Feeding cities and migration

Urban food systems in a spatial environmental perspective

L.L. de Rooij, P. Verweij, H.J. Agricola

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This research is part of programme Food Security and Valuing Water of Wageningen University & Research and was funded by the Dutch Ministry of Agriculture, Nature and Food Quality (project number KB-35-002-001).

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Het rapport *'Feeding cities and migration –The Urban food systems in an spatial environmental perspective'* verkent de ruimtelijke en omgevingsdimensies van het stedelijk voedselsysteem, beoordeelt bestaande goede voorbeelden van ruimtelijke analyses en reflecteert op veelbelovende benaderingen en instrumenten. Doel is om een basis te leggen voor toekomstige ondersteunende acties en onderzoek om tot gezamenlijk begrip te komen en integrale planningsbenaderingen voor interventies in het stedelijk voedselsysteem te ondersteunen om zo tot veerkracht en duurzaamheid te komen.

The report *'Feeding cities and migration –The Urban food systems in an spatial environmental perspective'* explores the spatial and environmental dimensions of the urban food system, reviews existing best practices in spatial analysis and reflects on promising approaches and tools. Aim is to set a basis for future supportive actions and research to reach common understanding and support integrative planning approaches for interventions in urban food systems for future improvement to develop resilience.

Keywords: food security, resilience, city region food system, spatial planning, environment, decision support systems, GIS, mapping, rural urban linkages, environment, resilience

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Wageningen Environmental Research (WENR) values the quality of our end products greatly. A review of the reports on scientific quality by a reviewer is a standard part of our quality policy.

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BENNY
POWDERED CHICKEN FLAVOURED STOCK

Summary

The world is rapidly urbanising. This highly urbanising society comes with many benefits, but also relies on specific systems. Amongst others, the urban food system is one of the most crucial ones. It is also one of the most complex and perhaps fragile systems, highly depending on the wider context, linkages and interdependencies within the system and to other domains. Although, it is recognized that food systems have a spatial and environmental dimension, the food system remains a stranger in the planning field and vice versa. The last few years several initiatives, like the City Region Food System and the Milan Urban Food Pact, paved the way towards a better spatial understanding and strategy. Nevertheless, there is still need for improving the uptake and development of supportive systems and actions towards spatial integration and interventions to improve and sustain food systems.

This report explores the spatial and environmental dimensions of the urban food system, reviews existing best practices in spatial analysis and reflects on promising approaches and tools. Aim is to set a basis for future supporting actions and research to reach common understanding and support integrative planning approaches for interventions in urban food systems for future improvement and to develop resilience.

1 Introduction

The world is rapidly urbanising. Urban population grow up to 1.5 million per week and 65 million every year (UN, 2014). This highly urbanising society comes with many benefits, but also relies on certain systems. Amongst other, the urban food system is one of the most crucial ones. It is also one of the most complex and perhaps fragile systems (FAO, 2019; Berkum, 2018; Kasper, 2017). In many parts of the world this urban food system is already highly under pressure, but the current insights on the existing –multifaceted- system, its functioning and its responsiveness remain low (Pothukuchi, 2017; FAO, 2019; Berkum, 2018).

To secure a sustainable food future in both urban and rural communities action is needed. Strategic interventions across the system are necessary. But to really have the right intervention at the proper place with maximum effect it is important to have better insights. This starts with a common understanding and a broad, open view. Bringing together the different dimensions and angles that will put the urban food system and future interventions in the right perspective.

In 2019 the Knowledge Base[1]-project 'Feeding cities and migration' was launched. This research is part of programme Food Security and Valuing Water of Wageningen University & Research and was funded by the Dutch Ministry of Agriculture, Nature and Food Quality (project number KB-35-002-001). The overall goal of the Feeding cities project is to contribute to resilient and sustainable urban food systems that provide food- and nutrition security for all, by increasing understanding of the complexity of these systems and by developing approaches and solutions for urbanizing and expanding cities in Africa and Asia to respond adequately to the pressures of the food system, with particular attention to the role of migration in these areas. The project aims at building a solid basis for proper interventions along the urban food system:

- based on a better understanding of the urban food system (city-region) and the interlinkages within (social, economic and environmental);
- including the responsiveness of the urban food system;
  to migration and other sudden or slow-onset changes;
- providing tool and guidance;
  (decision support tools, diagnostic tools and tailored participatory guidance);
- linking action research, contextualisation and generic insights.

This report aims to contribute to a better understanding of the urban food system and puts an emphasis the city-region approach. This means: improving connectivity between urban areas and their hinterland, enhancing urban food system outcomes in terms of food security, socio-economic and environmental performance. Last but not least, the study also focuses on the potential impact of different non-climatic or climatic variables, such as migration and extreme weather events, on the food system. Working on a transition to resilient and sustainable food systems

In this project different research institutions within Wageningen University & Research work together, covering the broad expertise required for the right action perspective.

[1] Knowledge Base research is funded by the Dutch Ministry of Agriculture, Nature and Food Quality. The program aims at providing a solid basis for new knowledge that would be relevant for future policies and actions in the upcoming years. It is setting the scene and provides new insights and potential tools.

1.1 Scope

The recently published Framework on the Urban Food Agenda FAO states "Fostering resilient and economically food systems, integrated across landscapes and based on multi-stakeholder, multi-scalar and multi-sector collaboration, is key to support more sustainable urban processes through safeguarding ecosystem service and provision of good" (FAO, 219). Taken into account that the food system does not stop at urban or administrative boundaries, the term 'urban food system' is not undisputed. Blay-Palmer et al. (2018) define a sustainable, resilient city region food system as one that aspires to enhance sustainability across scales and sectors as it increases access to food, generates decent jobs and income, increases the region's resilience, fosters rural-urban linkages, promotes ecosystem and natural resources management and support participatory governance.

The way urban food systems are framed and which spatial scale is taken into account could make the difference. In this project the urban food system does not stop at the boundaries of urbanized areas, but fully addresses interlinked rural challenges and interdependencies. In this we build upon the current City Region Food System approach (FAO, 2019), introduced by FAO and the RUAF Foundation (Dubbeling, 2016), and the Wageningen Food System Approach (Van Berkum, 2018).

There is a clear need for further understanding, data and supportive tools which could strengthen the approach, common understanding and knowledge basis and –last but not least- future interventions (see Chapter 2). This links closely to the evidence-based Food System Design (EFSD) approach (Van Bossum, 2019). In this report we focus especially on the spatial environmental dimensions of the urban food system, including urban-rural linkages and bring different frameworks and tools together. Nevertheless, besides these data-driven focus, we give ample notice to the importance of actors and stakeholders, their (spatial) organisation, their roles and their linkages in terms of the (value) chains. Strategies, interventions and support tools only work well if they fit into a proper participatory approach of joint fact-finding, co-creation and action.

1.2 Methodology

This research and report is part of the KB-project Feeding cities and migration.

We carried out a literature study on the spatial environmental dimensions of the urban food system, with an emphasis on the way spatial analysis and spatial planning is included in current policies and practices. Secondly, we reviewed a selection of examples and best practices of current spatial analysis and support systems. Each example has been reviewed on both spatial focus and food system focus, as well as data availability and representation. Additional, some promising tools and approaches are set out, including lessons-learned and important recommendations for future processes, spatial analytics, supportive tools and (spatial) planning. Finally, next steps are proposed to uptake the spatial environmental dimensions and spatial analytics and planning into future activities within the KB-project Feeding cities and migration.

2 The spatial environmental perspective

The environment plays an important role in enabling a good and rightful food environment. On the one hand the environment is crucial in providing enough and sufficient food, on the other hand the environmental conditions have a significant direct effect on accessibility and availability of food and also provides resources for proper utilisation. The environment itself is also highly influenced by the food system, the choices made within and -last but not least- it outcomes.

It should come without saying that in the spatial environmental perspective the urban food system goes beyond the boundaries of urban tissues. It highly relies on provisional services of rural areas. These rural areas or on their turn also effected by the urban metabolism and outcomes. In fact the urban food system is a prime example of the interdependence of city and hinterland in all its facets.

By 2050, 80% of food is expected to be consumed in cities (Ellen MacArthur Foundation, 2019). Currently the food system is still highly linear organised. Figure 1 illustrates the flow of materials in the - currently still highly linear organised- food system. It shows that a high proportion of food flows into cities, where it is processed or consumed, creating organic waste in the form of discarded food, by-products or sewage. In cities only a very small proportion (<2%) of the valuable nutrients in these discarded organic resources gets looped back to productive use.

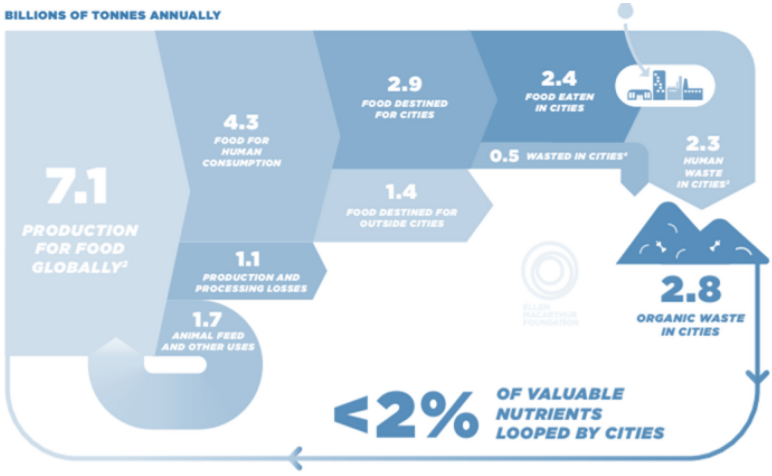


Figure 1 *Food and food waste flows (Ellen Mac Arthur Foundation, 2019)*

It is estimated that -directly or indirectly- between 20% and 50% of the total environmental pressures caused by humans can be attributed to the global food system. A large amount of these pressures are accounted to the urbanising world (Roy et al. 2012; Notarnicola et al. 2012; McLaren 2010, Goldstein 2017). Recent figures point out that by 2050 up to 68% of the world's population will be urban (UN, 2018). Although the actual share of land use is relatively small, urban areas currently account for 60-80% of global energy consumption, 75% of carbon emissions, and more than 75% of the world's natural resource consumption (UNEP, 2013).

It is difficult and hardly impossible to get the full picture in this dynamic and multifaceted domain, but nevertheless it is important to set some clear impact chain relations and feedback loops on different integrated themes to come to appropriate and differentiated interventions along the food chain.

In this chapter we review some existing frameworks and approaches on how the spatial environmental dimensions and dynamics are included and how this will be included in the Wageningen Approach on Feeding the Cities.

2.1 The spatial environmental perspective in existing frameworks and approaches

In the last decade many frameworks and approaches made an attempt to tackle the urban food challenges. There is a wide variety in focus, from urban agriculture to value chain development.

This chapter gives an overview of frameworks and approaches found in literature and developed by organisations like FAO, RUAF, the Milan Urban Food Policy Pact, and within Wageningen University & Research.

The City Region Food System (CFRS) has been introduced by FAO and the RUAF Foundation. In this approach the city region is defined and understood as "a given geographical region that includes one or more urban centres and their surrounding peri-urban and rural hinterland across which flows of people, food, goods, resources and ecosystem services are happening" (FAO, 2015). The City Region Food System approach is highly focusing on participatory mapping and stakeholder based decisions. CFRS also provides an extensive indicator framework (FAO, 2017) for assessing and addressing more sustainable and resilient food systems. This indicator framework is set along six sustainability areas: social sustainability, economic sustainability, environmental sustainability, urban-rural integration, food governance and reduce vulnerability and increase resilience.

These areas are set along the components of the food system, according to CFRS (box 1).

Box 1 Components of the food system City Food Region System, 2018

- Input supply and food production
- Food storage and processing
- Food wholesale and distribution
- Food marketing, catering and retail
- Food consumption
- Food and organic waste management

From the CFRS approach different pilot projects were carried out. In chapter 3 the approach and the outcomes of the pilots are reviewed.

Recently, FAO published its framework for the Urban Food Agenda. The Agenda has identified 4 cross-cutting guiding principles:

- Rural-urban synergies
- Social inclusion and equity
- Resilience and sustainability
- Food system (inter)connections

The different subprinciples that are brought forward are all highly depend on (spatial) data. Spatial data helps in recognizing the diversity of socio-geographical contexts, developing territorial strategies and supporting principles of circular bio-economy and sustainable natural resource management. Besides, it helps in horizontal integration across sectors and along all stages of the supply chain towards integrated visions and interventions. As FAO calls *"this would enable cities to build the necessary evidence (and insights) to design, implement and measure the impact of their initiatives ..."* (FAO, 2019). Urban planning is all about spatial decisions, design and guidance. To lever urban planning mechanisms and include food better in physical planning decision, spatial data should be a basic necessity also in developing integrated visions and developing pathways and interventions. This clear links to the targeted outcome of the agenda: empowered food system actors, based on a shared knowledge and evidence-base and support to participatory approaches.

With the Milan Urban Food Policy Pact (15 October 2015), numerous cities have committed to 'work to develop sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimise waste and conserve biodiversity while adapting to and mitigating impacts of climate change". The Milan Urban Food Pact encourages urban food policies and cooperation and coherence within food-related policies and programs. They have also set the commitment to review and amend existing urban policies, plans and regulations. In 2018 the Milan Urban Food Pact also provided a Milan Urban Food Policy Pact Monitoring Framework (MUFPPMF), which consists of different indicators (box 2).

Box 2 Indicators Milan Urban Food Policy Pact Monitoring Framework, 2018

- Food governance
- Sustainable diets and nutrition
- Social and economic equity
- Food production
- Food Supply and distribution
- Food waste

Mainly addressed within food governance, the framework mentions different outcome areas of the which are mostly relevant to this research. At first, participatory food governance structures should exist and should be cross jurisdictional, cross-sectorial and multi-stakeholder. Secondly, participatory food governance structures enhance transparency, ownership, collaboration and co-investment among multiple stakeholders. Thirdly, the food system should being included in city disaster and resilience assessments and response plans, and finally urban food system policies, legislation and strategies should exist and be integrated into other policies, planning processes and programmes.

There is a clear need for knowledge sharing mechanisms. To enable effective action the development or improvement of multisectoral information systems and knowledge sharing mechanisms should be developed and used for food policy development (*and actions)* and accountability by enhancing the availability, quality, quantity, coverage and management and exchange of data related to urban food systems (including both formal data collection and data generated by civil society and other partners) (MUFP, 2018). This raises the question if these mechanism and systems are already in place, how spatial information and coverage is included, and if these systems already sort effect on policy and actual interventions -also spatially.

In the backgrounds of the specific Indicator sheet, available on the website of the Milan Urban Food Pact (MUFP, 2018), some important notions have been made (box 3).

Box 3 Recommendations Milan Urban Food Policy Pact, 2018

- Data collected should be disaggregated for different income groups and spatial levels (within the city, but also in the city region)
- Spatial location of data will allow geographically link specific indicator data to specific areas in and around the city for further planning!
- Use different data source (governmental and non-governmental)
- Periodically asses/ review (or update) data for changes and monitoring
- Data should be made available to the public domain (open data)
- Multi-stakeholder participation in data analysis and policy design and review will enhance inclusiveness and efficiency gains

Related to the Milan Urban Food Policy Pact, the publication "Food & Cities. The role of cities for achieving the Sustainable Development Goals" (BCFN/MUFPP (2018) gives additional recommendations, that in the light of this research are highly relevant too (box 4).
To align territorial planning and food policy, promote territorial development and the city region approach, including urban-rural linkages, the spatial information and perspective (spatialisation and spatial planning) is crucial. One cannot go without the other.

Box 4 Recommendations Food & Cities, 2018

- Promote sustainable territorial development and city-region approach
- Align territorial planning and food policy
- Strengthen rural-urban linkages to secure well-functioning supply chains, protect and strengthen livelihoods and to increase access to markets and employment, while at the same time providing ecosystem services
- A sustainable, urban food system requires constant dialogue and close collaboration between the Municipality and the surrounding rural Municipalities as part of a city-region approach

Besides the different examples of the CFRS as mentioned before, another example of spatialisation can be found in the FP7 project 'Food Planning and Innovation for Sustainable Metropolitan Regions' FOODMETRES (Wascher, 2015). This project thrived to assess the environmental and the socio-economic impacts of food chains with regard to spatial, logistical and resource dimension of growing food as well as food planning and governance. The project came up with so-called "land footprints" of urban food consumptions in terms of the socio-economic and environmental impacts, and above all, an Common Operational Data Protocol and method was developed for Metropolitan Footprint Tools.

In contradiction to this more regional and scientific analytical approach, the direct food environment ("the interface where people interact with the wider food system to acquire and consume food") is the focal point and seen as a useful entry point in the report 'A menu of actions to shape urban food environments for improved nutrition' (Halliday, 2019), which is related to the Milan Urban Food Policy Pact too. It is reasoned that "*local governments and other actors at the local, city-level have limited capacity to influence the macro-level political, economic and socio-cultural factors that shape the food system*".

Both approaches add value. It is not about making choices, but about alignment of the different perspectives and smart use of different entry points (multi-level, multi-scale) in a tailored joint process, supported by proper (spatial) information about all levels to thrive interaction and integration.

In the Food System Approach as drawn up by Van Berkum (2018) the environment can be found at different places within the framework. Mainly the environment is seen as driver or basic condition for the food system activities. Within the food system activities the frameworks call upon an enabling environment and food environment. The framework also pays attention to potential outcomes and effects from the food system outcome on the environment and the environmental basic conditions and resources. In general the framework gives a good overview. Nevertheless, from the spatial environmental perspective there is a felt need to be more specific on direct relationships within the framework also to make it more operational in a planning perspective.

Regarding the spatial environmental perspective in existing frameworks and approaches it may be concluded that it has been recognized as a crucial factor in understanding food systems and potential interventions, but there is still a way to go to put it into effect.

2.2 Cherish complexity, make it work

Food systems are undoubtedly complex. In practice, often this complexity is unravelled and split in manageable parts, themes and targeted areas. Hence, potential feedback loops and crucial interactions could be missed. It is of utmost importance to design a holistic approach and process that succeeds in analysing and acting on specific topics and in specific areas, but clear linkages and uptakes should be granted in the overall process. It is all about cherishing the complexity and making it work.

Landscape and spatial planning can play a crucial role in this, and while territorial food planning is relatively uncapitalized, looking at other domains and urgent issues could inspire, for instance climate adaptation strategies: from local to regional and national. Tailored well-designed processes, with scale-specific measures and policies, but clearly interlinked to other scales and related policies and directions.

To bring in the spatial and landscape component -or better as a basis- more explicit, the framework of Van Berkum (Van Berkum, 2019) has been altered from a spatial environmental perspective. The term spatial environmental joins spatial configuration and environmental aspects as enabling factors for the food system. It is not solemnly focused on putting spatial planning into effect for environmental management only.

In our alteration the environment, in the broader and wider sense, should be seen as enabling factor and boundary condition to the urban food system, but also clearly links the effect of the outcomes of the urban food system and urbanization on this same enabling environment. The new scheme also puts in a first attempt to include the specific relevant context. For instance, the enabling environment stretches from the urban tissue to the hinterland, but also the urban food system should be seen in the context of urbanization and urban organization.

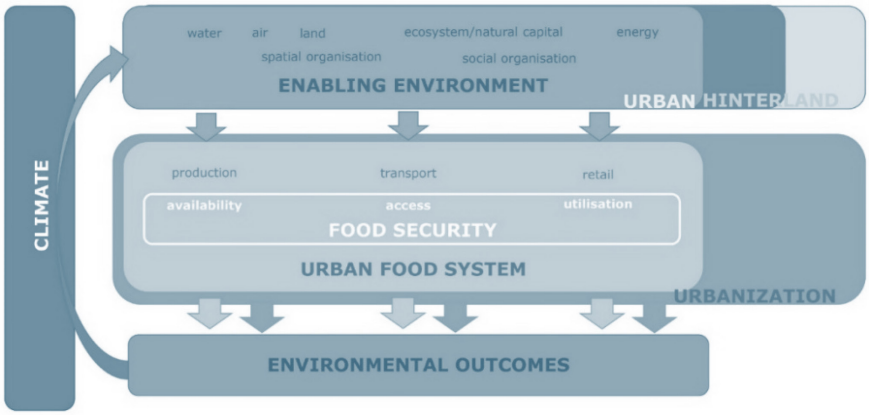


Figure 2 *The spatial environmental perspective (De Rooij, 2019; based on Van Berkum, 2018)*

This alteration can form a first guidance to required spatial information and arranging this information in spatial information systems. However, the scheme currently only brings in the wider feedback loop between the environment, the outcomes of the system and climatic conditions. The numerous feedback loops, causal chains and interlinkages within each component should be taken into account for further elaboration; the interaction makes the difference. The challenges is the way to put this in effect in spatial planning and spatial information systems, in an orderly, understandable and practical way.

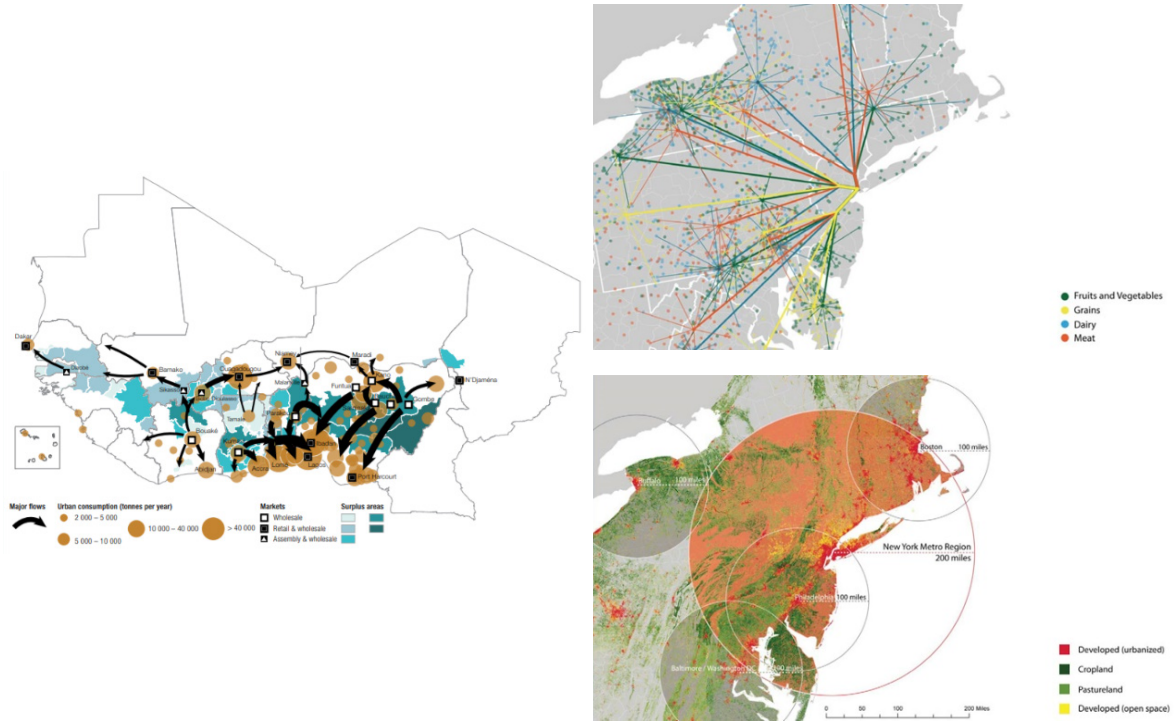
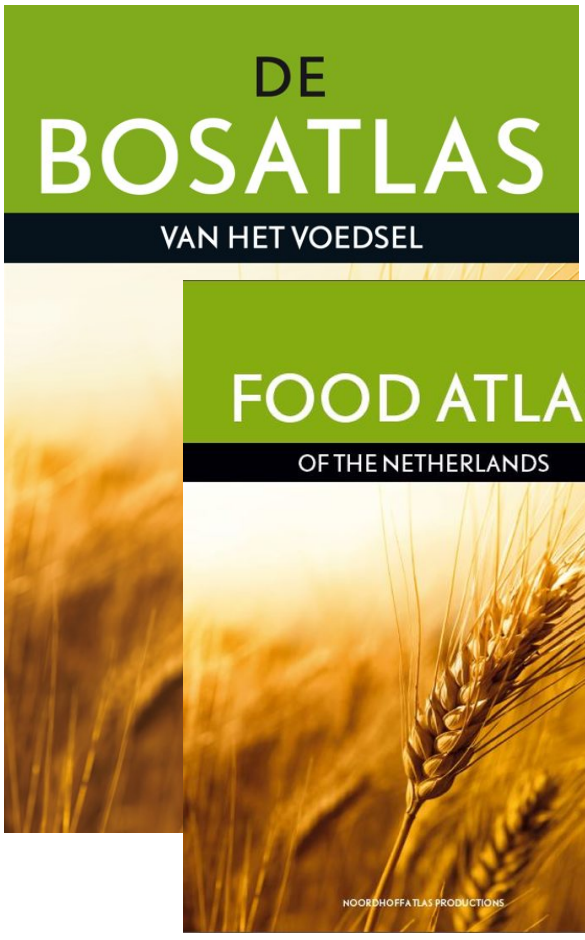
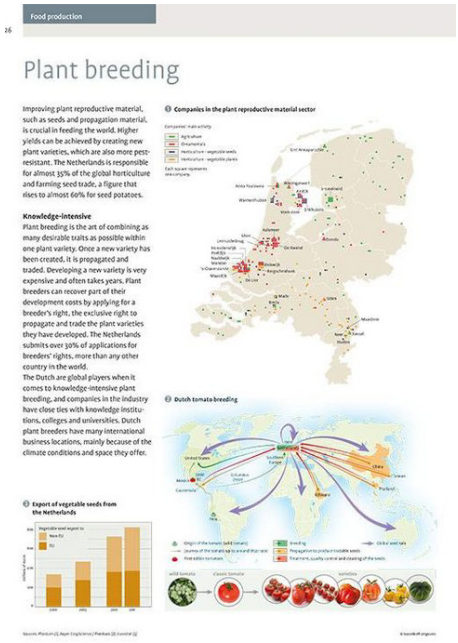


Figure 3 *Examples spatial analysis regional food sheds*
a. Flows of maize Sahel and West Africa (left)
b. Regional Food Shed New York (right)
(Sources: NYC Regional Foodshed Initiative (http://urbandesignlab.columbia.edu/) and OECD Sahel and West Africa, 2013)



In 2014 the Food Atlas of the Netherlands was published. This Atlas gives an interesting overview in maps and charts about the different entry points, relationships and scales within the food system.

(Noordhoff Atlasproducties, 2014)



Land, water, air, energy ... and food

The (urban) food system is complex and deals with numerous feedback loops, dependencies and - undoubtely- is connected with the spatial organisation and issues (spatial?). A quick dive into the topic from an environmental perspective and relevance, easily brings this forwards:

Depending on the definition of 'urban' used, urban areas currently cover only 1 to 3% of the land (Liu, 2014), with regional differences. The expectation is this will increase in the upcoming decades to up to 10%. This will lead to actual loss of agricultural land, but also effects land and productivity via fragmentation and land degradation. And what to think about the increasing demand for land for land fillings in relation to urban food waste, which not only is another competing land claim, but also effects soil conditions and quality in and around urban areas.

Much of the world's most productive farmland is directly threatened by urbanisation, directly or indirectly. Over 40% of the world's cropland and 60% of world's irrigated cropland is located in peri-urban areas, the land within a 20 km radius around "urban boundaries" (Bren d'Amour, 2017; Thebo, 2017). Nevertheless, land is crucial production factor to feed the cities also in the future. The share of land required for food production for the urban areas is substantially increasing (G. Li, 2013). The number of urban residents depending on each farm will almost double (Proctor, 2016) and the available land per capita will drop to 0.19ha average to 0.14ha in developing countries (in 1960: 0.42ha) (Silva, 2018). It comes almost without saying agricultural activity and productivity should increase to meet the demands, but figures already show that the total factor productivity cannot keep up (GAP, 2018) and the increase in productivity often comes with challenges for sustainability.

It is also interesting to notice that the domestic production, the regional food shed and urban-rural linkages are of utmost importance (Figure 3a and b). As Vorley and Lancon mention: "the prevailing picture of urbanisation being associated with rapid growth of import dependence is inaccurate" (Vorley, 2016), nevertheless there is a need for an integrated and inclusive food approach to sustain and develop. Besides, the informal part of the food system should be included, which challenges policy makers and (spatial) planners due to lack on vast information and understanding.

It is estimated that by 2050 1.9 billion dwellers will be confronted with seasonal water shortage and water demand will increase with 50-70% over the next decades (WorldBank, 2018). The WorldBank states "Although many cities understand the strategic importance of sound water management, many urban water utilities remain unaware of these challenges, mired in linear and narrow engineering approaches". If we put this in the perspective of food, one could see that besides land, water is a crucial factor for production, but also essential for transport, storage, processing and utilisation of food.

Up to 70% of global water use is accounted to agriculture. But also 90% of global power, crucial for instance cooling or utilisation, is water intense! As such, both water stress, weather extremes and water competition will challenge the (urban) food system at different points, between the urban areas and their hinterland and between sectors. These water challenges will also affect further land degradation. And again, also on the domain of water urban food waste management is important. The increasing flow of urban (food) waste often leads to disturbances and qualitative challenges in the (urban) water system.

Besides, cities are also believed to alter (qualitative and quantitative hydrological and climatic effects in the wider region. Cities can influence weather. Urbanisation boosts shifts in precipitation and evaporation (Gober, 2010, Grimmond, 2011, IPPC, 2014) and have an impact on the productivity of the hinterland. Also the effect of urbanization on air quality has a direct effect on productivity, for instance due to extreme smog levels.

The above is just a glimp of the interwoven relationships between food and the environment, but already puts and emphasis on enhancing the understanding. There are many entry points (Figure 4), but despite which entry point chosen we should always consider the full picture. The best way to do that is to put it in a spatial-environmental perspective; the landscape. This is where it all comes together and makes it concrete.

2.3 Spatial planning: the missing link?

It is stunning to notice that already in 2000, almost two decades ago, Pthukuchi and Kaufman (2000) called the food system a stranger in the planning field. They mention that 'air, water, shelter and food are among the essentials of life, but food has been virtually ignored by planners'. And still, 20 years later, food is still not commonly included in spatial planning actions and physical planning policy choices. The planning community still struggles with the complexity and the multileveled/multi actor (governance) and multi scale (spatial) nature of these phenomena.

Spatial organisation and features have a significant impact on the food system, its reliability, vulnerability and its outcomes. And these outcomes also effect other planning domains. Spatialisation serves as "a lens for analysing food as part of the urban metabolism with flows between components and interfaces with other relevant thematic fields of urban planning" (Kasper, 2017). Distinguishing five spatialised urban food system components, which link closely to the other frameworks used (FAO/RUAF, WUR), production, processing, distribution/access, consumption and disposal/valorisation serves as a framework for analysing and understanding the (complex) systemic linkages and processes with regard to food and the city. As such, food should be considered as an urban (trans-sectoral and interactive) infrastructure -corresponding to water, waste and energy- which can be tracked down in its spatial manifestation and to spatial entities (Kasper, 2017).

> *"The spatial component of work allows for more detailed rather than general discussions" (Blackett et al, 2007).*

Although at different places food is set on the agenda, the how question and the linkages with other domains, like climate and water, are poor. Food is still often treated separately and is not explicit part of other strategies. It is important to align territorial planning and food policy (BCFN, MUFPP (2018); FAO, 2019). Building integrated visions, shared interventions, within the diversity of socio-geographical contexts and in full perspective; so across borders. Spatial planning and the food systems is challenged by the complexity, but also with uncertainties and the huge dynamics. The power of visualization and mapping should not be underestimated; not only for understanding, but also for envisioning.

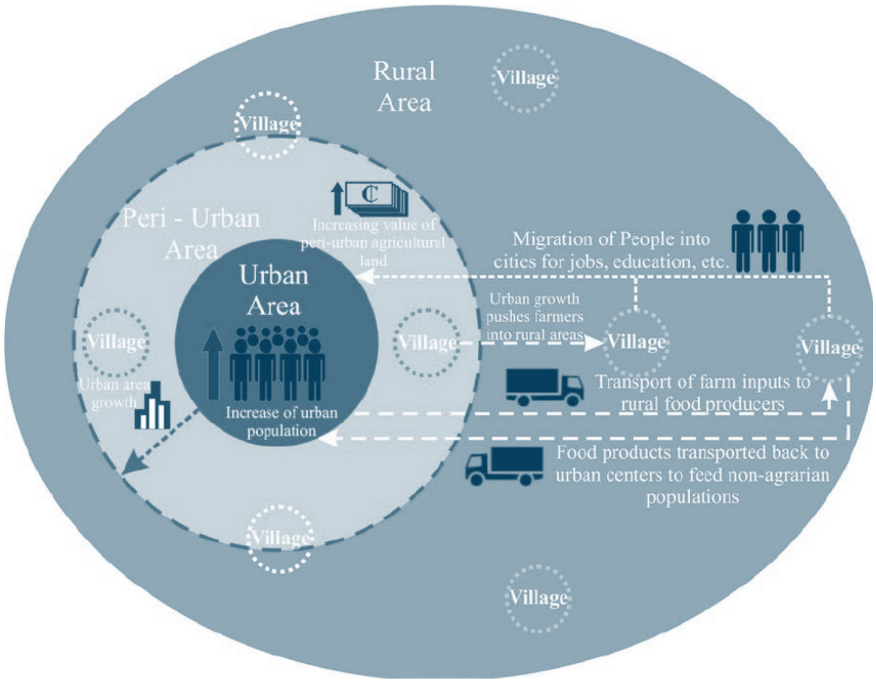


Figure 4 *Urban-Rural interrelationships with the food system (Kuusaana, 2013)*

3 Review spatial analytics and indicator sets

This research has reviewed a selection of food system analysis. Against the background that the spatial component is important - as well in the analysis as in the way it is presented and maintained -, it will help in further common understanding of 'urban' food systems and bring integrated solutions more in range.

For this project we have made a review of a wide variety of these food systems, based on their relation with spatial phenomena and planning (decision support systems). Though further reviewing is necessary, this first attempt shows some valuabe results for the Knowledge Base.

3.1 FoodMetres/ Evidence-based Food System Design

3.1.1 General description

The project 'Food Planning and Innovation for Sustainable Metropolitan Regions' FOODMETRES (Wascher, 2015) thrives to assess both the environmental and the socio-economic impacts of food chains with regard to spatial, logistical and resource dimension of growing food as well as food planning and governance. FOODMETRES uses food-chain characteristics (such as environmental and performance indicators) to assess the "land footprint" of urban food consumptions in terms of the socio-economic and environmental impacts.

The main goals are:
- Identify opportunities for food chain innovation at both the local-regional as well the large-scale metropolitan level;
- Assess the economic, environmental and social impacts of food chain systems by means of ecological footprint and product life cycle analysis;
- Study and compare technical, logistical, organisational and governance aspects of innovative food chain systems in selected case studies in Europe and Africa;
- Develop and provide scenario modelling and impact assessment tools in support of stakeholder interaction and policy making;
- Apply knowledge brokerage techniques to speed up innovation and innovation exchange within the case studies.

In industrialised countries, Food Chains receive the increasing attention of society, since they relate to questions of sustainable production: here, considerations such as the ecological footprint, the origin of food, transparency of the value chain, underlying agricultural business models as well as the role of (metropolitan) regions are closely interlinked. The relationship between these different factors can be interpreted in form of the so-called 'Food-Triangle' in which food chains take a key position between food safety, accessibility/availability as well as landscapes and ecosystem services on the one hand and food quality as a matter of ethical considerations on the other hand. The Food Triangle is not only a way of defining functional relationships, it clearly postulates that food is also about ethics, and that FOODMETRES is designed to give to also address ethical questions on the intricate relationships that exists between food, the environment and people.

3.1.2 Spatial Focus

Main aim of FoodMetres is to foster a spatially explicit approach towards food planning and innovation for sustainable metropolitan regions. Funded by the European Union, the project has involved 18 academic and business partners who engaged in a variety of research, tool and capacity-building exercises. The project incorporated an international dimension as well as focussing on concrete cases at the regional level in and around the cities of Rotterdam, Berlin, London, Milano, Ljubljana and Nairobi. The spatial focus of Footmeters is the peri urban scale, or metropoles with their hinterland.

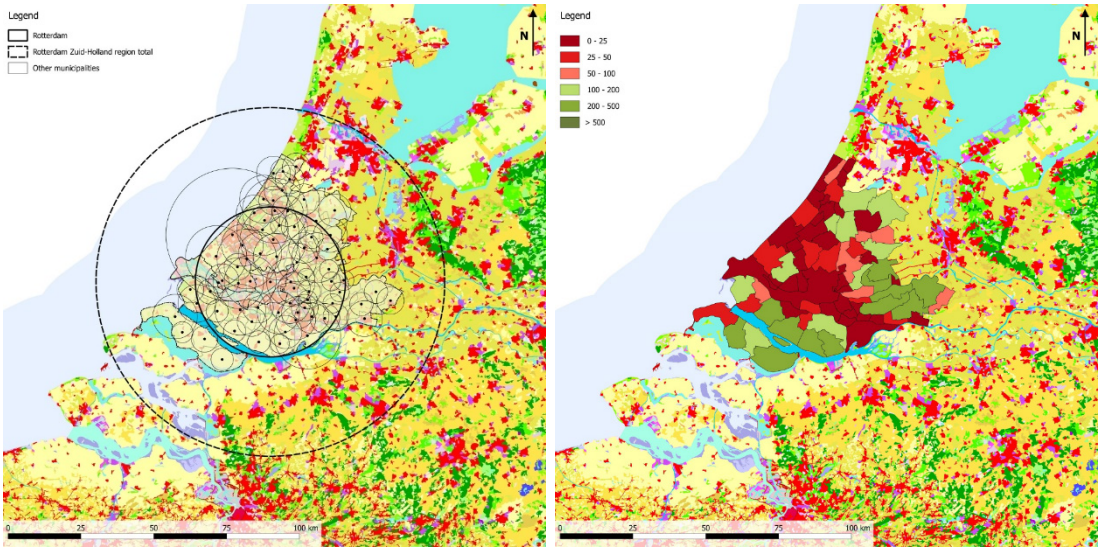


Figure 5 *Rotterdam Area demand conventional food production (l) and Self-sufficiency level at municipality level (r)*

3.1.3 Food system focus

Main aim of FoodMetres is to foster a spatially explicit approach towards food planning and innovation for sustainable metropolitan regions. FoodMetres addresses food chains of regional food supply in metropolitan regions. It distinguishes three different sorts of chains: Long Global -, Long Regional- and short Regional Food Chains.

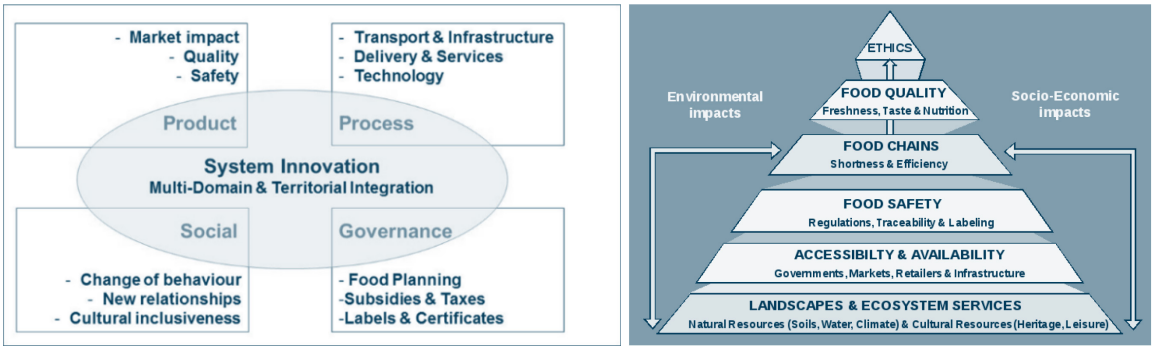


Figure 6 *System Innovation (Multi Domain and Territorial integration (l) and the Food Triangle (r)*

The project has developed a Sustainability Food Impact Assessment (SFIA) with a focus on impacts of different food innovation within the different dimensions of sustainability.
The objective to spatially analyse the footprint of metropolitan food supply implies two specific challenges, which require the application of different methodological approaches – (i) The analysis of the spatial extent of the agricultural area required for food production ("How much?"); and (ii) the distribution of the various land use types, which are required for food production ("Where"?). Both modelling approaches feature not only methodological differences, but also in terms of input data, modelling rational and the degree of stakeholder interaction. However, both models apply a common spatial understanding of minimizing the distance of food production and consumption location (urban core), resulting in an idealized circular representation of food zones, comparable to the renowned model by Heinrich von Thünen (1826) about the spatial distribution of agricultural commodities as a function of transportation cost to the central market.

The project of Evidence-based Food System Design is building up on the methodology of FOODMETRES and collects data in the context of ecological footprint, city metabolism and city infrastructure. The method focuses on land use analysis and the development of design proposals for Smart Urban Food Districts in Amsterdam (Park21 / Haarlemmermeer), Milan (Porto di Mare) and Lisbon. (EFSD-AMS, 2018).

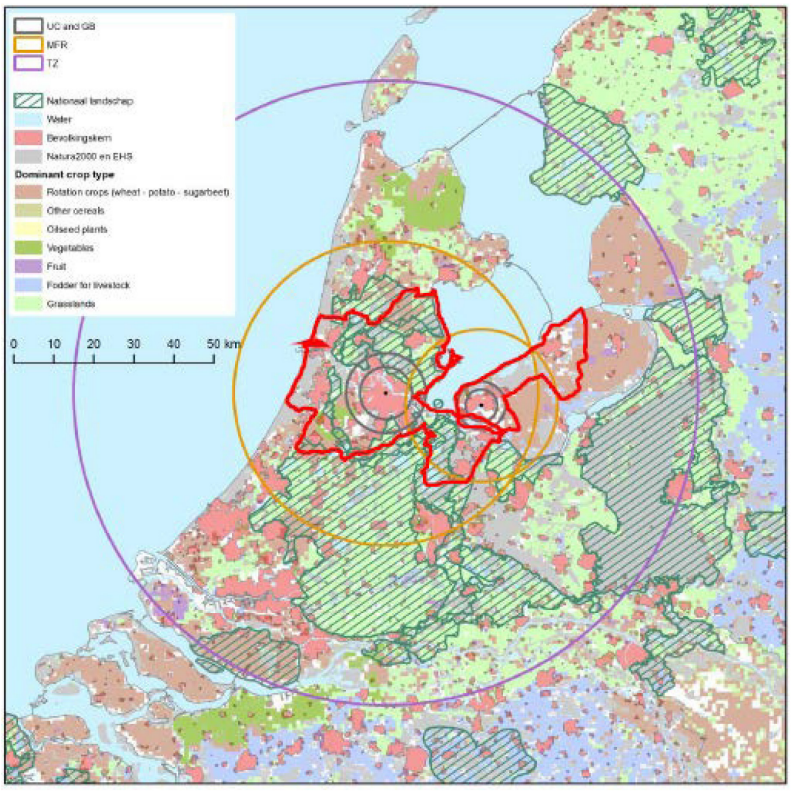


Figure 7 *Food print Map Amsterdam EFSD, 2018*

3.1.4 Data availability

In the FOODMETRES approach, the question of the area demand for food supply is addressed by the Metropolitan Area Profile and Scenario (MAPS) tool, which adopts a straightforward data-driven approach of connecting regional food demand (local hectares) with the regional area productivity. Its main strengths are (1) the spatial representation (mapping approach), (2) model differentiation of commodity types, (3) the ability to apply different food production regimes (e.g. organic farming, food loss) and consumption patterns (e.g. vegetarian, healthy diets) or population scenarios, and (4) the analysis of theoretical self-sufficiency levels at different administrative levels.

The Metropolitan Foodscape Planner (MFP) offers (1) hands-on impact assessment allowing stakeholders to re-allocate commodities on a digital map table, (2) quantification and geo-referencing of up to 10 commodity types at the scale of 1 hectare-grids, (3) the analysis of self-sufficiency based on a regional concept consisting of four metropolitan food zones, (4) landscape-ecological allocation rules to base land use decisions on sustainable principles, and (5) European data such as EFSA, LANMAP, HSMU and CORINE Land Cover to allow future top-down tool applications for all metropolitan regions throughout the EU.

The MAPS and MFP tools are accompanied by the economic assessment of the Metropolitan Economic Food Balance (MEFB) tool, which is aimed at understanding how economic dimensions of agricultural systems are linked one another into a complex structure. Based on the calculation of quantitative elements expressing the relation between food production and consumption at staple food level, such an approach reveals the chances of getting them closer and serves as a tool for the assessment of performances of regional agro-food systems (Figure 8).

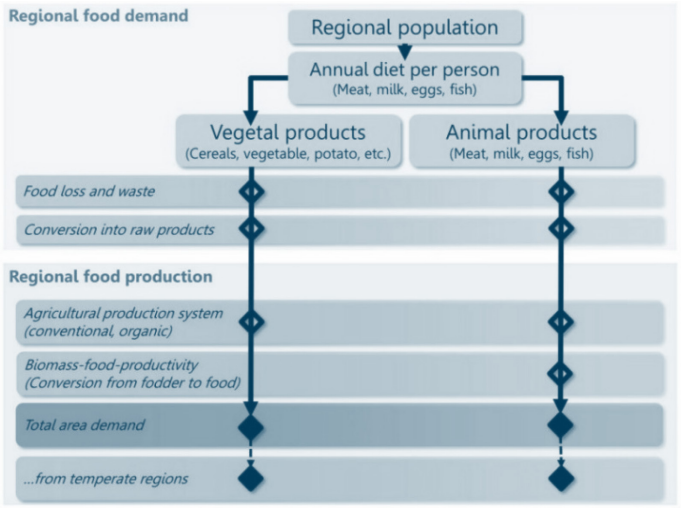


Figure 8 *Demand analysis for the case study area Berlin-Brandenburg as developed for MAPS (source: http://www.foodmetres-kp.eu/)*

The EFSD-project also developed an online map with food actors in the Metropolitan Region of Amsterdam (Figure 9). The interactivity is limited, but it provides a good overview of different actors and categories and the spatial division. The map is an addition to the EFSD demand supply method, providing an overview of the various food chain stakeholders.

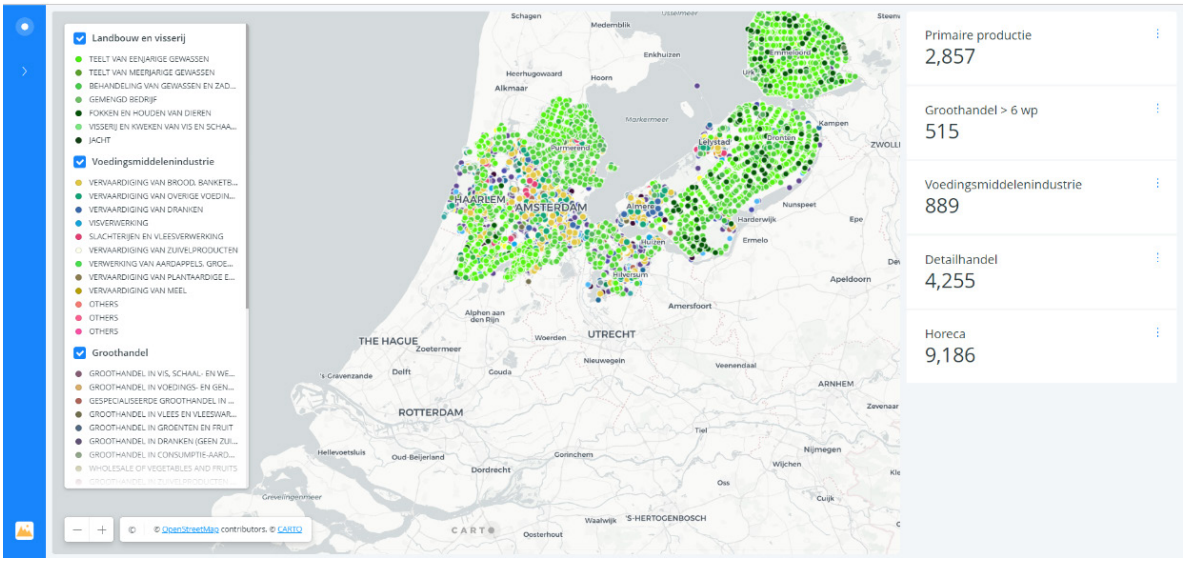


Figure 9 *Screenshot MRA Food actors map*

3.1.5 Conclusion

The method developed in FoodMetres/ Evidence-based Food System Design provides insight in the supply and demand of food for metropolitan areas and the associated footprint. It offers tools for interactively designing innovative sustainable food systems for peri-urban areas. The method is driven by land use data and knowledge of the urban food system. In the most recent report of EFSD the key recommendation is given to invest in the creation of a data platform, where information is stored and made accessible.

The EFSD method requires on the supply side data on land use. The more differentiated the data, the more accurately an estimate can be made of food production. For the demand side, there are no spatial requirements, different from the number of inhabitants in the area concerned. Generic data is needed to determine what quantities are required per part of the diet.

3.2 CGIAR Atlas of West African Urban Food System

3.2.1 General description case study

The "Atlas of West African urban food systems: examples from Ghana and Burkina Faso" (Karg and Drechsel, 2018.) summarizes recent advances in interdisciplinary approaches and research to address the different components of West African urban food systems, including urban and peri-urban agriculture. It thereby draws on the results of several major collaborative research projects and stakeholder consultations conducted in West Africa over the past two decades, and in particular on the UrbanFoodPlus project in Ghana and Burkina Faso (www.urbanfoodplus.org). The publication targets with its innovative design a broad range of stakeholders.

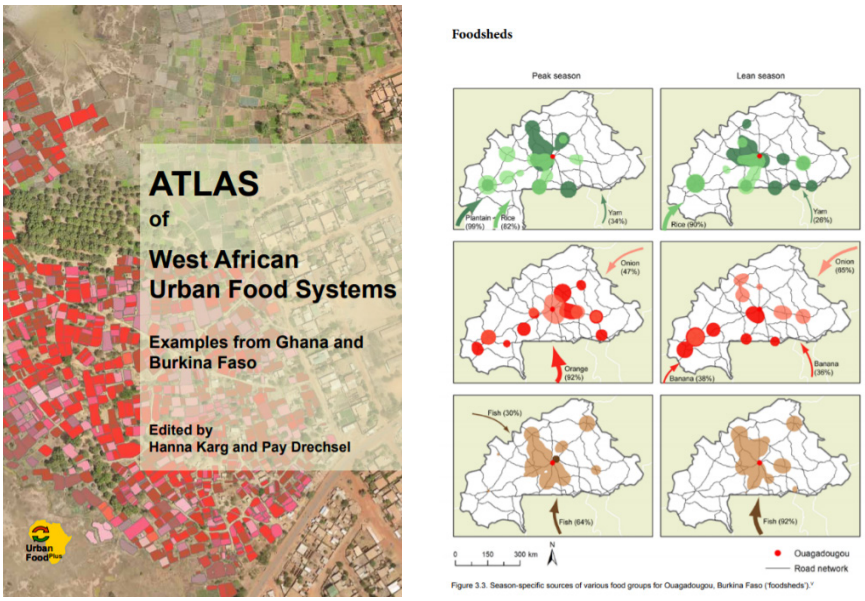


Figure 10 *Atlas of West African Urban Food Systems*

The study comprises a background chapter on urban development and four main chapters describing urban food system activities that start with urban farming activities in Tamale and Ouagadougou. Urban food supply includes food flows and supply challenges. The chapters on markets and consumption give insights into retail markets and changing consumption patterns. The last chapter provides insights into stakeholder dialogues, a process which has accompanied the project from the very beginning.

3.2.2 Spatial focus

The focus of the study is on the peri-urban scale level and wants to give an impetus to urban agriculture. It presents findings of project activities in Ouagadougou, Burkina Faso, and Tamale, Ghana carried out between 2013 and 2017 and provides a selection of the comprehensive results generated by the project on food system activities, including urban production, distribution, marketing and consumption, in these cities in the context of rapid urban growth and planning challenges. Expanding urban farming in support of urban food supply requires formalizing landuse planning. But in many cities, rapid growth is disrupting the land market. Conflicts occur when traditional and modern land rights clash. The first step to improved land use planning in growing cities is to address such conflicts in a timely and transparent manner.
Urban farming links and supports many urban development objectives. The complexity of the urban institutional environment calls for multi-stakeholder dialogues to address farming-related challenges and opportunities through a participatory planning process. Local nongovernmental organizations (NGOs) can be instrumental in facilitating related dialogues, ideally supported by action research for informed decision making, as exemplified by the GlobE UrbanFoodPlus project.

3.2.3 Food system focus

Up to half of urban food needs, covering the main food groups, is met from smallholder farms within an average radius of about 100 km from the cities. The analysis of these urban 'foodsheds' allows to determine the nature of 'rural–urban linkages' and the relative contribution e.g., of urban farming, which has a particular role in the supply of fresh crop and livestock products that easily spoil if transported over longer distances.
The longer the food supply chain cities have, the higher the risk of disruptions, for example through flooding or droughts, which can significantly affect food prices. A larger geographical diversity of food sourcing areas helps to enhance the resilience of urban food systems. In addition, infrastructure investments, such as storage facilities for key commodities, can help buffer shocks.

3.2.4 Data availability.

Besides providing data, the authors of this atlas want to stimulate discussions about the role of the different stakeholders and provide a framework for site-specific analysis and action rather than a one-fits-all blueprint. Bringing urban food systems out of the shadow of illegality is necessary as they provide nutritious food, jobs, biodiversity refugia and open green spaces in often overly busy cities throughout sub-Saharan Africa. Hence the emphasis of the study is on local research providing a framework for site-specific analysis.

3.2.5 Conclusion

The study gives examples of urban food systems in Western Africa, its specific uncertainties and disruptions and the positive role that urban agriculture can play in this. It can be labelled as a method for tailor-made interactive urban food planning, the scope for other areas is therefore limited.

3.3 Maryland Food System Map

3.3.1 General description case study

The Maryland Food System Map is an interactive mapping platform with data on the food system, the environment, and public health of the Maryland region (https://mdfoodsystemmap.org/). In contrast to the previous examples this not a study are method, it is a data platform that provides information about the regional food system, from local farms to grocery stores, layered with land use, health, demographic and social services data. Users are able to explore what is most interesting to them or to view the food system by neighbourhood, city, or state. Data from a vast range of sources have been compiled into this "collective resource" and are continuously updated through collaborations with students, organizational partners, and government agencies. The mapping application allows users to explore data to better understand geographic patterns and trends in their community, create their own maps, or download data for their own research and planning.

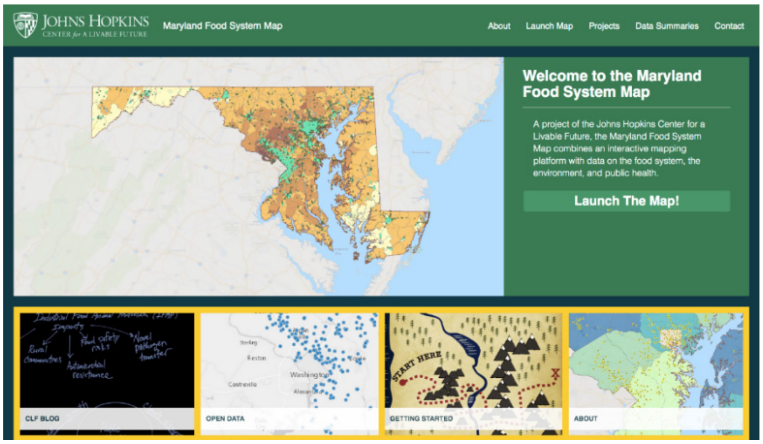


Figure 11 *Maryland Food System Map*

3.3.2 Spatial focus

The Maryland Food System Map shows all kind of Food System related data of the region around Baltimore. It provides data on: Agriculture, Aquaculture, Community Resources, Demographics, Environmental Indicators, Food Retail, Health, Institutions, Land Conservation, Nutrition Assistance, Processing & Distribution.

3.3.3 Food system focus

The first version of the Maryland Food System Map in 2012 consisted of 30 data indicators. Since then, the number of data indicators has increased to over 175. These data are collected from government databases, partnerships with organizations and through primary data collection and compilation. An updated version of the mapping application was released in 2017. New features of the mapping application include data filtering capabilities, as well as measure, search, and sharing tools. The website connects users to CLF's open data platform where they can search, view, and download all 175+ data indicators, and the application is now available on tablets and mobile devices.

3.3.4 Data availability.

The Maryland Food System Map can be seen a platform to exclude food system related data or a food system related GIS for Baltimore and its surroundings. There is a lot of data behind it and the application can easily be expanded further.

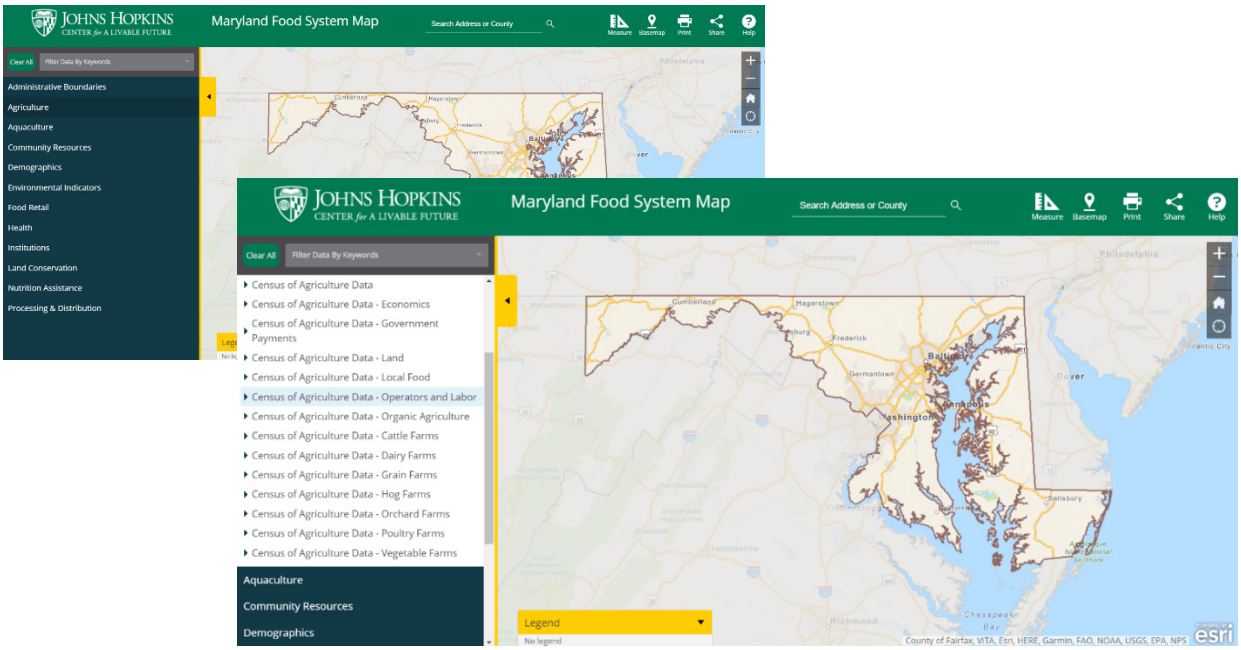


Figure 12 *Maryland Food System Map*

3.3.5 Conclusion

The application is very helpful to generate data of the regional food system of Maryland but is limited in terms of better understanding the impact of the food system since it shows merely 'flat' data. The portal looks especially useful for people who want to study the regional Food system of this region.

3.4 FAO City Region Food System Programme

3.4.1 General description

The City Region Food System Programme (CRFS) of FAO and RUAF Foundation aims to build sustainable, resilient and dynamic city region food systems, by strengthening rural-urban linkages (FAO, 2016). The programme provides assistance to local governments in identifying and understanding gaps, bottlenecks and opportunities for sustainable planning, informed decision-making, prioritizing investments, designing sustainable food policies and strategies to improve local food systems.
The international community urgently needs to better define its role and develop tools and methodologies to address the challenges of food and nutrition security, agriculture and management of natural resources in a context of urbanization, one of the major challenges of the 21st century. Moreover, there is the need to enable local authorities to ensure governance of dynamic and sustainable food systems, contributing to the realization of the right to food and to the promotion of sustainable diets, with strong urban-rural linkages and enabling the involvement of all key local stakeholders, with particular attention to smallholder farmers and local authorities. Although considerable progress has been achieved, more collaborative cooperation is still needed to deal with the potential hazards caused by the rapidly growing urban population and fragile food systems.

The CRFS programme focuses on:
- Strengthening capacity of local actors within a local food system;
- Strengthening rural-urban linkages for more inclusive, efficient and resilient activities of small-scale agriculture;
- Fostering participatory multi-stakeholder dialogue process to build ownership of actors, and
- Scaling up practices.

3.4.2 Spatial Focus

CRFS assessments are conducted in each city region to identify the gaps to be bridged and the bottlenecks to be opened for creating more sustainable and resilient food systems. Special attention is given to improving the vulnerable and poor urban population's access to adequate food, and to improving market access for smallholder farmers in urban, peri-urban and rural areas. Further assessments on the evolution of food systems, existing food policies, and urban development are carried out to better adapt to local conditions.

A city region is defined as: "as larger urban centre or conglomeration of smaller urban centres and the surrounding and interspersed peri-urban and rural hinterland". Although contexts differ across cities and regions, such urban-rural partnerships and inter-municipal cooperation always extend beyond traditional administrative boundaries. A CRFS is defined as "all the actors, processes and relationships that are involved in food production, processing, distribution and consumption in a given city region".

3.4.3 Food system focus

A CRFS is defined as "all the actors, processes and relationships that are involved in food production, processing, distribution and consumption in a given city region". Through a scenario building exercise, CRFS provides support to local governments to elaborate, through multi-stakeholder dialogues, strategies and action plans to improve the city region food systems. A strong commitment from local authorities and the involvement of all key stakeholders is necessary to ensure the success of the city region food system approach.

3.4.4 Data availability

The CRFS toolkit provides guidance on how to assess and build sustainable city region food systems. It includes support material on how to: define and map your city region; collect data on your city region food system; gather and analyse information on different CRFS components and sustainability dimensions through both rapid and in-depth assessments; and how to use a multi stakeholder process

to engage policymakers and other stakeholders in the design of more sustainable and resilient city region food systems.

The toolkit outlines the approach, techniques and tools used by seven cities that engaged in a CRFS assessment and planning process in the period 2015-2017:

- Colombo
- Lusaka
- Kitwe
- Medellin
- Utrecht
- Quito
- Toronto

The way the CFRS is visualised is highly depending on the individual choices that have been made throughout the participatory process, starting with setting together the boundaries of the local city region and the city region food system. Different criteria are used, like main sources of food and food flows, natural boundaries, administrative or jurisdictional boundaries.
The CFRS toolkit explains why and how this process has been implemented and what outcomes have been achieved. It is meant to be a resource for policymakers, researchers, and other key stakeholders and participants who want to better understand their own CRFS and plan for improvements.

The CRFS assessment is aimed to help strengthen the understanding of the current functioning and performance of the city region food system. It forms the basis for further development of policies and programmes to promote the sustainability and resilience of CRFS.

In the first evaluation the project cities encountered several constraints of which limited data availability is one of the top issues.

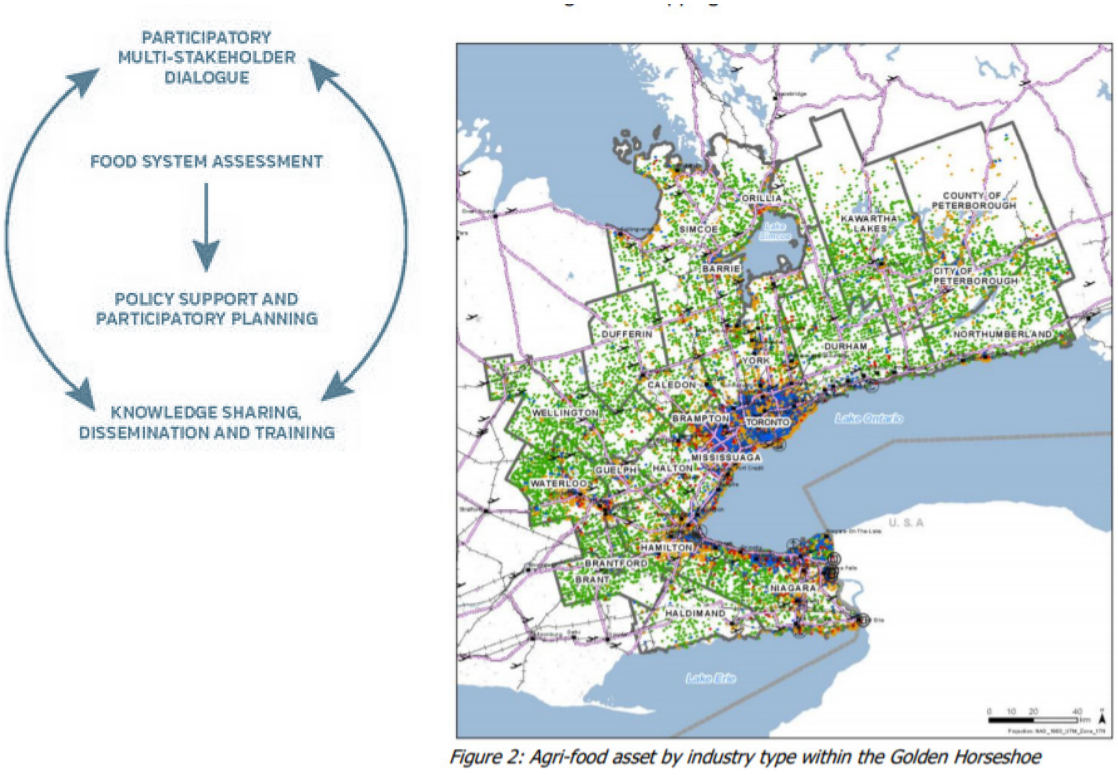


Figure 2: Agri-food asset by industry type within the Golden Horseshoe

Figure 13 *Example Asset mapping case Toronto*

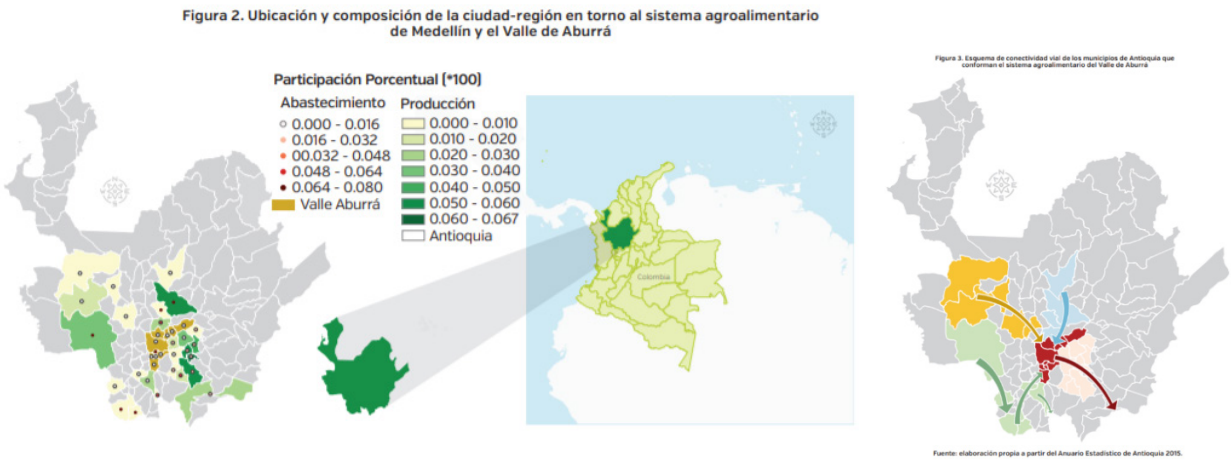


Figure 14 *Example Graphical representations case Medellin*

"The CRFS research illustrated the significant challenges arising from the dearth of data on, and empirical analysis of, food systems. Even in "data-rich" environments like Toronto, specific food system data was either not available, outdated or only available for specific jurisdictions (the city, the province), but not for the city region.
A combination of secondary and primary research was used to complement missing data. Stakeholder interviews and focused case studies provided needed additional sources of information and analysis. Meeting this challenge will also require first identifying and prioritizing the data, analysis and information needs, and, second, determining the multiple, innovative and efficient ways to systematically collect and analyze this data to produce the information required for decision-making. "

Dubbeling, M, Santini, G, City Region Food System Assessment and Planning, RUAF Urban Agriculture magazine, No.34, May 2018

3.4.5 Conclusion

The CRFS projects is a good hands on method to assist local governments in identifying and understanding gaps, bottlenecks and opportunities for sustainable (food) planning, informed decision-making, prioritizing investments, designing sustainable food policies and strategies to improve local food systems. Nevertheless, they address the need of a systemic data approach, which could be helpful supporting the process and a better understanding.

Besides the data challenge, also the multilevel and cross-boundary planning approach is mentioned.

"Interaction and coordination are necessary between different levels of governments (larger and smaller cities in the city region, city and provincial/national government). Many provincial/national programmes still prioritise rural over urban or city regional development. Smaller cities in the city region often have less human and financial capacity for intervention than do larger cities. Urban and rural authorities, and city level versus provincial authorities, may not have much history of engaging in joint policy and planning, especially when different political orientations are at play. From the start of the process, specific training, attention and time efforts have to be put in place to facilitate such coordination, horizontal and vertical policy integration."

Dubbeling, M, Santini, G, City Region Food System Assessment and Planning, RUAF Urban Agriculture magazine, No.34, May 2018

3.5 Dhaka

3.5.1 General description

Currently, Wageningen University is working on the project 'Support for Modelling, Planning and Improving Dhaka's Food System', in close cooperation with FAO and the City corporations of Dhaka City. The aim is to form a new Dhaka food policy council, with stakeholders from local City governments, knowledge institutes, civil society and private sector. Policy makers will be provided with better knowledge, tools and skills to perform successful urban food policy planning. With interactive models, stakeholders will be able to work on future policy scenarios and decide on interventions.

The Dhaka Metropolitan Area is currently home to more than 18 million people. However, by 2030, the population is projected to reach 27.4 million, an estimated increase of 86 percent over the population in 2010. Not unexpectedly, the rapid pace of urban development in Dhaka is leading to substantial environmental degradation and numerous social issues arising from unemployment, poverty, inadequate health care services and poor sanitation. Rapid population growth and urbanization are putting pressure on adjacent agricultural lands, water bodies, forest areas and wetlands. A natural consequence of such rapid urban growth is that peri-urban and rural lands are being developed for residential and industrial purposes. Risks associated with Dhaka's largely unplanned urban growth are being further compounded by rapid industrialization and inadequate infrastructure investments, especially in transport, water and drainage, and energy.

3.5.2 Spatial Focus

Agriculture producers and others involved in the food sector face a challenging paradox. With Bangladesh's population continuing to grow, a prosperous economy, growing demand for food, and about 45% of people engaged in agriculture-related livelihoods, farmers and producers still struggle to turn a profit. Numerous bottlenecks in the food system, such as lack of scientific post-harvest techniques, poor transportation networks that delay delivery of food, and poor information and communication, all contribute to inefficiencies that result in a variety of problems. Such problems include farmers losing revenue because animals become sick, retailers suffering losses because they are unable to estimate demand, and consumers having to pay higher than necessary prices for their food. While these problems appear solvable when isolated, it is difficult to do so because the steps and actors within the food system are so interconnected, and relationships between them are so complex. To successfully identify solutions it is important to first map out a food value chain -- this clarifies the relationships between stakeholders, identifies where challenges exist, and ultimately locates where policies and targeted interventions can contribute to greater efficiency and sustainability.

3.5.3 Food system focus

With population growth and the increasing pace of urbanization, new concerns around food security and nutrition are emerging. These include poor food safety, increasing obesity - especially among women and children - and the high cost of food and food preparation, especially for the residents of the informal low-income settlements. Despite improvements in food availability and access, levels of both chronic and acute under-nutrition remain at unacceptably high levels.

As the majority of foodstuffs are either produced in rural areas (predominantly by smallholder farmers) or imported, understanding the flow of food products to and within the DMA and the interactions between food producers, collector agents and traders, logistics service providers, wholesalers and retailers and the various regulatory agencies is necessary to facilitate the development of a safe, sustainable and resilient food system for the city of Dhaka. To support policy makers in the four city corporations that comprise the DMA information is required that identifies impediments and opportunities to improve the performance of the food system.

3.5.4 Data availability

Currently spatial data is collected. Together with stakeholders a preliminary data need assessment has been carried out. The biggest challenge is to gather the data, sometimes data is not available -due to lack or data or restrictions by data owners.

Table 1 *Dhaka case study: first inventory data needs*

Domain	Indicators	Relevant Institute	LGD data request	Ministry
Infrastructure	Road			
	Building footprint			
	Water body/River			
	Water pipeline network			
	Sewerage line			
	Urban farming (rooftop farming)			
	Sanitation inside the market			
	Electricity (load shedding)			
	Accessibility to health institutes (private and public)			
	Bazar/market place			
	Restaurants			
	Ware house/cold storage			
	Density of population			
	Income			
	Land use			
	Land cover			
	Future land use			
	Educational background			
Natural hazards	Flood			
	Earth quake			
	Rainfall			
	Temperature			
	Pest infestation/control			
Geo-physical	Soil quality/AEZ			
	Elevation			
	River erosion			
	Air quality			
	Noise pollution			
	Urban heat islands			
	Water quality			
	Fish farms			
	Poultry farms			
	Cattle farms			
	Industry and sewerage outlets, agri. Runoff areas			
	Garbage Dumping Site			

3.5.5 Conclusion

Participatory value chain mapping is the process of bringing together stakeholders from from the entire food value chain to document the different steps and flows taken that a commodity travels from the farm to the consumer. This does not only result in a map, but also in a nuanced understanding of the relationships between stakeholders, who include farmers, aggregators, wholesalers, processors, retailers, and customers, and initiates a dialogue between them. Such an activity is often the first time that all these stakeholders come together and discuss something they're all dealing with.

But the map is also an important first step in value chain analysis as it helps to show where products come from, the places they pass and the locations where they end up. Thorough mapping can reveal critical moments in the journey, or even show how passage at different times of the day or year might take very different amounts of time. Thus the participatory value chain mapping exercise is an important starting point for a more in-depth investigation of the food system, and one that recognizes the need to engage stakeholders directly to do so.

3.6 Review conclusion

In this review some examples where highlighted of spatial mapping of 'urban' food systems. The objective was to get insights in similarities and differences in the way the food system is projected and which structure and layers are presented. The selection of the examples is based on the linkages with common used frameworks (City Food Region System, Evidence Based Food System Design and the Milan Food Pact), geographical spread and expert judgement. The selection is not intended to be complete, given the many projects and examples that are available, that is hardly possible.

The main conclusions from this review are:

- There are many good examples of spatial mapping of (urban) food systems
- There is no general approach in the selection of geographical boundaries of the projections; different criteria or choices are made. Often administrative boundaries are at the basis.
- There is a high variety in the specific focus (production, consumption, ...) and (the way) legends/data sets are being presented, as such, most of the examples miss the overall view of the different elements of the food system. Often there is a specific selection of commodities or focus on consumption/accessibility
- Most projections are based on the current situation (situational analysis)
- Most projections miss (potential) spatial or environmental vulnerabilities (like flood risk, drought, land degradation etc) or elements of food system outcomes
- Most projections miss the opportunity to make own combinations/to have an interactive portal to address crucial linkages and dependencies
- Data availability and gathering remains difficult

There is a need for a common approach and supportive tools based on geographical data and insights, not just to analyse the current situation but also to include forecasting and trend analysis. This supports a more informed discussion and geographical shifts/choices. Nevertheless, the supporting tools should be unbiased, present available information and leave conclusions to the (end)users by providing a platform for discussion and integration. A comprehensive approach seems conditional to proper collection of data, analysis and full insights. It should also be clear what to do with potential data gaps.

4 Promising approaches and tools

The inventory and review of different spatial representations of food systems shows a high variety in the way it is represented and which elements are taken into account. Each representation has its own focus, covering specific parts of the food system. There is still little common ground or approach in representation and terminology. The examples also show a high variety in data availability, not only area-based but also thematically. Besides, possible vulnerabilities are often not included.

Nevertheless each representation underlines the importance of making the food system also spatially explicit. It provides extra insights and also addresses territorial differences and focus themes. The way data is projected, structured and classified is important.

It would value to use the food system framework (Van Berkum, 2018) as guidance towards a common Food system Atlas: an interactive atlas that could serve as a supporting tool for further understanding and interactive (planning) processes for the city region food system. All counters of the framework, from production, transport and value chain, but also accessibility and consumption, should be included, together with necessary spatial environmental and spatial socio-economic data. This could form the basis for an informed discussion on feedback loops and dependencies. This kind of supporting systems also proved value in other domains, like climate adaptation. In this chapter we outline these examples and the main important lessons learned from these examples.

4.1 Adaptation Labs: Climate effect atlases, Climate ateliers and assessments

The Climate effect atlases (https://www.climateadaptationservices.com/en/) and Climate Ateliers have proven to add value in the common understanding and planning processes regarding climatic effects and potential adaptation strategies. Just like food systems, climate change and its effects is a very complex issue which deals with many topics and themes. It also counters many scales that influence each other in many ways and comes with many uncertainties. Accessible and understandable information is extremely important to create awareness, common understanding and a solid basis for action. Responses should be context-specific and people-centred. As such, process and content are seen as equally important. The different tools are presented in a clear overall approach, named Adaptation Labs (WUR, 2016).

In the approach three elements are combined: Inform, Create and Consider; all in a development perspective and contextualized. The spatial component makes information and discussion more detailed and specific.

Inform
Accessible and understandable information is seen as extremely important to create awareness, common understanding and a solid basis for action. As a first step in the process climate effect atlases are set up. These interactive climate effect atlases bring together spatial data about climate change, adverse effects and socio-economic data, standard geographical data and planning data (plans/regulation). It is not represented in a static way, but an interactive way. Users can make their own decision in which combinations of layers to project. Data includes data about current situations, but also scenario-based projections or historic data. It invites to find trends, linkages and dependencies.

The atlases are made available online at dedicated websites, but the same data can also be used and represented on the same way in interactive pdf's or touch tables. As such it helps in interactive processes, but data is also made widely available, including the possibility of drawing own conclusions

and urgencies. The atlases are highly user-centred. Recently the atlases are also supported by supportive storylines (per subtopic) and narratives. The atlases and related GIS-products support both individual understanding and sensemaking as well as interactive group work and stakeholder participation.

The climate effect atlases were developed by the CAS Foundation in cooperation with different knowledge partners. In international projects local partners were included and appointed for the data management, to strengthen local capacities, outreach and ownership.

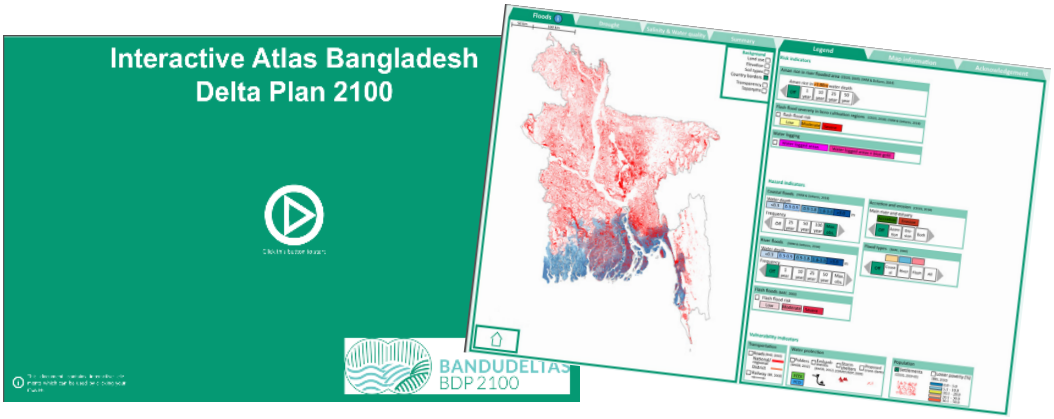


Figure 15 *Example of Interactive Atlas (interactive pdf)*

As for every atlas, the Climate effect atlas, depends on the correct setup, available information and the way the information is presented. All are also topic within the interactive planning process, from understanding toward envisioning. Early involvement of all stakeholders, make the alignment with daily practice better. Especially in the way the information is brought together, presented (interactive; non-judgmental; open) and is updated (maintenance). The Climate effect atlases seem not to have the intention to be complete or finished, but serve as a platform for further understanding and cooperation. In these complex matters being complete is almost hard to reach and while trying to be complete many windows of opportunity could also be missed already.

Create

Supported by the spatial data of the Climate effect atlas, Climate Ateliers and Adaptation Labs are organised. Most of the time, it is a sequence of Ateliers on different levels and in different areas, but well aligned. The starting point is to build common understanding and future perspectives together with all participants and stakeholders. That means working within a holistic, area-based and integrated approach towards inspiring, empowering and enabling perspectives. This boosts more energy and action and also clearly addresses the interdependencies and choices within the system. Nevertheless, also a clear breakdown structure is used to make comprehensive, viable actions, combining short term and long term, varying from enabling measures and policies to concrete operational projects and spatial planning activities. Key in the approach is direct translation and visualisation on premises; a design-approach. By doing so, one has to be more specific, it brings in the contextualisation, helps in developing a clear storyline and most of all it inspires.

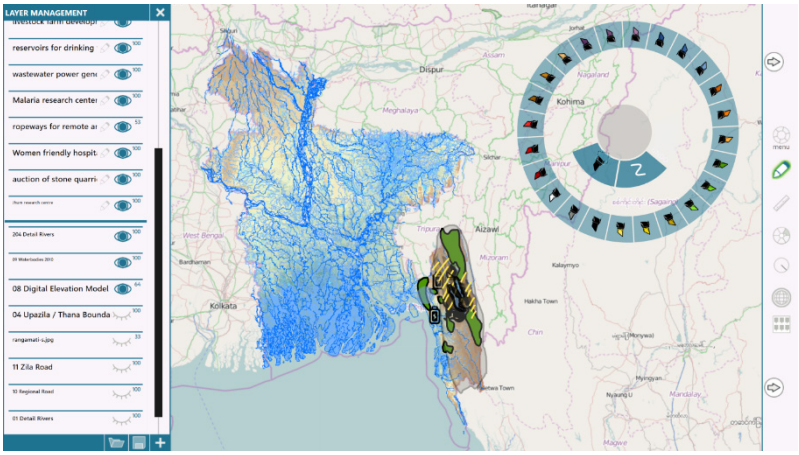


Figure 16 *Example of Touch Table (Phoenix)*

Figure 17 *Example of Touch Table use in Climate Atelier*

Consider
Recently, the approach is enriched with an easy method and tool to make first interactive assessments of the vision and measures that come up within the process. A rapid assessment based on qualitative indicators, for both overall strategies as specific measures, again stimulating an integrated view.

4.1.1 Lessons learned

The approach and the tools developed and used in the Adaptation Labs are very useful to come to a joint approach and supportive tools in understanding food systems and the city region food system.

The lessons learned that should be taken into account are:

- Building an open and interactive data portal (including related products) values. It is important data should be available or presented along a clear storyline and presented along clear categories supporting the overall storyline. The contextualisation (spatialized data) provides better insights. The spatial component values in interactive processes and makes choices more explicit.
- The data portal should be presented as a support system, which is updated regular and information can be added at all times (gradual development). It should also be clear where data is lacking or currently is the best data available (opening opportunities for better data acquisition or development).
- Data should be presented with a clear overall general structure according and based on a solid and shared framework (participatory).
- Tacit knowledge should be fully used. It can be used to validate data portal, but also to build new layers in the data portal. Within the design process tacit knowledge is highly valuable.
- The development of clear storylines supports data presentation and interactive processes.
- Both content and process are equally important.
- Most of all it is important to build local ownership and commitment. This is the fundament for future maintenance and full uptake.

4.2 QUICKScan

QUICKScan is a participatory mapping and impact modelling method that links stakeholder- and decision maker knowledge and preferences to available spatial and spatio-statistical data, and is designed for group use, in a multi-stakeholder workshop setting. QUICKScan was developed together with the European Commission in the early 2010's in their demand for an easy to handle research tool that is fast, simple and transparent, and that requires little data and can be carried out in a multi-actor setting (Verweij et al., 2016).

A QUICKScan within a food system assessment maps the natural resources system, natural risks (e.g. droughts and floods), the supply chain and it's actors including bottlenecks (e.g. in infrastructure, travel time, storage, or shortage of knowledge) and it explores alternative scenarios for the future and their likely impacts by addressing the following issues: 1) scope of the societal and environmental aspects with respect to spatial ambitions or risks (e.g. make an inventory of likely climate change projections and population growth); 2) describe typical 'pictures' of the past, actual condition and trends (e.g. map the location of current cropping areas, current and future suitable cropping areas, or changing diets); 3) identify the elements and interactions that are relevant for the persistence of these patterns, trends and impacts (e.g. urbanisation or intensification); 4) devise strategies and options to preserve, restore, use, improve, mitigate, or adapt (e.g. change crops or varieties, organise farmers, infrastructural works), and; 5) locate hotspot areas as targets for action (e.g. build water retention basins, dykes, or bridges to shorten travel time).

Each QUICKScan session follows a number of logical phases: a scoping phase to formulate key questions of the workshop, workshop preparation to select participants and available data, the workshop itself and reporting on results and observations.

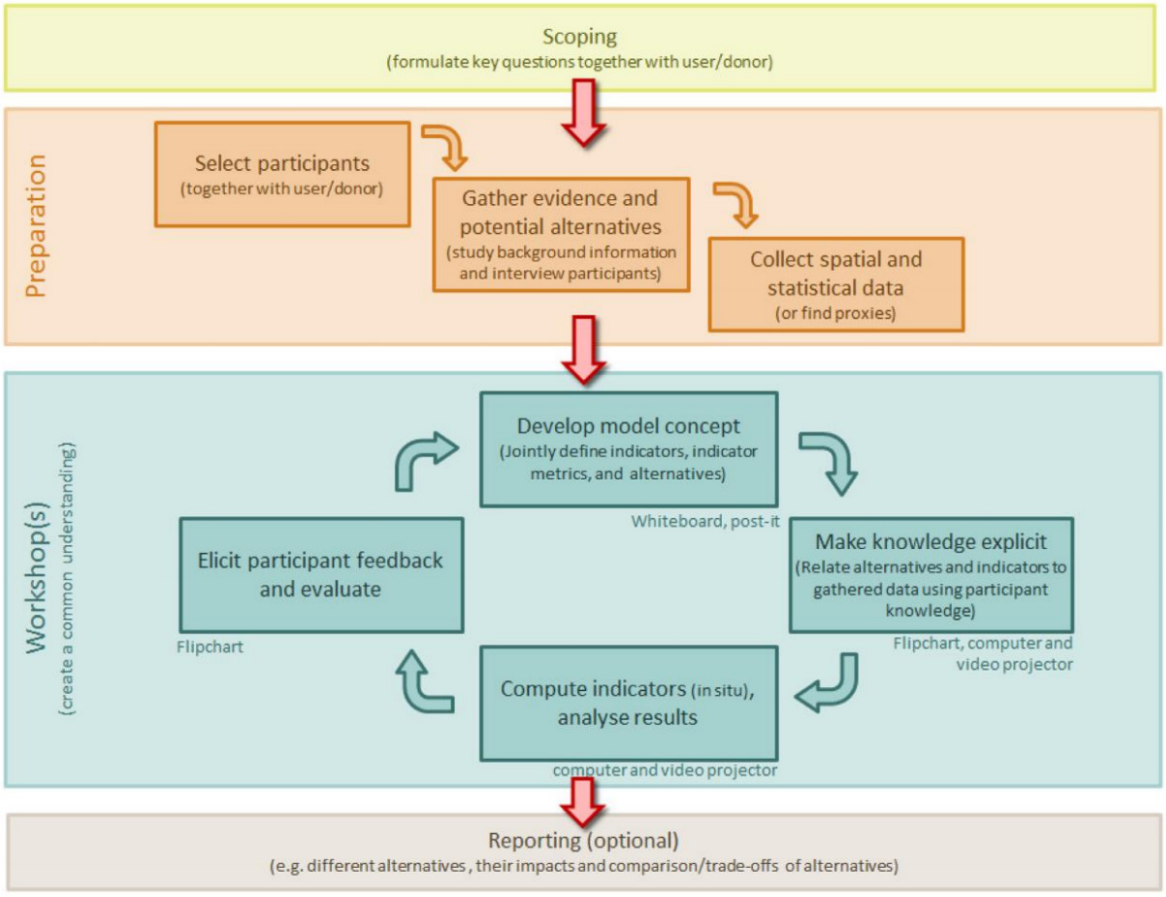


Figure 18 *Process scheme QuickScan*

4.2.1 Participatory spatial mapping

A scoping workshop with stakeholders may be used to conceptualise the food system and to map the natural resources subsystem (e.g. soil, water, biodiversity) with the activities at different locations and actors along the value chain: input supply, food production, processing and packaging, distribution and consumption (after Jacobi et al., 2019).

Figure 19 *Participatory mapping -joint fact finding and tacit knowledge*

Mapping is used as a diagnostic to understand a situation or a problem based on relationships between elements of some space and as a unifying context for actions. Typically these maps also include risks, like low production, transport problems, food waste and loss and conflicts (e.g. on land, or resources demand).

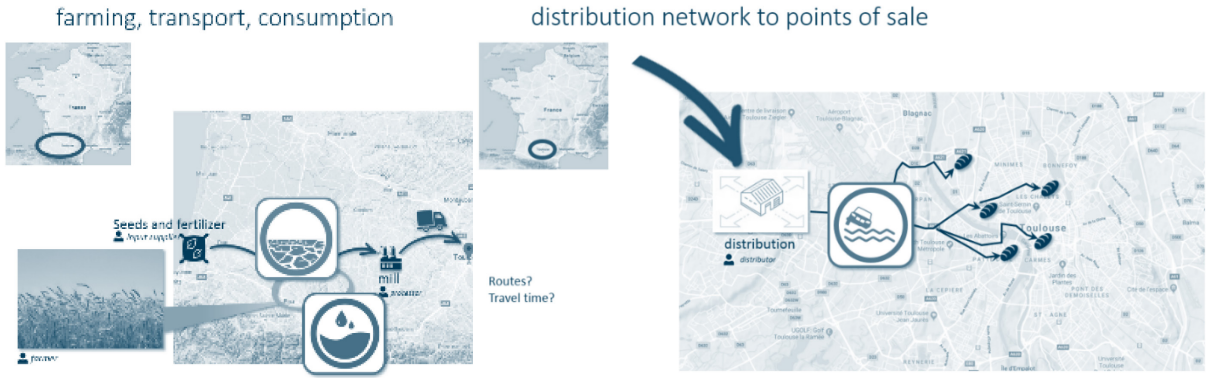
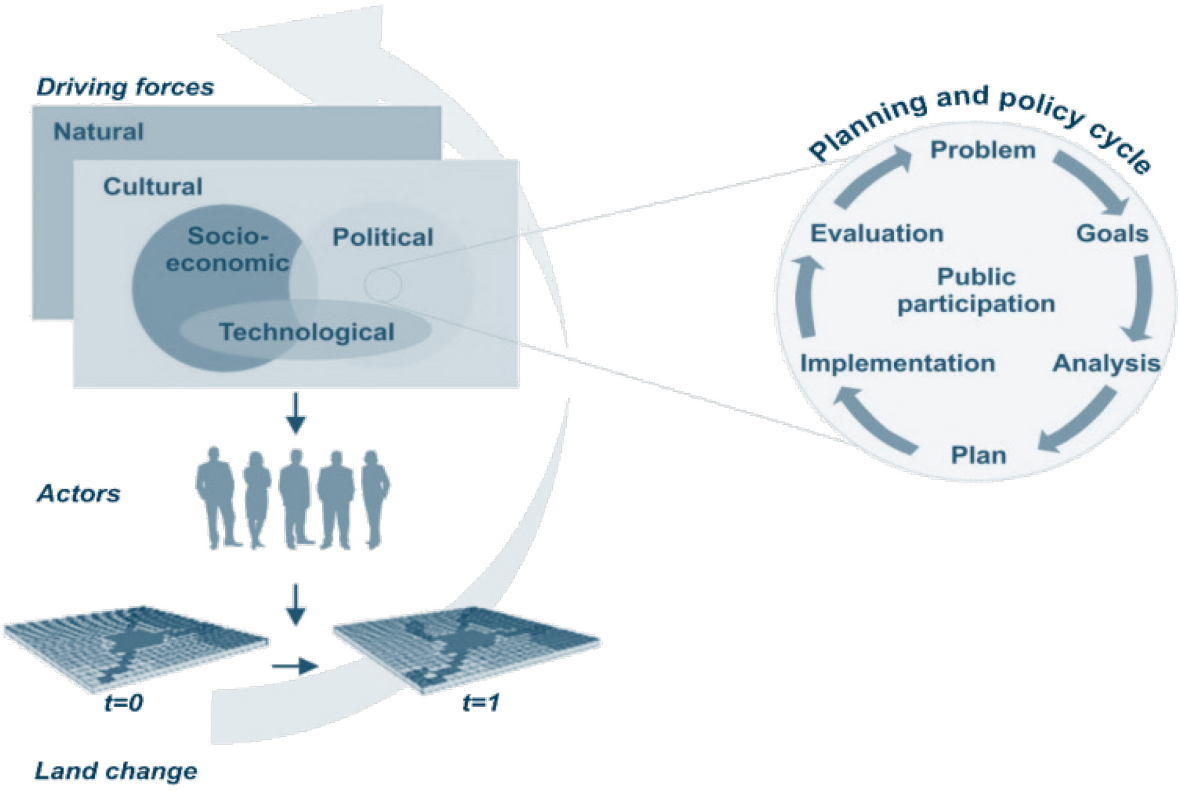


Figure 20 *Example Analysis on regional and local scale*

4.2.2 Participatory spatial modelling

Population growth, changes in population diet (incl. more meat which requires more space for growing fodder and feed), climate change and international politics (e.g. global market, trade-wars, BREXIT) put pressure on how land is used. Urban areas expand and occupy fertile agricultural lands, agriculture and forestry are becoming more and more crucial for energy production, forests are taken down for timber and space for urbanisation and agriculture, water is needed for agriculture, hydropower, drinking and washing and agriculture further intensifies to be able to deliver the huge quantities of food. Land use planning regulates policies and spatial planning in an effort to direct towards more desirable social, economic and environmental outcomes (OECD, 2017) and is a proposal as to how land should be used in accordance with a considered policy as expansion and restructuring proceed in the future. QUICKScan offers a method to jointly identify a problem and identify the impacts of potential solutions to the problem (see below figure, after Hersperger et al., 2018).



The following iterations of model conceptualisation are followed during the modelling workshop:

- Develop a model concept:
  The participants jointly make an inventory of relevant indicators, indicator metrics and alternatives; or compare different stakeholder perspectives.
- Make stakeholder knowledge explicit
  The participants relate indicator concepts to available data by building a causal chain of participants' knowledge.
- Compute the indicators
  The tool operator calculates indicator maps and summary charts as requested by the participants (e.g. averages per neighbourhood, or trade-off of a number of indicators per administrative unit).
- Evaluate
  The participants evaluate the performance of the indicators in a single alternative, or evaluate the performance of summaries of indicators across alternatives. The evaluation might trigger another iteration in which participants identify additional indicators, perspectives and refine knowledge.

The following figure illustrates a QUICKScan workshop and is an excerpt from a project on coffee production in Colombia.

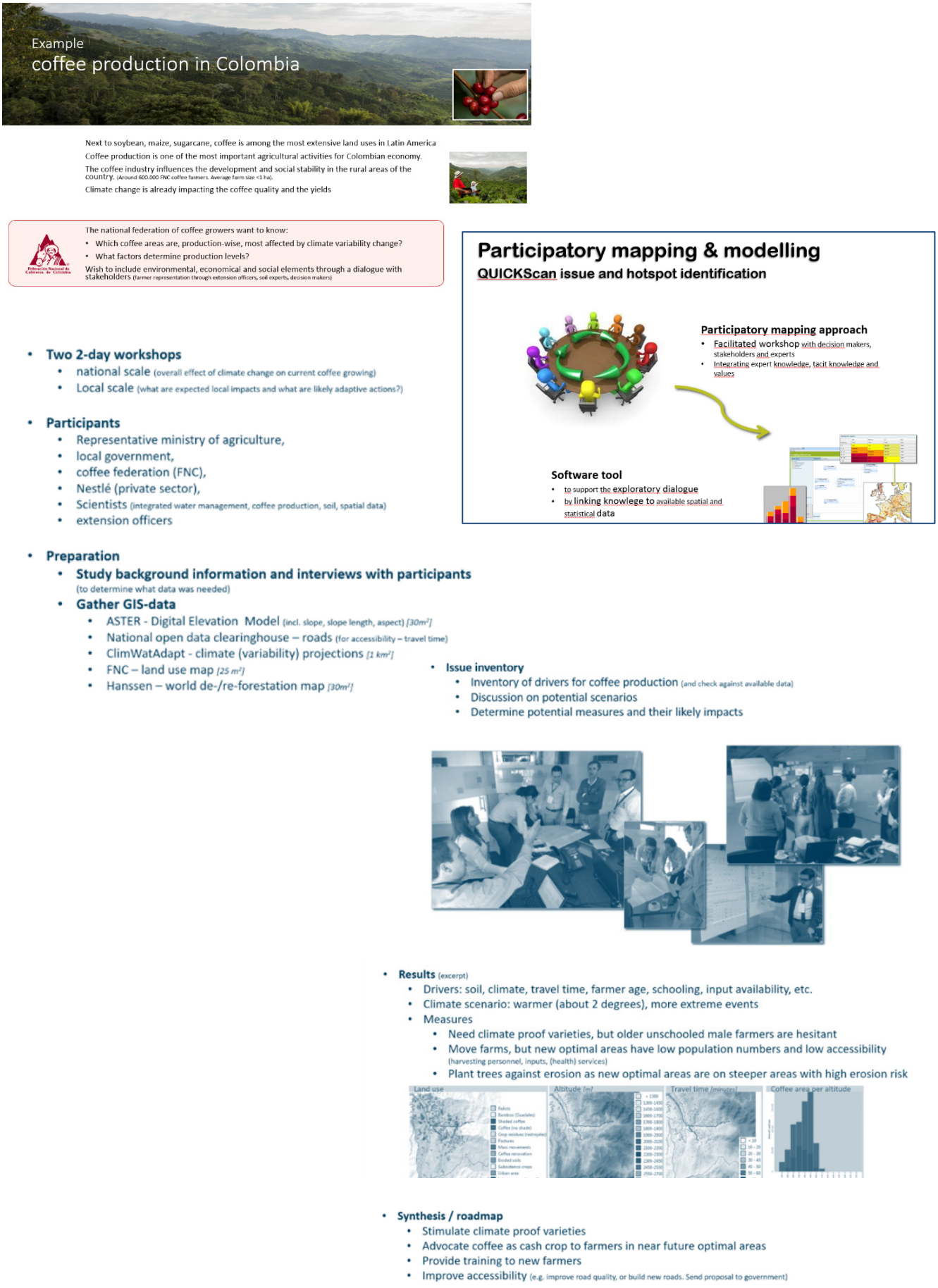


Figure 21 *Example workshop Participatory mapping and modelling with QUICKScan*

4.2.3 Lessons learned

The QUICKScan method combines participatory mapping and impact modelling method with stakeholder- and decision maker knowledge and preferences to available spatial and spatial-statistical data. It is designed for an interactive and multi-stakeholder workshop setting and follows a number of logical phases and clear steps. It has proven to add value in different projects across topics.

QUICKScan can be well adopted also for mapping and (spatial) planning of the food system. A first step is made in the Dhaka case study (par. 3.5).
A such, participatory spatially mapping of the food system:
- facilitates a dialogue between the actors and enables to converge perceptions
- locates actors, routings of commodities (of food) and (expected) bottlenecks
- provide action perspectives for policy development and spatial planning

The inclusion of spatial data in participatory mapping furthermore
- creates a formalized and shared representation of reality
- engages the implicit and explicit knowledge of stakeholders
- and enables quantification

4.3 Recommendations

The Adaptation lab approach as well as the QUICKScan method show the value of spatialization combined with a well-build informative and creative process. This approach enables to facilitate common understanding, joint fact finding and potential spatial strategies and measures, including the opportunity to assess the impact and effects. Both seem easily adoptable to the domain of Food systems.

Just like food systems, climate change and its effects is a very complex issue which deals with many topics and themes. It also counters many scales that influence each other in many ways. In these complex issues the value of spatial data and concrete spatial projections helps in further common understanding, essential linkages and bringing it also to the domain of strategic spatial planning. This is a crucial step towards potential interventions and not only valuable for interventions in the spatial-physical system but also in other domains like socio-economic development. Spatial projections and discussion will literally bring discussions closer to each other and make it more specific.

It is recommended to adjust the approach and method, tailored to the Food system design and to combine. Combining food system atlases with food ateliers, both putting the food system in its broader context. For instance, topics like migration can also be made spatially explicit as overlay to see where it could link to specific elements within the framework. Examples show the value of including demographic and socio-economic spatial data, i.e. to point out so-called ' Food Deserts'. Accounting the context-specific situation, but also building a common framework and recognizable structure. This brings in focus. Content and process are set equally important in a joined action. Building supportive systems and designing potential interventions based on spatial specific data, generates well-informed and more specific actions, action perspectives and integration with other domains.

Based on the experience from the Adaptation Labs and QUICKScan we recommend a gradual development. As mentioned, it is hard to understand the system as a whole, let alone to build a full information basis at start. Nevertheless, a clear framework, common glossary and terminology should be set at first. In chapter 5 a first attempt is been made, but this should be elaborated in joint actions in the different foreseen case studies in follow-up research.

Crucial for the development, uptake and sustaining the operational value also in the future is to organizational secure good data acquisition, management and representation.

Data acquisition
The data availability is often limited, restricted or highly variable in coverage or resolution. Nevertheless, it values to fill an atlas and information system with best available data. As such, it provides a starting point for further addressing data needs and validation. During 'food ateliers' the existing available data can also be validated and enriched with stakeholder information and tacit knowledge. One should consider to include not only static data, but also include model outcomes (forecasting) or trend data.

Data management
It is essential to appoint a data director, secure an open data policy and active data management (including regular updating). This also requires careful governance and cooperation between governmental organisations at different levels (national, regional, local), across sectors and non-governmental organisations and businesses.

Data representation and narratives
Data should be represented at an easy way and tailored to its purpose. Different means can be supported and correspond alike: an open and interactive platform or portal on the internet, an interactive design application and/or modelling tool. Especially for the open interactive platform it is important to create the opportunity to give the user its freedom to make its own combinations, but also to inspire via a clear overall narrative, specific narratives and integrative views. Different digital techniques are available and can be combined.

5 The next steps

As part of the Knowledge Base-project Feeding Cities and migration, follow-up actions are foreseen for the upcoming years. This years' research should be seen as a reconnaissance and its outcomes can be taken up into next years' plans.

The project plan 2020 of the overall project aims at:

- Analysing food security, food safety and nutrition situations in selected, various action sites
- Elaborating food system mapping and databases through co-creation experiments
- Implementing co-creation strategies and developing institutional arrangements in selected action sites, including application/development innovative approaches and interventions in technology and governance

The proposed supportive spatial tools and approaches could be further developed in these actions and action sites. It is not only about the technical development of the supportive tools, but also on how to include these in the specific interactive processes (co-creation), the public domain and (spatial) planning decisions. This is supported by different advices from FAO and the Milan Urban Food pact.

In "A menu of actions to shape urban food environments for improved nutrition" (GAIN, the Milan Urban Food Policy Pact (MUFPP) Secretariat and the RUAF Foundation, 2019), cities are advised to take baseline measurements and closely monitor process outcomes and impacts of an action on nutrition throughout implementation. Partnerships with universities can support the development of appropriate and robust methodologies, and ensure that both successes and unintended consequences are measured (Halliday, 2019). The Milan Urban Food Pact recalls "to enable effective action for the development or improvement of multisectoral information systems and knowledge sharing mechanisms should be developed and used for food policy development (and actions) and accountability by enhancing the availability, quality, quantity, coverage and management and exchange of data related to urban food systems (including both formal data collection and data generated by civil society and other partners)" (MUFP, 2018). Finally, FAO also commits in their Urban Food Agenda to the development and dissemination of methodologies and tools that enhance national and local understanding of food system characteristics, dynamics, constraints and connections (FAO, 2019). The foreseen tools and systems are supportive to the overall approach suggested in the City Region Food System and its toolkit, which much follows the process schemes like the Adaptation Labs and QuickScan. Valuable lessons can be drawn from different projects following the landscape approach, which uses the landscape as binding medium (Sayer, 2013).

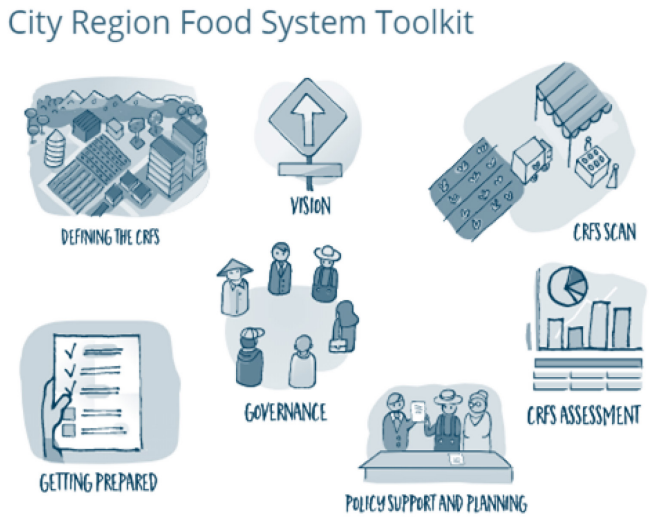


Figure 22 *City Region Food System toolkit*

It values to build further on current cooperation with these partners and local partners, to join in action and elaborate this together for the specific selected areas and towards a general approach and (supportive) systems. This should build an operational supportive system and spatial planning approach that clearly links to the themes and classifications used in available general frameworks and the WUR specific framework and which will be widely supported. The wide experience of WUR with spatial planning and spatial information systems on other domains, will provide an opportunity and a window to bring food also in the spatial domain and, as such, strengthen the territorial food governance.

5.1 Planning city region food systems

There is still a gap in (strategic) spatial planning and food system activities and research (Pothukuchi, 2000; FAO, 2019). As such, not only a gap between food system activities and spatial planning occurs, also missed opportunities in linking with other domains, like climate adaptation, remain evident. This can only be bridged by bringing these different spatial activities together at a common stage: the landscape. The multi-scale approach of the city region food system will be taken as main principle. The landscape will be represented at different scales (neighbourhood, city, region, ...), but available in one information system. This will also link the different subsystems (natural resources, political and information/services), as all of these could be also spatially be represented.

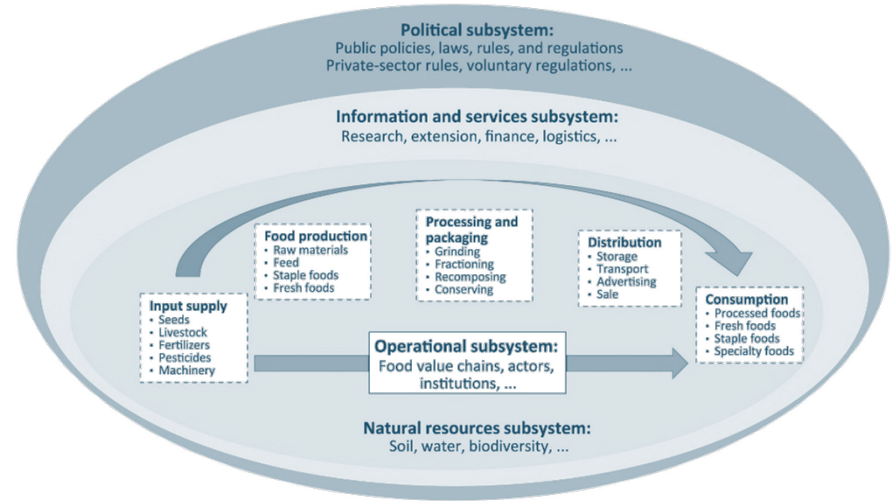


Figure 23 *Conceptualization of a food system*
(Jacobi 2019, adapted from Rist and Jacobi 2016, based on Rastoin and Ghersi 2010)

As such, the systems show the dependencies and interlinkages in a spatial perspective, but also brings in focus in specific action perspectives (area-based): territorial food governance and food planning.

Making it spatially explicit also draws upon the opportunities to actual co-create specific measures, draw conceivable concepts and visual implications and manifestation. This brings it closer to ones world of experience and the shared environment. As Einstein ones said: "I'm enough of an artist to draw freely on my imagination, which I think is more important than knowledge. Knowledge is limited. Imagination encircles the world". Close collaboration with spatial planners and research by design will value the actual development and uptake of the food system approach based on a landscape approach and integrated view.

The key elements within the process proposed:
- Common understanding and joint fact finding (FAO/RUAF: Defining CFRS, CFRS Scan)
- Co-creation and co-design (Research by Design) (FAO/RUAF: Vision, Policy support an planning)
- Multi-criteria assessment (FAO CFRS Assesment)
- Programming (FAO/RUAF: policy support and planning)

These elements come together in an overall process and in dedicated local and regional processes. It's important not to develop a solemnly food agenda and actions, but to focus to integrate; including other benefits in the food agenda and getting food also into the other agenda's and programming. Building a common language, common focus and joint actions is necessary. Ongoing governance actions are a crucial factor to achieve this, as well as good process design and management and last but not least excellent spatial data management. This process is not linear, but consists of circular steps and parallel subprocesses.

The key values are:
- Multi-scale
- Multi-level
- Multi-stakeholder

- Cross-sectoral
- Landscape approach

- Design approach (constructive, creative, adaptive and transformative)
- Clear (integrative) storylines

To put these values in place, a common information level, a spatial perspective and alignment throughout the process are crucial.

5.2 Proposed themes and classification

In the final paragraph a preliminary setup of themes and classification (future legend) of an integrated Food Atlas is proposed. The aim is to elaborated this further together with stakeholders in selected case study areas. Based on this first setup an overall legend could be defined with basic layers relevant for all case studies and other areas. This can be enriched with specific issues or more detailed information for each specific case study. The initial setup is based on the elements of the conceptual framework of WUR (Figure 24) and the City Food Region System (Figure 25).

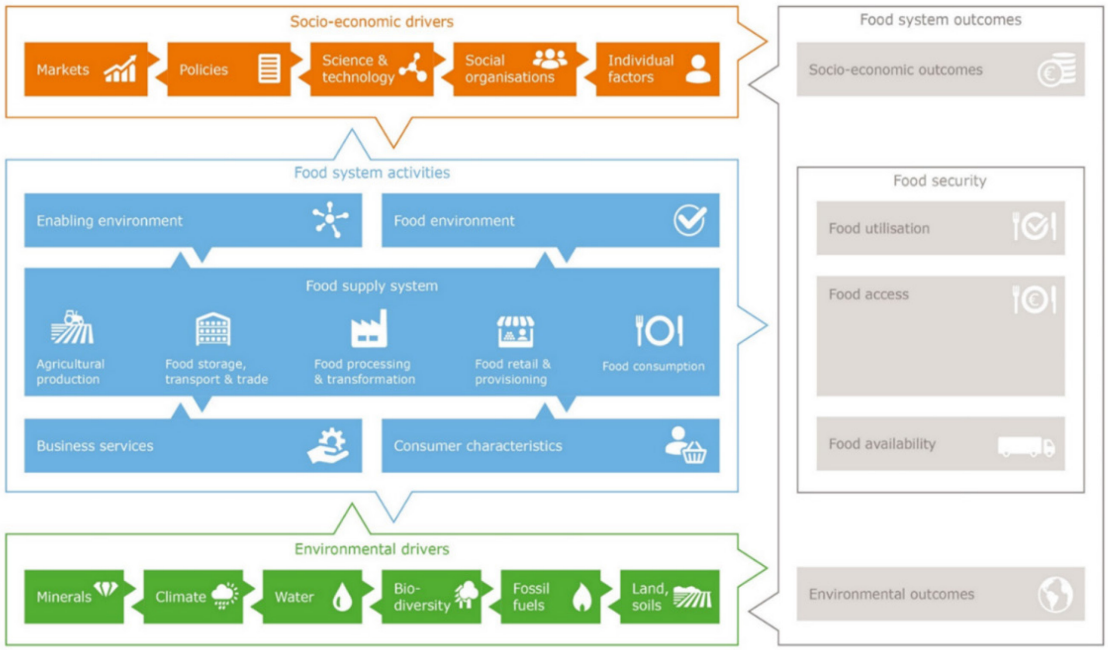


Figure 24 *Conceptual framework of mapping the relationships of food system activities to its drivers and outcomes*
(source: Van Berkum et al., 2018)

Figure 25 *Draft setup City Region Food Atlas -themes and subthemes*

Based on the analysis of this research we propose three main themes and initial subthemes for further research, based on the different frameworks discussed in chapter 2:

- Enabling environment
  - Land
  - Water
  - Climate
  - Energy
  - Demographics
  - Natural hazards and vulnerabilities
  - Boundaries and governance
- Food system activities
  - Input supply
  - Production
  - Food storage, transport and trade
  - Food processing
  - Food retail and provisioning
  - Consumption
- Food system outcomes
  - Health and well-being
  - Food waste and loss
  - Economy and employment
  - Environment

Within each subthemes different geographical information will be made available. Each layer can be changed in opacity and multiple layers can be selected and projected. In the last table potential layers are further elaborated as a first draft setup. The decision on the exact themes, subthemes and essential and potential layers depend on the follow-up process with stakeholders, potential end-users and data managers. Together we can build a supportive system for an overall approach, common understanding, shared vision and practical solutions at different scales from a spatial, environmental and inclusive perspective.

Table 2 *First setup themes, subthemes and potential data layers*

Theme	Subtheme	Layers
Enabling environment	**Land**	Soil types
		Soil quality
		Land structure and parcelling
		Elevation
	Water	Water structure
		Rivers
		Water quality
		Ground water tables
		Ground water quality
		Sewage system
		Drinking water
		Water extraction
	Energy	Power network
		Power plants
	Climate	Eco-climatic zones
		Precipitation and evaporation
		Climate projections
	Infrastructure	Road network (incl types)
		Navigation network
		(Air)Ports
		Avg travel time
	Demographics	Population size
		Population density
		Population projections

Theme	Subtheme	Layers
		Migrant population
		Average household income
		Employment rate
		Type of employment
	Natural vulnerabilities and hazards	Flood prone areas
		Drought prone areas
		Salinization
		River erosion
		Extreme weather
		Earthquake zones
		Urban Heat Islands
		Landslides
		Avalanches
Food system activities	**Input supply**	Seed production
		Breeding
		Fertilizer production and use
		Pesticide production and use
		Machinery (sell and use)
	Production	Farm types
		(Avg.) Farm size
		Crop types
		Livestock (types) and density
		Urban agriculture
		Crop cycles
		Production rate
		Fisheries and fish farms
	Food storage, transport and trade	Warehousing
		Transport firms
		Terminals and hubs
	Food processing	Food processing industries
	Food retail and provisioning	Gross sell
		Shops and supermarkets
	Consumption	Average food expenditure
		Restaurants
		Streetfood
Food system outcomes	**Health and well-being**	(Under)nourishment
	Food loss and waste	
	Economy and employment	Employment in production/processing/...
	Environment	Greenhouse gas emissions
		Land degradation
		Air quality
		Waste water flows and treatment
		Waste management
		Soil pollution

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