Urban Metabolism and Urban Agriculture: How might growing food in cities ‘mend’ the metabolic rift?

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5.0 Introduction
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‘Urban metabolism’ is a concept that relates to the movement, circulation and dislocation of material resources in the city, and to the social, political and economic processes that govern these flows. To take the analogy with human metabolism: we know that age, climate, physical activity and emotions impact on the ability of our body to digest and metabolise food as much as the quality and quantity of the food we eat, and the speed at which it is ingested. Both human and urban metabolisms refer implicitly to a notion of health: changing human metabolism can be disruptive, carry discomfort and lead to more serious diseases such as obesity, cardiovascular disease and diabetes. Similarly, urban metabolism can be related to overconsumption and depletion of natural resources, pollution, natural disasters, the creation of toxic and obesogenic environments. Ultimately, as we will show later in this section, urban and human metabolisms are part of a continuum that is shaped daily (among other things) by agro-ecological relations and that can be shaped by Urban Agriculture.

In this section we present the outcomes of discussions among an interdisciplinary group of academics, practitioners and policy makers that looked at the relation between urban agriculture and urban metabolism from two different perspectives, but engaged with the challenge of bridging the gaps between them. The first perspective, which is predominantly used among physical scientists (i.e. soil and water scientists, biologists and ecologists), is known as ‘industrial ecology’; the second one, more popular among social scientists (i.e. geographers, planners and sociologists), is known as ‘political ecology’.

From an industrial ecology perspective, urban agriculture is analysed for its potential beneficial impact on the flow of water, carbon and more in general for the provision of ‘ecosystem services’: for example the diversion of run-off water for urban irrigation, potentially reducing flood risk in urban areas; the reduction of food carbon footprints by sourcing locally, requiring less packaging and reducing organic waste; or the improvement of urban micro-climate provided by plant transpiration. This perspective is also looking at the human risk associated to growing food in cities due to the existence of polluted soil, water and air which can be absorbed by plants and enter the food chain, and it reflects on the opportunities for fito-remediation. More in general it explores the potential for closing ‘loops’ of resources needed for food production (i.e. by sourcing all locally and disposing locally) and it paves the way to establish a ‘circular economy’ by increasing the re-use and recycling of organic waste, contributing to and strengthening sustainable production.

A political ecology perspective, on the other side, is looking more closely at the decisions that influence these flows, which have origins in social, political, cultural and economic spheres. For example, cultural perceptions of what is ‘dirt’ and ‘waste’ can impact negatively
on recycling and composting organic waste at the household level, therefore reducing the effective potential of urban agriculture to close nutrients loops. The availability (or scarcity) of land, or constraints to its cultivability is also often determined politically and regulated through planning regulation, zoning, and the land tenure system, and these largely limit the possibility for Urban Agriculture (i.e. banning animal breeding, or the cultivation of street verges, urban greens and even private front gardens). State or local regulation is also often at the origin of a system of rules that govern the management of water (i.e. access to fresh water), waste (i.e. possibility to use dry toilets in urban environments and disconnect from mains), and nutrients (possibility to move or keep ownership of own organic waste): all factors that can prevent Urban Agriculture from flourishing and impacting significantly on the ‘metabolic rift’, which is the break in the ecological exchange between humans and the natural environment (see chapter 5.2).

To bridge the gap between the two perspectives and to provide an overview of the ways in which urban agriculture contributes to re-shape the urban metabolism we have elaborated a conceptual model. This is represented in figure 1, and is referred to, informally, as ‘the egg’. The egg does not represent an existing geographical entity: it is not a representation of the city. It is instead a way to capture the complexity of the multiple links and relations that bind together food systems, agricultural production, urban space and green infrastructure management, public health, education, economic relations, citizenship and human rights.

Figure 1 – A conceptual model for the integration of metabolic perspectives (Source: authors' own elaboration)
The egg model comprises three levels: key elements that materially constitute urban agriculture are shown at the core. Emancipatory social processes that should be the ultimate goal of human actions (i.e. sustainable human development, justice, wellbeing) are placed on the external layer, to indicate that they frame (or should do) social and physical processes. In the middle ring we have identified the processes and interactions that shape metabolic flows (and with them Urban Agriculture) and determine whether or not, in certain context, these will produce the emancipatory practices indicated in the outer layer. Urban Agriculture is made of, unfolds through, and impact on all of them.

Recognising that the stock of natural elements and biophysical resources within urban areas are under enormous duress, yet are central to any hope of mending the metabolic rift, the heuristic figure places these at the centre. Issues surrounding the availability and biochemical quality of soil are especially important for urban agriculture given that soil remains the dominant medium for plant growing (although nutrient film and other synthetic materials can be important substitutes in indoor schemes), but an industrial legacy of toxic contamination or other pollutants might prevents its immediate utilisation for food growing. Similarly, the management of water in urban areas presents significant challenges particularly for the largest cities. For the extent of impermeable surfaces in urban areas presents difficulties for the replenishment of groundwater and invariably demands that the freshwater requirements of the city are met through complex infrastructure harnessing sufficient and secure supplies up to hundreds of kilometres away. At the same time, cities build and maintain additional infrastructure designed to deal with grey water comprising storm water and industrial and domestic effluents. Here the matter of scale becomes a salient variable, because addressing these challenges at the city-wide, macro-scale presumes technical solutions must be found at a comparable level. This inevitably results in concentrating decision-making in the hands of civil engineering and planning authorities who are regarded as the sole locus of professional expertise capable of addressing such large-scale problems. Yet, as we reduce the scale of these challenges so a widening array of potential solutions come into sharper relief. This is especially evident as we examine the management of both solid and liquid wastes. Separation at source enables potentially valuable, nutrient-rich organic fractions – with appropriate management such as composting - to be utilised as inputs for food growing. The challenge here is not technical: it is a question of scale and of local participation.

After highlighting the circulation and links between the core elements (energy, water, soil, etc.) mobilised through Urban Agriculture, chapter 5.1 (not available here) addresses exactly the potential of recovering these nutrient-rich fractions. The authors explore the extent to which a skilful recycling of urban organic waste can lead to the production of soil and growing substrate with the potential to (at least partially) emancipate urbanites from land ownership, bypass the problem of growing in potentially contaminated soils, and efficiently turn unused sealed lands into growing sites.

Placing biophysical resources and ecosystem services at the centre of our model demonstrates just how important these are to the quality of urban life, to human health and well-being. It is becoming increasingly recognised that green space (preferably comprising native plant species) is vital to urban areas for a multitude of reasons: from shading, carbon capture, air quality and reducing the urban heat island effect, to a range of human benefits. These include psychological (mood enhancement); physiological improvements, such as the
encouragement of more physical activity in the presence of nature (cardiovascular and skeletal strengthening); community benefits that arise from greater social interaction as a consequence of individuals being outdoors; or educational, enabling people to re-learn important skills in food growing, seasonality and natural processes. It is in this context that Urban Agriculture clearly demonstrates potential for multi-functional, multi-attribute performance that engages people to enhance the quality of the built environment. This is why, in our view, Urban Agriculture has moved from being a fringe matter to one that has the power to reshape our cities.

Chapter 5.2 provides precisely a reflection on why the intersection between urban agriculture and urban metabolism is a fertile ground to rethink the urban condition, and identify models of urbanism that non only accommodate urban agriculture, but recognise it as a core element needed to deliver a resourceful, emancipatory, healthy and socially just city. In this chapter we discuss some of the processes and interactions listed in the ring (Figure 1), such as infrastructural elements, biodiversity, education, access to land and health, and explain why their regulation via policy/direct action or other forms of agency is crucial to deliver the emancipatory processes listed in the third/outer layer of the conceptual model.

Chapter 5.3 delve into practical examples of farming and gardening practices in urban environments, and interrogate them from both, the industrial and political ecology perspective of metabolism. Taking example from European case studies explored during the life of the COST Action (Michel Bidaux Farm, in Geneva) and cases studies explored by Tornaghi (2014) during a Short Term Scientific Mission in the Netherlands (in particular case studies from Rotterdam), this chapter highlights opportunities and constraints to the access and re-use of nutrients and to the relocalisation of agricultural production in urban areas, bridging reflections on the availability of material resources, with the analysis of regulatory mechanism (ring) that enable more or less socially empowering and economically virtuous practices of recycling.

References for 5.0
5.2. Mending the metabolic rift: Placing the ‘urban’ in Urban Agriculture

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The concept of ‘metabolic rift’ has its origins in the work of Karl Marx. It was John Bellamy Foster, however, who coined the term as a foundational concept in environmental sociology (Foster 1999, Schneider and McMichael 2010). Marx pointed to “both a rupture in nutrient cycling between town and country and a rupture in the metabolic relation between humans and nature under capitalism” (Schneider and McMichael 2010, 462). The ‘rift’ describes the disruption of traditional forms of exchange between humans and nature (e.g., through agriculture and other forms of resource extraction and use) through which people secured their social reproduction. The rise of urbanization alongside industrialization as a consequence of capitalist development is regarded as the original cause. In this process, relations of production and consumption are increasingly (geographically) separated. As a consequence, the ecological and nutrient cycles that once maintained soil fertility while minimizing the accumulation of organic waste are severed.

The alienation from nature evoked by the metabolic rift has many other expressions. One concerns the rise of increasingly sedentary lifestyles that have resulted in diminishing levels of physical activity particularly in the presence of nature. With greater distances separating spheres of human activity, car-based (and public) transportation makes it hard to build exercise outside the home-school-workplace-shops-home nexus. At the same time energy-dense diets have exacerbated the fact that human metabolism is failing to effectively balance energy input-output for many bodies. Consequently, levels of non-communicable disease such as those associated with overweight and obesity have risen alarmingly and governments are increasingly worried about rising healthcare costs. Rayner and Lang (2012) argue that the obesity crisis is simply one amongst many of the complex and inter-connected urban challenges of the twenty-first century.

The metaphor of the metabolic rift exposes the fundamental asymmetry in the relationship between country and town, and has served as the basis of what has been called ‘the urban question’ (Castells 1977). The reform, regulation, and planning of urban areas under capitalism has been used time and again to remediate this asymmetrical relationship, and to address the reproduction crisis of modern society caused by the process of urban accumulation encompassing the recurrent crises of public health, housing, energy, and food security. It is in this context that we discuss urban agriculture as a tool for an alternative urbanism which seeks to qualify and mend the metabolic rift. Urban Agriculture, we argue, finds itself at the centre of a deeply political discussion on how the urban question is addressed, to what end, and for whose benefit.

The image of the metabolic rift tends to provoke two counter imaginaries: one which argues for a technocratic fix of broken cycles, restoring an image of a world in which flows are monitored, managed, and fully regulated; and the other which builds upon a radical critique of the agro-industrial complex that developed hand in hand with capitalist urbanisation, and which explores pre- and even anti-urban imaginaries. Both positions are present within the
Urban Agriculture debate; however, neither offers a singular solution to ‘mending’ the metabolic rift.

The true potential of the Urban Agriculture debate, we would argue, lies in its capacity to promote another line of development, one which embraces the urban as an emancipatory force and situates the power of utopian thinking (‘another world is possible’) neither in a problem free and technologically resolved future, nor in an imaginary past, but rather carves out localized utopias within the city as the potential seedbeds of an insurgent form of social change. Mending the metabolic rift is not a half-baked proposition which tries to smooth the internal contradictions of the urban. Rather, it is a potentially radical proposition which - without seeking to step outside of the forces of history - seeks to empower communities to take back the urban and to shape it in their own image.

In what follows we first try to place the discussion of Urban Agriculture within the urban by framing food as an urban question. Secondly, we try to elaborate our understanding of urban agriculture as a tool for an alternative urbanism taking the lead from agroecology. Agroecology presents a potential solution for Urban Agricultural initiatives in a way that ensures collective, local responsibility over health and nutrient flows that can help to mend the metabolic rift.

**Food as an urban question**

The city and the process of urbanization exist by virtue of the break between relations of production and consumption. Cities emerged historically as a progressive concentration of functions, arts and crafts, merchants and citizens, disenfranchised from direct intensive self-cultivation of food. Apart from a structural metabolic imbalance, the break between production and consumption in all the spheres of life produces a process of spatial differentiation and social division of labour and the loss of a potentially emancipatory opportunity for the urban population to benefit from a diverse array of cultural and educational opportunities. Urbanisation, while providing a higher level of food security than in rural areas, has nonetheless progressively separated citizens from food production. Consequently, we seek to explore what models of urbanism might present new emancipatory opportunities through food production that can overcome the legacy of the metabolic rift and the territorial separation of the city and countryside.

The question of food provision in cities has enjoyed great interest over the past decade with research highlighting the extent to which the city depends on increasingly complex socio-technical arrangements in providing food (Steel 2009). Moving to the city, more than ever, subjects people to an urban diet - a supermarket diet - and makes people, as far as their access to food is concerned, dependent on a limited set of options. When it comes to control over resources and different ways of having access to food, the city, rather than multiplying the options seems to radically reduce them. On the one hand, urban environments offer an unprecedented variety of foods, from different cuisines, from faraway places, throughout the seasons. On the other hand it offers this seeming variety through a limited number of channels, controlled by an ever decreasing number of players.

Food provision in an urban context is an integral part of the ‘urban question’. By drawing upon this notion in the work of Manuel Castells (1977), we emphasize the extent to which
urban populations are at the mercy of arrangements for ‘collective consumption’. Urbanites, in general, are not food producers, but rather consumers: food is one of the services that need to be delivered to them by "collective arrangements". The urban milieu offers a range of opportunities but also structures the unevenly distributed access to these opportunities. This holds for access to housing, for the question of water and energy provision, but also, as we wish to emphasize here, the way in which food is provided.

Access to collective services is typically a function of people’s ability to pay, access to state service and their (remaining) capacity of self-provision (Saunders 1986). This means that some goods and services are provided by the state (i.e. health services and education), but many are not (i.e. food), and must be allocated through the market or other forms of provision. Because of the failure of the collective arrangements in place, many people live in areas known as ‘food deserts’ or ‘obesogenic environments’ and the current politics of austerity has indeed increased the number of urban food insecure populations. According to the Trussell Trust over 1 million people in the UK received three days of emergency food from its’ food banks in 2014.

In the introduction we presented a general framework through which to explore the links between the resources for agricultural production (the core of Figure 1) and the social-infrastructural processes (within the ‘ring’) highlighting the way in which they impact on society (exemplified by the four key emancipatory processes in the outer layer). It is these relationships that are mobilized and rearticulated within various forms of Urban Agriculture and that capture its utopian potential. Thus, by framing food as an urban question and recognising the significance of the metabolic rift, we can understand the potential of urban agriculture to challenge the ways in which the collective interdependence of urban citizens is handled and articulated. Moreover, we can distinguish between development strategies that produce ‘parasitic’ and ‘generative’ forms of collective consumption (Merrifield 2014): between strategies that structure the urban as a world of uneven development, inequity and non-choice or, alternatively, contribute to fair access and the even distribution of the city as a collective good. The ‘urban’, in our perspective, is neither inherently good nor bad but, rather, defines the process and conditions within which concrete possibilities of renegotiating collective arrangements around the production and consumption of food can be redefined.

Urban Agriculture, in other words, may be understood as a practice contributing to a family of different urbanisms that question the current status quo of urban food, where the process of urbanization cuts people off from mechanisms of self-provision and subjugates them to a global food regime (McMichael 2013) based on intensive, exploitative, polluting and resource-depleting industrial food production. As soon as we begin to reframe the discussion in terms of food justice, food sovereignty (Edelman et al 2014) and political gardening (Certoma and Tornaghi, forthcoming 2015) we look at the possibility of constructing the urban diet differently. This requires us to consider residual or enduring aspects of self-provision (such as gardening and other forms of food growing); the re-localization (or ‘reterritorializing’) of the urban food market (eg the rise in short food supply chains such as farmers markets); establishing the notion of social justice and individual rights to food; and to find ways of reconstructing the notion of ‘commons’ around food, requiring efforts toward decommodification and forms of collective production.
Mending the rift through urban agriculture: an urban agroecology perspective

Given the nature of urbanisation and the uneven effects on food allocation and health of inefficient and unjust mechanisms of food provision, how can we conceive a progressive role for urban agriculture? There is not, however, a single answer to this question. As we stated above, urban agriculture is a component of a number of alternative visions that are in various stages of execution. Some are more focussed on the re-design of the urban fabric, promoting the construction of continuous productive urban landscapes-CPULs (Viljoen 2005; Bohn and Viljoen 2014) or the inclusion of productive spaces across the rural-urban transect (Duany 2011). Other initiatives, such as Transition Towns (Pinkerton and Hopkins 2009) are focussed on the development of multifunctional synergies and building community resilience (Sage 2014). Some approaches, such as Permaculture (Whitefield 2011), place special emphasis on the preservation of biodiversity, or the promotion of public health, as in the case of the Biophilic Cities model (Beatley 2010). These are just some of the many models currently being advanced as solutions for the rejuvenation of urban centres. We take the liberty here to advance a new proposal for an alternative urbanism based on the principles of agroecology, which promise to be particularly suited to help mend the metabolic rift.

While Urban Agriculture gradually finds its way into the fabric of the city, often through grassroots-led initiatives, and starts to transform urban metabolism (through modifying the diet of community food growers, recycling kitchen waste or realising the agricultural potential of urban green spaces), many of these initiatives remain isolated and residual. Even when economically viable and thriving, they do not necessarily impact on the issues of justice, health, resourcefulness or progressive development. We argue that for these practices to be able to ‘mend’ the metabolic rift, and contribute to food justice, food sovereignty and other emancipatory goals, they need to be framed in regulatory and conceptual terms that deal with both the social and the ecological dimensions. We argue that urban agricultural practices, when embedded within an *urban agroecological* perspective, bear a revolutionary potential: they can mobilise those processes in ‘the ring’ (Fig 1) to fashion convergence towards an emancipatory society. The agroecological perspective produces the ‘utopian’ urban seedbeds that may help to radicalize the urban (agriculture) agenda.

Agroecology has been defined as the application of ecological principles to the study, design and management of agroecosystems that are both productive and natural resource conserving, as well as culturally sensitive, socially just and economically viable (Altieri and Toledo 2011; Gliessman 2012). An agroecology-informed urban agriculture implies not only the cultivation of urban soil for food production, but most importantly involves taking control of the nutrients, water, soil, and energy (including the sun), needed for plant cultivation. It also implies the sharing and reproduction of knowledge needed to master these processes. In short, it requires sovereignty over knowledge and resources.

An ‘urban’ agroecology, is not simply an agroecology-informed urban agriculture. It is rather a way of conceiving of a city, its functions, zoning, green infrastructure, and governance, within an agroecological perspective which marks the main rationale for the politics of space, and of the social processes of production and reproduction within the city: it is a model for sustainable urbanisation. The *agroecological city* is a place where food production is rooted within the community with neighbourhood production sites run by what in the UK are called “Community Interest Companies” (a legal definition for community-owned businesses
producing benefits that advance their own development). In the wave of privatisation and dismantling of welfare states justified under neoliberalism, this could be a viable way to keep common goods under shared ownership. Here nutrients would be recovered from local waste streams including the organic kitchen waste from restaurants, cafés and households; and other biodegradable wastes (e.g., grass cuttings) such as those identified by recent research commissioned by Rotterdam City Council. Chapter 5.3 presents some observations on recent experiences and issues arising from such urban circular waste stream initiatives.

An urban agroecology consequently unfolds across the city in a range of spaces: on existing green or agricultural land (that also serve as hubs of knowledge-exchange and grassroots re-skilling); but also a considerable part will likely comprise indoor and outdoor spaces integrated into the existing built infrastructure (such as vertical walls, street verges, rooftops), utilising growing research on the re-purposing of existing and disused industrial infrastructure. Abandoned factories are now becoming important sites for low energy protein production, such as aquaponics, mushroom growing and insect farming. The potential for such initiatives is also being matched by a new creativity in rethinking circuits and currencies of exchange designed to retain value within the local economy.

In conclusion we believe that an urban agroecology offers considerable potential not only to help mend the metabolic rift but to provide the basis of an alternative urbanism and can do so in at least three ways:

1) Localised, neighbourhood-level production offers an optimum scale for closing nutrient cycles through capturing organic wastes and returning these as soil amendments for food gardening while also enabling the community to manage these resources and up-skill through mutual learning and experimentation.

2) By providing a focus on resource sovereignty (MacKinnon and Derickson 2013) that promotes better environmental stewardship but also generates opportunities for employment.

3) Recovers the centrality of food as a key dimension of social reproduction and a pivotal point for the redesign of economic relations and ecological models. Engagement with food production reveals the ecological basis of our food needs (Sage 2012) and the exploitative nature of the prevailing model of agri-food provisioning.

Ultimately an urban agroecological perspective presents a vision of an enabling environment where human wellbeing is fundamentally connected to food production and where this cannot be left to uneven forms of market allocation, dictated by wealth, opportunism or profitability, but rather by a coherent agenda for social emancipation that recognise its constitution within ecological relations.

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5.3 Practices of urban agriculture on the metabolic frontier: cases from Geneva and Rotterdam

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Chapters 5.1 and 5.2 made the claim that urban agriculture may help to mend the metabolic rift, re-building missing links and moving us from predominantly linear input-output relations towards more circular arrangements. What this means may be best understood by thinking through a series of examples. These examples not only illustrate the extent to which urban agriculture is implicated within urban metabolism, they first and foremost exemplify the various ways in which urban agriculture may contribute to metabolic change and strategically amend the current status quo. The discussion moves from a description of the different material and energy flows to question the political underpinnings and implications of specific choices within urban agriculture. Who benefits from improved metabolic cycles? Who gains control over resources in general and nutrients in particular? What is the direct effect on the health and well-being of individuals? The selection of examples included here encompasses professional farmers as well as community groups, microfarmers, and environmental activists, and aims to exemplify how nutrient recovery (via urban agriculture) is not only crucial for mending the metabolic rift, but reveals how it happens, with which constraints and why it needs to be regulated.

Managing waste, energy and nutrient flows: the farm of Michel Bidaux, Geneva

The commercially run farm of Michel Bidaux is located south of Lake Geneva on almost flat land near the French border. In 1985 Michel Bidaux joined his uncle’s farm and today he runs a business with the help of his family (wife and three children) and eight employees. The products he provides are as diverse as his customers. Beside the direct sales to consumers of his self-produced wine and chicken, he runs a company which processes chicken manure, household waste, and biomass, producing compost for his own farm as well as biogas.

Over one year about 4.000 chickens are bred within a three-month cycle. The chicks are bought from other farmers. Chickens are sold directly to consumers living in the surrounding area who order them in advance and come once every three months to pick up their share. The manure produced by the chickens goes to a biogas plant that is run by a nearby farmer. After fermentation within plant the digested residue that comes out of the biogas plant goes back to the Bidaux farm where it is added to his local compost programme. Through the biogas fermentation the manure has lost its ugly smell. Additionally it has been sterilized and it can no longer inflame during the process of composting. The biogas obtained in the plant is used to generate electricity and the heat derived from the process is used to warm a nearby school.

The compost is used for the fertilization of 60 ha in which field crops such as wheat, barley, canola, peas and soybeans are grown. No chemical fertilizers are used for these crops the largest proportion of which is used to feed the chickens. On 3.5 ha of land grapes are cultivated for which some fertilizer is purchased. The wine is sold to nearby urban
customers. All crops receive sufficient moisture through rainfall: additional irrigation is unnecessary. Moreover as a service to the local public authority the Bidaux farm offers wood cutting and roadside maintenance. Around 1700 tons of material is processed as woodchips and sold to a nearby public school for heating purposes. Some waste material is also added to the on-farm composting process which, besides the fermented chicken manure, also includes organic household waste from urban households and for which Mr. Bidaux receives financial support from the city of Geneva.

It is clear that the farm is playing a role in “tightening” the energy and waste cycles in the peri-urban area of Geneva. The farm reduces its dependency on external energy sources and is itself a source of renewable energy as it provides renewable biomass for the heating of the school and a local biogass plant. The farm also contributes to nutrient cycling through the co-composting of green waste and digested chicken manure. Chicken manure is a highly nitrogenous waste, which tends to limit its use as a fertilizer (nitrogen fertilizers can be readily transported to water bodies and cause major damage, therefore their application is strictly controlled). Combining the ‘digested’ chicken manure with food waste results in a more balanced fertilizer which can be used on the farm. The balanced nature of the compost will maximize the likelihood that these nutrients will remain within the agricultural system.

Finally the farm is playing a significant role in the conversion of waste to useful products within the greater urban area of Geneva. Again the conversion of chicken waste to energy and compost is important. Due to its highly pathogenic nature, its imbalanced nutrient content and its strong odour, chicken manure can be a difficult waste to manage sustainably. This case appears to be an effective management system. Furthermore, there is the composting of green household waste and green waste from hedge cuttings. The wood fraction of the hedge cuttings is turned into biomass for energy production.

The farm of Mr Bidaux provides a good example of the multiple possibilities in building new links within the urban metabolism. Managing wastes in a sustainable manner as shown in this case study benefits the urban metabolism in several dimensions: lower energy inputs, greater nutrient cycling, reduced outputs (in terms of waste, air pollution, water pollution), and improved farm profitability. The case is representative of many examples we find throughout Europe of small enterprises that succeed in turning the difficulties of working within an urban context into a potential advantage, dealing with the complex logistics required to manage these different material streams. A relatively small organization, like that of Mr Bidaux, turns out to be well placed to devise a solution that embraces the collection of household waste, producing woodchips, and transporting animal feeds and compost: all are optimized within the organization of the enterprise.

From closing cycles to urban metabolism: nutrient sovereignty and the right to waste

Thinking metabolically about urban agriculture opens new perspectives that are not limited to the multifunctional and cyclical reframing of food production but can identify new entrepreneurial frontiers beyond the more conventional focus. It enables a growing awareness of the various ways in which food production is embedded within urban metabolism, revealing some of the processes that turn natural resources into edible goods (see chapter 5.2). The question of how water, waste, material and energy cycles are handled
is more than a matter of efficiency and reduction of environmental externalities, but has serious implications for the control that urban residents can exercise over resources that play a role in food production. If the urban environment generally tends to place people in a position of dependence as far as food provisioning is concerned, urban agriculture may play a role in regaining control over the urban food system. Whether or not it does, is not simply a question of efficiency.

Various initiatives within the Rotterdam context have chosen to reframe discussions in those terms. The 2014 edition of the international Architecture Biennale ‘Urban by Nature’ mounted a broad discussion framing questions of urban development in metabolic terms (IABR 2014). In the run up to the show the office of James Corner (Field Operations) and the Dutch design firm Fabric were asked to conduct a large reflection on Rotterdam in metabolic terms, identifying various opportunities within a combined analysis of water, energy, material and waste flows. These resulted in various proposals including reflections on neighbourhood urban farming (IABR 2014), and on households’ kitchen waste stream recycling, but it also addressed the potential of ‘mining’ phosphate from the sewage system (which deals with an estimated 582 tons of phosphates per year) and from the Maas, making use of Rotterdam’s downstream position within the Rhine-Meuse River system.

Perhaps even more interesting than these design exercises are the various bottom up initiatives that have emerged in the Rotterdam context (for a wider overview see Tornaghi 2014). The recognition that much urban waste is actually an asset in the urban production of food is certainly very much pioneered by them. Driven by attempts to close energy loops, sensitise the city to unsustainable farming practices (i.e. industrial meat production), establish economically sustainable urban farming (make a living out of urban agriculture), and increase food self-reliance (by creating "productive landscapes"), a number of projects linked to the umbrella organisation "Edible Rotterdam" have all faced the issue of ensuring access to the nutrients needed for their farming practices.

While the Bidaux farm in Geneva reveals a successful and thriving business around a particular configuration of agreements and rights that guarantees it access to key resources (such as local waste), the Dutch context within which the grassroots projects were dealing was – to some extent - much less favourable given the appropriation of waste aimed at food production. For example, a community garden set up in Willemstuin in Rotterdam city centre on a site due to be redeveloped, had to deal with very poor soil. How was it to improve soil fertility when financial resources to buy compost were limited? The question quickly arose: shouldn't open community gardens, which provide a number of collective benefits such as improving the appearance of the built environment, opportunities for socialising and food provisioning have the right to access free compost produced by the city council from its grass and tree cuttings in public parks? If local taxes are used to pay for the removal of grass and the production of compost surely it would logically follow that the final product should be the common property of taxpayers as use-value, and not a new commodity for the market. Within this reasoning, and jointly with other community gardens active in the Edible Rotterdam platform, a number of local growers have won ‘the battle’ for their right to a bag of compost per person, though this is hardly sufficient for the needs of a productive community garden.
Willemstuin community garden is run by a trained ‘compost ambassador’, who aimed to set up on site a community composting area. This sounded like a perfect solution: the garden needs good soil to thrive, and every gardener, as any human being, is an organic waste producer. Given the limited nutrient content provided by the ‘civic’ bag of compost per capita, the obvious next choice to improve soil quality was to bring their own home waste to the garden, to be composted, rather than disposing of the food waste through the municipal household collection system. After all they paid for that waste in the first place: for the banana skin, for the potato peels, for the tea bags, the eggs shells, and all the inedible parts of their food when they bought it. They also pay household waste collection tax, whether they produce waste or not. But while their argument seems entirely rational it is, currently, legally impractical, for the city council is bound by an agreement with the incineration company to deliver a minimum quantity of waste each week. Consequently, if every citizen began to divert his or her waste to composting, the incinerator and all the complex economy around it would have to change. There is also a wide range of health and hygiene regulations related to urban transport of waste. As a consequence, Willemstuin’s gardeners do not have the right to move freely with their bag of kitchen waste to bring it to the garden. Their community compost, and with it the aim of closing nutrient loops for their food growing project, is consequently facing some difficulties.

Willemstuin is not the only project struggling to retain or to access community waste. The "Pig House" had gone through similar troubles: funded by an arts grant, a group of environmentalist-artists set up a pig sty in a city square, with the aim of raising awareness about the meat industry. The local community had planned to feed the pigs with their own kitchen waste for two years, and would then have been involved in slaughtering the animals, and sharing the meat. While pig rearing is an efficient way to dispose of kitchen waste, and the ‘emotional bundle’ related to rearing-slaughtering-eating was a brilliant tool to bring attention to animal rights, industrial farming and ethical/sustainable consumption, the project encountered a whole range of obstacles that impeded its full development and required lengthy negotiations with the council around permission to keep and move urban waste across the neighbourhood. So as we can see, when waste becomes more widely recognised as an asset, a number of competing groups advance demands for its use. Indeed, let us imagine for a moment that Bidaux’s farm was located in Rotterdam, a city where the promises of the circular economy are very much known by a wide number of actors: the grass cutting and tree pruning that he is paid to take away in Geneva, as a service, would likely be seen as a matter of contention in Rotterdam. Indeed, we do not know if there are groups in Geneva opposed to this arrangement; but evidence would suggest that in many places waste is undergoing re-evaluation as a valuable resource.

Another, perhaps even more controversial example related to the circulation of nutrients in urban environments is constituted by what is called ‘human manure’, also known as ‘night soil’, which has been historically used as agricultural fertilisers for 40 centuries (King 1911), both before and partially after the metabolic rift. Human excrement is not a very popular topic among urban gardeners and farmers in western cities, despite a growing number of publications and handbooks for DIY gardeners that highlights its benefits and practicalities (see for example Jenkins 2006 and Steinfeld 2004) and well known experiences of closed energy, water and waste loops that include compost toilets and agriculture (for example at the Centre for Alternative Technology, Wales). It is interesting to note, however, that in a dynamic and forward looking context such as Rotterdam - one of the few European cities
with an Urban Agriculture Strategy, in a country that has now a well established “National day of urban farming” – both the city council and the Dutch Water company (as well as a few community gardens) have admitted to testing the benefits of recycling human waste.

To conclude, we want to underline that when waste ceases to be something to dispose of and, instead, becomes an asset for urban food production, a whole range of new regulatory issues come to the fore. The question is not only how urban cultivation can improve metabolic processes and improve urban sustainability, but critically raises the question: who has rights to waste? When waste is an essential element for food production – whether as rainwater, residual or surplus food, animal and human excrement, tree-and lawn cuttings – the question of waste recycling can become a matter of nutrient sovereignty. Consequently, the question - How can urban metabolism enable Urban Agriculture? – requires us to explore virtuous recycling pathways. Without them, urban cultivation will remain dependent upon external inputs (chemical fertilisers, industrially produced compost and mulch). By incorporating all manner of appropriate, biodegradable wastes as a source of nutrients, urban agriculture has the potential to mend – rather than reproduce - the metabolic rift.

References for 5.3
Steinfeld, Carol: The Lore and Logic of Using Urine to Grow Plants. Totnes 2004
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