Offering a series of decision support tools for stakeholders of urban-metropolitan agriculture, the European research project ‘Food Planning and Innovation for Sustainable Metropolitan Regions’ (short FOODMETRES) aims at describing, analysing and facilitating the development of innovative short chain food systems geared towards urban demand for safe and healthy food on the basis of evidence-based decision making.

The goal of FOODMETRES has been to identify opportunities for increasing and diversifying agriculture and food supply and for shortening food chains in metropolitan regions, including their urban and peri-urban as well as rural areas. The research carried out in this project covers questions of food production, processing and logistics and focusses on sustainable and resource-efficient solutions which are socially and ecologically embedded. Prior to entering into dialogue with relevant stakeholders from farming, food processing, fresh chain management, retailing, consumption, planning and governance, FOODMETRES has gained the necessary technical and institutional insights by studying six metropolitan regions in Europe and Africa.

Central to the FOODMETRES approach is the development of a set of complementary tools, namely:

- Innovation storylines that link food chain spatial and functional characteristics with different innovation domains and performance indicators;
- A typology for short food supply chains that serves as a reference for running qualitative Sustainability Impact Assessment (SIA) along socio-economic and environmental criteria, tested for further application during interactive Knowledge Brokerage (KB) workshops;
- A set of three metropolitan footprint tools designed to frame, communicate and manage the impacts of urban food consumption on metropolitan regions, namely the:
(1) Metropolitan Economic Balance Assessment (MEBA), a measure of framing aspects of food security and supply at the statistical meta level of urban metropoles;
(2) Regional Metropolitan Area Profiles and Scenario (MAPS) demand tool producing scenarios at the level of administrative units, and
(3) European ‘Metropolitan Foodscape Planner (MFP) supply tool, an interactive, spatially dynamic approach at the land use level based on GIS-technology;
• Rural Development Policy Assessment regarding the different short food supply chains at the level of stakeholders and expert panels;
• Food Safety and Quality Assessment on the basis of indicators and thresholds as part of food-chain-specific questionnaires;
• Knowledge Brokerage (KB) tools for both stakeholder interaction in support of food chain innovation during regional workshops as well as by means of an internet-based KB-Platform.

By offering tools for both bottom-up processes on the basis of Innovation Storylines, as well as European data-driven top-down tools such as the food demand-supply scenarios, the impact assessment and footprint tools, FOODMETRES intends to bridge the gap between the international dimensions of food policy, trade and consumption on the one hand, and the regional reality of local actors and consumers on the other hand.

Project Context and Objectives:
The launch of the FOODMETRES project coincided with growing societal concerns about the way food chains affect life on our planet. Advances in production, logistics, processing and retail mean that ever more people have access to consistent quality, safe and affordable food. Yet serious concerns remain about, for example, the environmental impacts of food chains, the marginalization of small-scale farmers, inequalities in access to affordable, healthy food and the longer-term resilience of food chains in the face of natural resource depletion, climate change and global population growth.

In Europe's metropolitan regions, there is an increasing trend towards large-scale food production geared towards export markets, while cultural landscapes and ecological resources are under pressure from both urbanisation and agricultural intensification. At the same time, there is a trend towards smaller, but highly popular urban agricultural initiatives boosting technical innovations and social cohesion by means of community gardening projects. The latter also create new opportunities for citizen, entrepreneurial and policy engagement in debates and innovations to improve sustainability, challenge unethical practices and address diet-related health inequalities. Cities are becoming increasingly important drivers of change in food chains. In particular, through exerting demand for shorter food chains, local food and community food production, cities are increasing the amount of food grown inside their boundaries and in their associated metropolitan regions. Some cities build on existing traditions and cultural practices, whereas others create new structures and practices in order to increase the amount of urban and metropolitan food production. Responding to these issues, FOODMETRES has focused on metropolitan food governance and innovation as reflected in the project's full title: ‘Food Planning and Innovation for Sustainable Metropolitan Regions’.

FOODMETRES has combined quantitative and qualitative methods and engaged with a variety of actors in metropolitan regions including food producers, civic food organisations, and government bodies. FOODMETRES defines metropolitan regions in the context of the land use impacts of cities on their surrounding areas. It hence considers phenomena such as urban food consumption patterns, recreational behaviour and preferences, infrastructure and urbanisation processes as drivers that shape and define the surrounding metropolitan regions. Metropolitan regions are therefore dynamic in terms of size and character, and are not defined by sharp boundaries but soft transition zones. FOODMETRES has applied a spatial zoning concept for metropolitan regions that is based on the notion of regional food zones and urban recreational needs (like green buffers, corridors or nature reserves).

FOODMETRES has developed a series of decision support tools allowing stakeholders from urban and peri-urban agriculture, food business, governance and civil society to enter a knowledge-driven debate on how to optimise the regional food supply of metropolitan areas around cities, by means of sustainable and innovative food chain planning and governance. The project's novel approach lies in the combination of two distinct yet inter-related strands of metropolitan agro-food systems: first, the spatial dimension of regionally grown food in terms of ‘local footprint hectares’ necessary to feed urban populations and second, the concrete innovation potentials for short food supply chains linking consumers with regional producers. In practical terms, FOODMETRES has drawn upon European as well as regional datasets, allowing cross-scale assessments at different resolutions. It also means that we have engaged with food chain stakeholders during regional workshops in which knowledge brokerage tools have been applied to enable mutual learning processes and capacity building.

One of the project's novel contributions is to enable the visualisation of metropolitan supply and demand scenarios through interactive mapping tools, which help stakeholders to better understand the possibilities for increasing metropolitan food sufficiency. Central to
these efforts has been attention to different types of food chain innovation, namely product, process, governance and various social forms of innovation. Rather than suggesting one single form of sustainable food chain innovation, FOODMETRES has applied its evidence-based assessment tools to a wide range of food-chains ranging from community-supported agriculture in London, Ljubljana or Berlin and subsistence farming methods in Nairobi, to large-scale greenhouse glass production such as in Rotterdam-Westland. Offering new ways of framing regional food supply capacities, food chain innovation strategies and stakeholder interaction by means of sustainability impact assessment tools, FOODMETRES invokes the agro-food sector, civil society, planners and policy makers to address the full scale and resource potential of metropolitan regions for making urban food systems more sustainable and self-sufficient.

Project Results:
FOODMETRES aims at describing, analysing and facilitating the development of short food supply chain innovations in metropolitan regions. For this purpose, different tools have been developed and tested in five European case study regions and in Nairobi, Kenya, that in future could serve other city regions once the knowledge brokerage and information platforms will be made accessible. Three of these tools are introduced in this article. The innovation storylines can help to structure evidence along innovation domains and hence facilitate exploring potentials of metropolitan SFSC across commodities and across regions. The SIA tool supports profiling of different food chain types towards innovation goals in terms of impact areas which are specific to food chain innovation. The Metropolitan Footprint Tool integrates relevant planning dimensions, e.g. demand and supply of agricultural productive land and land use composition, with stakeholder preferences on spatial allocations. Physical tools like the Maptable technology are helpful means to support discussion and decision processes, particularly for scenario building integrating multiple land use purposes, zoning and future conceptual designs and delineations. Project results indicate that the developed tools are relevant starting points for structured exchange between regions and stakeholders engaged in SFSC innovation.

Innovation Domains and Storylines
Innovation storylines are focussed on specific innovation domain(s) that are relevant to regional stakeholders (mainly entrepreneurs) for developing more sustainable food chains. Beyond product innovations, these may emphasise process innovation such as the use of alternative energy sources or different forms of logistical arrangements. They could also be targeted at social innovation by involving the consumers in an early stage of the food chain – e.g. during the harvesting of the food, or at governance innovation integrating new stakeholders into local food planning strategies. The storylines follow a pre-designed script book, in order to make sure that food chains for different commodities can be compared on the basis of a set of agreed-upon indicators. The storylines have a strong scenario dimension because the corresponding food chains are still in the process of development (i.e. business cases). In the different case studies we selected commodity groups such as dairy products, potatoes, fruit and vegetables. Concrete food products associated with these groups include tomatoes, cabbage, herbs, spinach, kale and bananas (the latter for Nairobi) as well as many others.

According to the features and definitions of Local Agro-Food Systems (LAS), Metropolitan Agro-Food Systems (MAS) and Global Agro-Food Systems (GAS), main actors involved in food supply chains can be localized from the point of view of the systems in which they mainly operate (Figure 1 attached). The urban context at the interface between LAS and MAS represents a domain of high consumer concentration. Also producers can be found here according to urban and peri-urban agricultural activities that, however, may not realize an individual food chain (non-professional producers and consumers may overlap, i.e. self-consumption in urban gardens), but contribute to the sustainability and supplying capacity of a city. Consequently all identifiable food chains, whether short or long, are directed to this area, in order to satisfy the demand and the requirements of consumers, or equivalently, of urban population.

Generally in the agro-food system, technological innovation is still considered as the main driver for creating a competitive business advantage, rather than focussing on more sustainable forms of global resource efficiency and being directed towards social, economic and environmental sustainability. Building on the work by Avermaete et al (2003) we see added value in incorporating these innovation domains in an integrated approach which we call system innovation (see Figure 2 attached). System innovation is a non-linear learning process, that is, the process occurs in a manner which builds in feedback loops enabling constant re-evaluation and revision. This is a fundamental change from the formerly prevalent top-down model of knowledge transfer from scientific experts to practitioners. Based on Van der Vorst and Beulens (2002) FOODMETRES uses a list of redesign strategies for attaining more sustainable supply chain objectives (see Table 1). ‘Redesign principles’ are a technical term that has become a key reference in the field of food chain logistics addressing the different system dimensions of food chains from a business perspective.

Table 1: Typology of generic supply chain management redesign principles (SCM-RP)
SCM concept element SCM redesign principle
Managed system ① Redesign the roles and processes in the supply chain
Managing system ② Reduce customer order lead times
  ③ Synchronise all logistical processes to the consumer demand process
  ④ Co-ordinate logistical decisions
Information system ⑤ Create information transparency in the supply chain
Organisational structure ⑥ Jointly define objectives and performance indicators for the entire supply chain

Performance indicators around food safety, food quality and logistics are generic and applicable to every case study scenario. For specific case studies, specific (relevant) indicators within each group should be selected. FOODMETRES has developed sets of performance indicators which are provided as references to the stakeholder dialogues, to provide a pool of indicators to draw upon if needed.

Sustainability Impact Assessment
Sustainability Impact Assessment (SIA) has become an obligatory requirement for all EU policies as well as for many national legislations, e.g. as ex-ante assessments prior to policy implementation. With the objective to avoid or minimise negative effects resulting from policies and decision-making, SIA has also developed relevance in food and food supply (see Yakovleva et al. 2010, FAO 2013). In FOODMETRES, the SIA process is carried out by applying an assessment framework consisting of a food-oriented set of impact areas, which are understood as wider impact and policy fields, rather than narrow indicators (Zasada et al. 2014).

Impact areas thus provide a politically and scientifically established framework for determining which issues (or ‘areas’) are at stake when assessing the effects of a new policy or innovation proposal. They can be correlated to the set innovation goals for short food supply chains on the one hand, and to political agenda setting towards meeting societal challenges on the other hand.

Building upon the European Union approach towards sustainability impact assessment (CEC 2009), FOODMETRES developed the impact areas aiming at the integration of three sustainability dimensions: (i) environment, (ii) economy, and (iii) society. Examples of impact indicators in these different areas are for example food-miles (transport distance) for the environmental impact area, or number of jobs along the food chain as an economic impact indicator, or the occurrence of pathogens along the food chain under the food safety domain. We consider the list of food chain impact areas as one of the key outputs of FOODMETRES since this fills an important gap in this emerging policy field.

The SIA were conducted in a participatory way, based both on international expert and on regional stakeholder judgements, through an online survey and case study workshops with practitioners, comparing impact areas among a consistent set of short food supply chain (SFSC)-types, which include both localised, alternative and social innovation driven (Committee of the Regions, 2011) as well as efficiency-oriented, sustainable intensification-based food supply systems.

The typology developed for the FOODMETRES food chains takes into consideration, that short food chains are embedded in a territorial and social context and therefore puts the consumer-producer relation up front. Most types also relate to the different spatial dimensions (local, metropolitan & global) as well as different commodity groups. Preliminary results of the SIA reveal distinct differences between the experts’ and the practitioners’ perspective as well as between the different case study sites, highlighting the importance of regional situation-adjusted strategies and solutions to short food supply innovation. Compared to conventional long food supply chains, all SFSC-types show positive contributions to the various impact fields. However, depending on the impact and policy area of interest, the application of locally specific and different SFSC-types would be necessary (Zasada et al. 2014). In this respect, the developed SFSC typology also serves as a good communication tool. In the future, the typology can be expected to be extended to cover further types and aspects of food chains not present in the FOODMETRES project.

Metropolitan Footprint Tools
The modelling approach addressed in the FOODMETRES project particularly focusses on the spatiality of metropolitan agri-food systems (AFS). It elaborates the question of area-wise relevance of food demand and food supply (Which relation is there between demand and supply?). The Metropolitan Economic Balance Assessment (MEBA) tool represents the starting point of a comprehensive cascade of complementary models.

The MEBA applies an economic approach to assess the food demand-supply balance within a metropolitan region. 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.

The Metropolitan Area Prole and Scenario (MAPS) tool adopts a straightforward data-driven approach of connecting regional food demand (local hectares) with the regional area productivity. It is the objective to assess the spatial extent of the agricultural area required for food production ("How much area is needed?"). 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), in addition, addresses the question of the spatial distribution of the various land use types, which are required for the production of specific crops ("Where to produce?"). This tool offers (1) hands-on assessment allowing stakeholders to re-allocate commodities on a digital mapable, (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 described modelling approaches feature not only methodological differences, but also in terms of input data, modelling rational and the degree of stakeholder interaction. However, the 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 results of the modelling approaches presented in this paper reveal strong commonalities across regions in terms of diets, area demands, etc., allowing for derivation of generic mechanisms and impacts of changing scenario situations and political and technological efforts to change the metropolitan AFS. The tools and models (MEBA, MAPS, MFP) deliver relevant information on the (i) food and area demand-supply balance, (ii) ex-ante assessment of changing scenario situations (population sizes and composition, diets), agricultural system and intensity (intensive, greenhouse, organic), (iii) the role of geographical framework conditions, and (iv) potentials to optimise production (spatial distribution, food chain organisation). These results and functionalities are essential as basis to inform food planning and policy making in the case study regions and elsewhere. They provide important knowledge on the room of manoeuvre to set policy goals towards enhanced regional self-sufficiency through shortening of food chains and regionalisation of food production.

MEBA offers a basic set of information about the shape of agro-food system, revealing the relation between the first and the last step of food chain, production and consumption, at the level of raw products. The latter aspect strongly connects the diet profile with the cropping pattern decisions taken by farmers, revealing which sectors are lacking and what policy actions can be undertaken. Though production choices are driven by global market, new social pressures as well as security and environmental concerns could lead to rethinking of the land use planning role in defining what and where to produce.

Despite its spatial representation, the purpose and functionality of the MAPS tool is less a spatial analysis as such, but should be rather understood a mean of communication of the spatial dimension of food consumption and production. It shall raise awareness among stakeholders and decision-makers in urban and regional food planning and policy about the agricultural area required. It also provides the opportunity to assess the effects of future changes in either food consumption, e.g. healthy or vegetarian diets or population changes, reduction of food waste and loss or changes in the agricultural production systems, such as organic and expensive production or sustainable intensification. In this sense the MAPS tool can be used to explore difference regional scenarios and future pathways.

The main strengths of the tool less in the attempt to explicitly delineate the specific agricultural area necessary to cover the food demand, but to model the necessary area and illustrate the actual extent through a mapping approach. It helps increasing of regional resilience by provide a broad and diverse basis stock of food supply across many commodities. It also supports the identification of hot and cold spot areas of food stress and help to quantify political targeting in terms of food policy. The MAPS tool can be used to develop a “food land account”, which informs on the questions of the availability of food production area, its utilization, the necessary changes for regional supply (where the MFP tool links in).

The Metropolitan Foodscape Planner (MFP), at the contrary, offers (1) hands-on impact assessment tool for balancing commodity
The concept of spatially allocating specific food groups for which a certain supply deficit has been recognised – e.g. vegetables or oil seeds are typically underrepresented in the metropolitan surroundings of cities – to areas with clear food supply surplus coverage, for example grasslands, points at the need to guide such stakeholder decisions by offering additional land use related references. We are aware that introducing clear spatial demarcations for different food groups in the forms of zones is drastically contrasting with the everyday situation in our current metropolitan regions. However, rather than intending to reflect the agricultural status quo, the MAPS-concept offers a quantitative look at agricultural resource potentials in which key issues such as the impacts and location of protein consumption, human requirements for recreation and nature, as well as availability of land to provide regional food is visualised in one scheme. Making use of the digital Maptable technology, stakeholders can engage in ‘serious gaming’ exercises and develop proposal for increasing the supply with regional food for up to 12 food groups on the basis of the urban consumption needs. In order to provide further guidance during this process, MFP offers the spatial references of the European Landscape Typology (LANMAP) to ensure that stakeholders receive ‘alert’ messages if their changes they propose are in conflict with the allocation rules laid down as part of the landscape-ecological references. Both the MFP-zoning concept and the LANMAP-based allocation rules are in principle open to stakeholder revisions prior to engaging in the MapTable exercise. This way, a high level of tool transparency and flexibility can be achieved – the basis for gaining trust and ownership throughout the process.

Potential Impact:

Potential Impact Food Safety and Quality tools

Tools have been developed to assess food security and food safety at local and metropolitan regions. These tools showed that, depending on the region, areas can be self-sufficient. However, more densely populated areas limit the possibilities for metropolitan food supply. Spatial planning of activities should take various aspects, such as food safety, into account.

The food safety questionnaire proved to be successful in pinpointing critical areas that need further attention to improve food safety at the local level.

Production of healthy food requires avoiding excessive accumulation of undesirable or even harmful substances like heavy metals or nitrate in the products, which can be a problem in urban agriculture. The by far major share of food produced in urban agriculture is consumed directly by the growers themselves, without having passed any health security assurance system.

Potential impact of food safety and quality tools:

• Introduction of spatial planning modules as a pre-cautionary food safety principle according to which food chain operations are managed within clearly defined zones.
• Increasing the resource efficiency of food system operations within dedicated regional zones that separate livestock farming from vegetable production.
• Supporting support policy makers in establishing optimal spatial planning of metropolitan food production.
• Enabling actors within the food supply to assess possible critical points for producing safe and good quality end products.
• Enabling more research into the food safety consequences of a transition from global to metropolitan or local food production.
• Performing more analyses and give targeted professional advice on food safety issues to practitioners who are laypersons.

Metropolitan Foodprint Tools

Focussing on the spatial dimension of metropolitan regions, FOODMETRES puts forward three footprint assessment tools allowing stakeholders from agro-food business, governance and civil society organisations to enter a knowledge-driven debate on sustainable and innovative food chain planning:

• The Metropolitan Economic Balance Assessment (MEBA) tool applies an economic approach to assess the food demand-supply balance within a metropolitan region;
• The Metropolitan Area Profile and Scenario (MAPS) tool adopts a straightforward data-driven approach to applying different food production regimes (e.g. organic farming, food loss) and consumption patterns (e.g. vegetarian, healthy diets) or population scenarios; and
• The Metropolitan Foodscape Planner (MFP) allowing stakeholders to re-allocate up to 10 commodities on the basis of landscape-ecological principles while measuring the ecological footprint effects at the scale of 1 hectare-grids.

The results demonstrate that quantitative assessments can provide important contributions to a wider societal debate on the
characteristics and effectiveness of Metropolitan Agro-Food Systems (MAS).

Re-interpreting the Thünen model we have demonstrated that data on regional food supply potentials can help to frame the dynamics of metropolitan regions in the light of spatial planning, rural development objectives and food chain innovation. The results are considered as valuable references for the emerging discipline of sustainable food planning as a young branch at the very interface between social and environmental sciences.

Potential impacts:
• Contributing to a common understanding on how metropolitan regions are triggers for sustainable development in rural regions, and that funding instruments and rules require appropriate consideration in territorial eligibility settings.
• Stimulating and profiling references for future incentives and financial support for the agro-food sector where system innovation including aspects of governance and social embedding are properly addressed at the level of metropolitan food sheds.
• Supporting the establishment of European Cross-border Partnerships between policy makers, spatial planners and entrepreneurs to share experiences and to build up cross-border food shed activities for metropolitan regions.
• Making RIS 3 (Regional Innovation Strategies of Smart Specialization) an approach to develop metropolitan innovation strategies targeting at Agrofood clusters that act as technological, infrastructural and economical hubs.
• Offering ‘off-the-shelf’- footprint assessment tools in knowledge brokerage session to raise the awareness regarding impacts of urban food consumption;
• Monitoring and reporting on innovation impacts on the ecological footprints at the level of metropolitan regions metropolitan regions at a regular base.

Rural Development Policy Assessment
Results confirm that to set a food policy able to deal with the challenges of urban food supply, adequate cognitive, simulation and planning instruments are needed.
• RDP should include new areas like metropolitan regions and new groups, not only farmers.
• RDP should consider and support new food chains models in particular SFSCs, which benefit from a great recognition in civil society.
• RDP should assess and monitor the sustainability (environmental, economic and social) of SFSCs in comparison with the conventional food chains.

Potential impacts
At European level the innovative approach to the RDP offers the tools and methods to address specific measures to the sustainable development of SFSCs including areas and social groups other than rural ones within a metropolitan and regional vision.
At local level Rural Development Programs can draw upon the specificity and diversity of SFSCs which arise from the local contexts and adapt measures and actions to support the most sustainable and promising initiatives according to sustainability goals.

Sustainability Impact Assessment of SFSCs
Potential solutions for the problems in the current urban food systems can be found in food chain types which are related to the integrated territorial agri-food paradigm (alternative short food chains) as well as in long, large-scale, (eco)-efficient types like Metropolitan Food Clusters AgroParks which present the agri-industrial paradigm. Regional (short and long) food chains are not per se more sustainable than conventional global chains. The Sustainability Impact Assessment (SIA) reveals also that certain food chains types (short alternative) possess typical weaknesses (e. g. transportation efficiency or profitability), which might be inherent with to chain system and scale. Therefore further research is required in order to identify existing (practical) solutions or to develop new solutions (innovations) which can improve the sustainability in this field. This can be done only on the level of existing (regional) food chains in their systemic context.

The developed approach of a qualitative expert-based sustainability impact assessment of food chain types fills a gap between quantitative evaluations of certain commodity chains which focus mainly on environmental effects (e.g. LCA or carbon accounting) and qualitative estimations for one specific short chain type (e. g. CSA by Saltmarsh et al. 2011) and offers the possibility of a direct comparison of different types of short food chains. The achieved results are valuable and can be proved by results from the existing literature. The advantage of the approach is that it allows not only statements about the direction of an expected/perceived effect, but also about its intensity.

The SIA approach is quite feasible to assess food chain types within and without their regional context (regional SIA workshops for concrete chains and online survey at European level) and was very useful as a discussion tool in the regional workshops. Nevertheless the SIA requires further methodological development, because some participants in the online survey and the regional workshops had
some difficulties (e.g. with the terminology, selection of the impact fields) and assumptions for the evaluations were not made explicit.

List of Websites:
Knowledge Platform: http://www.foodmetres-kp.eu
FoodMetres webpage: http://www.foodmetres.eu
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