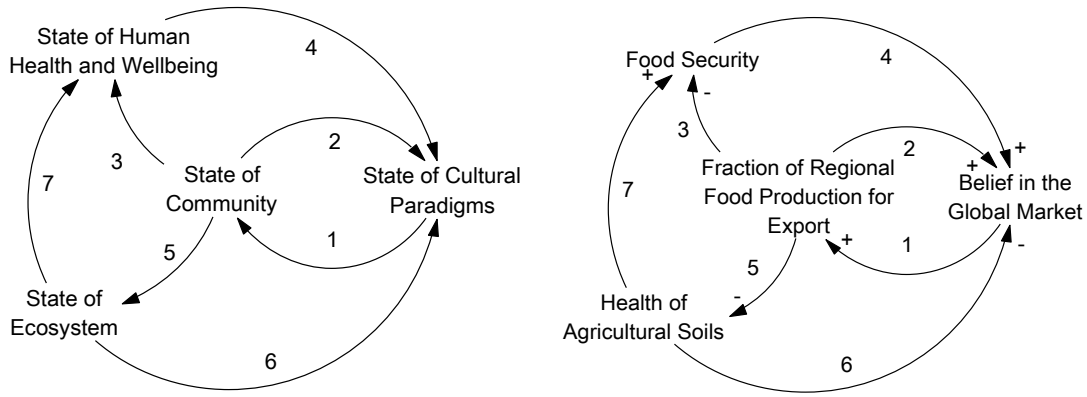

Figure 5. Food Security in Canberra. The diagram on the left is the cultural adaptation template (Figure 1). On the right is a system-of-interest diagram that focuses attention on some implications of a belief in global markets for the people of Canberra (adapted from Dyball and Newell 2015).

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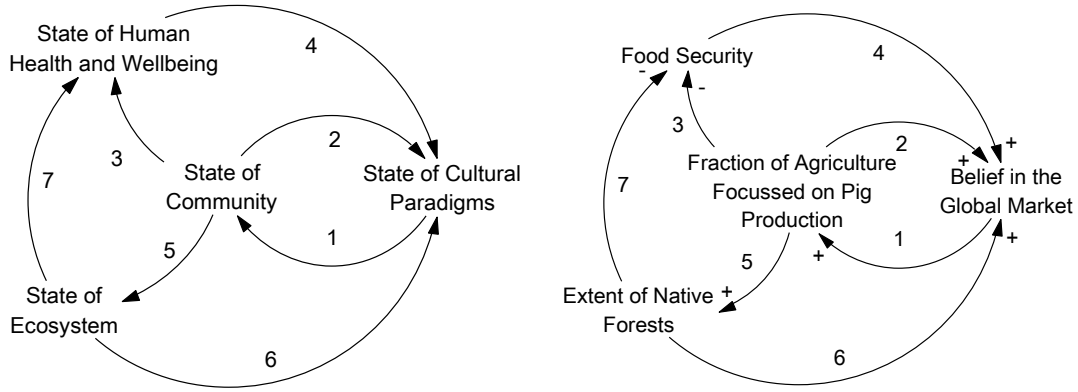

Figure 6. Food Security in Copenhagen. The diagram on the left is the cultural adaptation template (Figure 1). On the right is a system-of-interest diagram that focuses attention on some implications of a belief in global markets for the community of Copenhagen (adapted from Dyball and Newell 2015).

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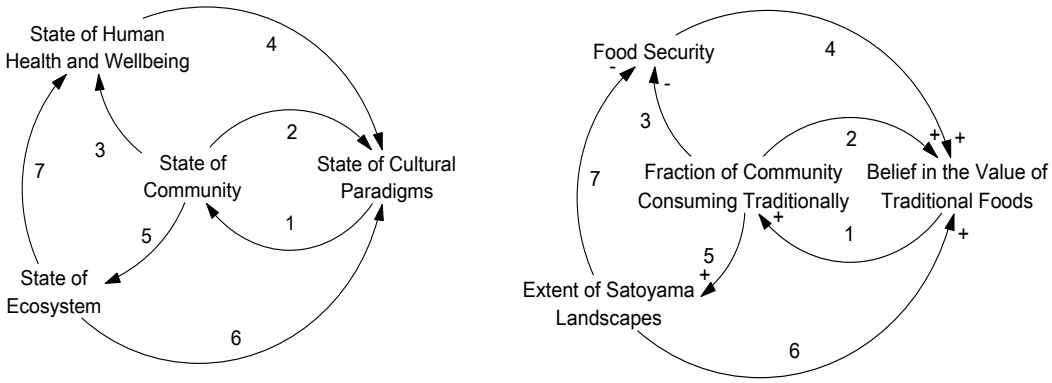

Figure 7. Food Security in Tokyo. The diagram on the left is the cultural adaptation template (Figure 1). On the right is a system-of-interest diagram that focuses attention on some implications of a belief in the need to maintain self-sufficiency in traditional foods (adapted from Dyball and Newell 2015).