D2.1
FoodMetres
Analysis of food demand and supply in the Metropolitan Region

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1. Introduction

The main purpose of this report is to explore the relationships between demand and supply in agro-food system seen from a territorial approach point of view. These components have not to be considered as separated elements, but rather they have meaning only if analyzed together and in relation to the territorial context they operate in. In this sense, they are also strictly linked to basic dynamics of food demand and supply, as these latter could play a role as the driving forces to promote innovations in the agro-food system. It becomes then necessary to define the "benchmark" territorial system this kind of analyses has to deal with. Literature has provided several conceptual and analytical frameworks to characterize metropolitan and, more widely, local systems.

In the first section, a quite exhaustive review of these issues is reported. Further characteristics of defined concepts of Local, Metropolitan and Global Agro-Food Systems (LAS, MAS and GAS) are described in D3.1. In addition, a first qualitative assessment of economic dynamics and relationships amongst actors in food chains is described. In the second chapter the operative tool to spatially delimitate the reference territorial system (MAS) is presented and results for case study regions are given. In the third and fourth section a methodology for the analysis of food demand and supply is applied to case study areas, along with a second approach proposed. Finally, each case study provides a brief description of examples of food chains in LAS and MAS.

2. Agro-Food Systems: an overview

"Agro-Food System" (AFS) was defined by the Malassis school as the set of interdependent elements that work together towards the end of satisfying food needs of a given population in a given space and time (Malassis, 1979). This is one of the first widely accepted definitions which is followed by many other. The actual complexity and the real meaning of the AFS, include aspects related to the geographical location of its components, the flows of goods, to the relationships between the actors; it is not then a stable system, but rather it is a dynamic entity subjected to the changing of its components.

The work done in this WP2 and, more generally, the aim of FoodMetres focuses on the territorial components of the AFS, therefore it is important to deepen a set of elements that link the AFS with the location.

2.1. Foodshed

The term "*foodshed*" was defined for the first time in 1929, as the geographic area that represents the flow of foodstuffs from their origin to consumer markets, driven by economic principles (*Hedden, 1929*). The concept derives from that of "*watershed*", as both are portions of a region where resources (food or water) are conveyed to nourish the region itself. However, foodshed boundaries are not limited only to spatial and geographic limits. According to *Kleppenburg et al.* (1996), in fact, the foodshed brings together cultural (food-) and natural aspects (-shed), expressing the coexistence of society and nature, and derives and interacts with the wider context it is located in. Foodshed could be then intended as an agro-food system that develops in and insists on a specific area. In this sense it comprehends all the elements needed in feeding population (e.g. biological processes, infrastructures and technologies, the inputs needed and outputs generated at each step, human resources, research and education). Therefore the foodshed is strongly affected by social, political, economic and environmental contexts (*Qazi and Selfa, 2005; Winter, 2003; DePuis and Goodman, 2005*) and becomes then "*a socio-geographic space*" (*Kleppenburg et al., 1996*), which provides a more accurate definition as actually site-specific, depending on two main components: a territorial component and a socio-economic and relational one. In particular, the latter is strictly connected and linked to governance processes and relationships among different actors involved (farmers, enterprises, governors, etc.) and affected by changes in the coordination or management of its features, such as the development of Alternative Agro-food Networks (AAFNs) or Sustainable Food Chains (SFCs), or the introduction of different kind of innovations. It emerges the dynamic dimension of an agro-food system, whose evolution is driven by several factors.

Permaculturist Arthur Getz (1991), in providing a further definition of the foodshed, considered where the food is coming from and how it gets there, or, in other words, the connection between food and its source. On this basis he hypothesized that the "*most rudimentary map of a foodshed might cover the globe"* (*Getz, 1991, p. 26*), like an octopus whose tentacles represent extensive global food chains. In fact, in a globalized world, the transfer of agricultural commodities and food products cross the oceans and are distributed in every continent. Getz is pointing here at the fact that Global Agro-Food Systems (GAS) have pushed the boundaries of the term foodshed – originally associated with a bio-geographic food-supply region – to encompass the whole world. And exactly here lies a challenge for what FoodMetres is pogrammed to explore: identifying the sustainable limits of foodsheds for future metropolitan food supply.

2.2. The footprint of Food: the "Foodprint"

According to *Asher (2001)*, a city is not able to provide resources and feed entirely its population; this capacity comes actually from the surrounding rural areas. *Von Thünen (1826*) developed an economic-geographic model, arguing that city tends to be surrounded by several concentric rings within which livestock and agricultural activities providing food are concentrated. Nowadays their distribution is changed but this does not affect the dependence, at least in part, of the city from these areas.

Urban growth determines a parallel increase in population needs and in demand for resources, or "*metabolism*" of a city (*Wolman, 1965; Kennedy et al., 2007*). However, as this trend occurs, since resources become more and more limited and limiting, boundaries of their supply areas extend consequently, also due to increased trade and improvements in transportation (*Swaney et al., 2012*). The interaction among these factors is the basis for the determination of spatial limit and shape of a city, but it must be considered that its size determines, in turn, the amount of the demand for resources and then the area required to satisfy them. This assumption reminds of the first definition of “*foodshed*” provided by *Hedden (1929)*. However, in relation to what previously introduced, some clarifications must be given.

Under the name of “foodshed analyses” several studies and methods can be found that actually focus on what is assumed to be the spatial dimension of agricultural land around the city needed for feed its population, and not on the foodshed as a real bordered region. Thus, most of them aim at studying and estimating the potential of agricultural production needed for the city, rather than at specific metropolitan regions and their real production of food (*Swaney et al., 2012*). The quantification of the extent of a foodshed becomes then more similar to what *Billen et al. (2009)* identified as “foodprint”, i.e. the effective area of the surrounding territory required to meet urban demand or produce agricultural goods, with current farming techniques. This definition differs from concept of ecological footprint (EF, *Wackernagel and Rees, 1996*), both semantically and from an operational and methodological approach. EF expresses the amount of total productive area needed to produce the resources consumed by a population under prevailing world technology and according to carrying capacity, and its estimation in global hectares is based on the assumption that each consumed unit of energy or material ensured by a certain extension of land able to absorb emissions, according to different elements and types of soil (*World Conservation Unit, 1991*) and not only limited to food production. It leads to the estimation of the productive land population insist on, even if it does not coincide with the effective land (*Bagliani et al., 2001*). However EF does not fully catch relationships and food flows between the city and the suburbs, as on the contrary does the foodprint-approach, finally allowing the distinction between *autotrophic* and *heterotrophic areas* (*Billen et al., 2009*).

In any case the land area required to meet population demand depends both on the ecological and productive features of the system and food consumption patterns (*Chen et al., 2010*), which is related to nutritional status and concerns with types and quantities of food in combination into different meals.
This relationship and its effects on agricultural land required for food was firstly investigated for The Netherlands by *Gerbens-Leenes et al. (2002)*, who demonstrated that the higher level of scale of consumption, from local to national level, is the more land is required. On these bases *Zhen et al. (2010)* applied the method to two different scales, analyzing land requirements per household in a Chinese district in comparison to the average of China.
Food consumption patterns and diet are important elements to be considered in order to get results towards sustainability in agriculture (*White, 2000*), as some diets in favour of welfare and human health have lower environmental impacts (*Duchin, 2005*). A scenario analysis has been made through ALBIO model (*Wirsenius et al., 2010*) to calculate land area and crop production necessary to provide levels of consumption according to dietary changes and an increase in livestock productivity in 2030. The model returns an average decrease of the requested area from 19% to 39%, depending on the case study region, and its decrease according to higher livestock productivity and a lower animal protein content in the diet.

Nevertheless, to better calculate foodprint, it is necessary to adopt methods and methodologies based on the combination, comparison and balance between food demand and supply. Literature provides several studies directed in this sense:

- The definition of Western Washington foodshed (*Born and Martin, 2011*) does not define a territorial extent, but it is confined to the comparison between the amount of consumption and requirements levels, to seek whether a healthy and balanced diet can met them.
- *Herrin and Gussow (1989)* determined the extent of Montana's food self-reliance starting from production and consumption data, from marketing data and national surveys. Thus, it is shown that self-reliance declined over time, but a shift towards a varied diet and to a priority to seasonal products leads to the possibility to find many food resources locally.
- *Desjardin et al. (2010)*, in their study for Waterloo Region, Canada, focused on the estimation of the amount of locally grown products needed to meet population nutritional requirements. Food intake was compared to nutritional needs, as a proxy for food demand, and finally converted into land that could potentially supply the production of these quantities.
- A similar analysis was conducted for Willamette Valley, Oregon, U.S.A. (*Giombolini et al., 2011*). Servings produced derived from agricultural production were calculated trough the conversion from yields and compared to the total recommended dietary requirements for population, derived from the combination of population statistics and recommended number of servings. Following this approach it may occur an insufficient production for feeding local population, but it must be taken into account, that a variable amount of production may be removed from the supply of local populations to be sold on global markets or exported. However, this would not represent a limit both for current and future provisioning because a change in market structure would affect, in turn, supplying capacities (*Giombolini et al., 2011*).
- Other methodologies applied are those of *Billen et al. (2009)* and *Darrot et al. (2011)*, which both focused on French contexts. The former proposed a method to analyze foodprint of Paris through the examination of nitrogen flows. In particular the study aimed to analyze if rural and surrounding areas and regions were able to meet the demand of nitrogen-containing food products that comes from the city.
- *Darrot et al. (2011)* investigated the food needs, in terms of caloric intake, of the city of Rennes, the available land within the city to meet food requirements and analyzed its potential for production under two different nutritional conditions, i.e. under different total caloric intake. Then a simplified food balance was carried out, and on this basis was calculated and defined the radius of the area around Rennes potentially needed to meet the consumptions of the population.
- In addition, according to *Cowell and Parkinson (2003)*, land use may represent an indicator to examine the feasibility of localizing food system, since localization is believed to play a role as a policy strategy towards more sustainable societies. In their study, localized production is calculated, and then the area to produce a given amount of food, both for crops and meat and dairy products, considering, in this case the requirements to produce feed for animals during their entire life-cycle and to maintaining breeding stock. However, even feasible on

the basis of land area, localization may not be always convenient if considered energy consumptions: as the authors indicated, in some cases is to be preferred the import of foodstuffs from high-yielded crops using less energy-intensive production processes, rather than local production with lower yields but higher energy-consumer production processes.

- Finally, other approaches utilize optimization models and combine them with GIS, in order to get to a spatial map of the foodshed, as the basin the food for the city comes from. It assumes here a different meaning from that of foodprint, but rather it more follows the definition provided by *Getz (1991).*
- Although several studies have dealt with this kind of analysis, many of them have focused their attention mainly on the supply side. *Aubry and Kebir* (2013) investigated the role of Short Supply Food Chains in the area of Ile de France, focusing on farmers' markets through survey to farmers and local decision-makers.
- Others authors based their researches on the number of intermediaries involved in the supply food chain and the individual or collective feature of the chain itself (*Chaffotte and Chiffoleau, 2007*), or on the typology of vegetable box schemes (*Dürrschmidt, 1999*) and Community Supported Agriculture (CSA) organization (*Kremer and De Liberty, 2011*). These studies provide useful insights into the nature and form of local food chains, but only from an individual retail perspective (*Ilbery and Maye, 2006*).
- The assessment of local supply capacity of Detroit (*Colasanti and Hamm, 2010*) allowed to study in-depth the capability of local urban agriculture and food production to meet recommended dietary intake of fruits and vegetables and estimated how much land is necessary to achieve this level of production, even according to the given amount and distribution of vacant and publicly owned land.
- With a similar idea, *Peters et al. (2009)* mapped the "potential foodshed" in New York State, developing a hybrid spatial-optimization model to evaluate the capacity for New York State population centres to supply their food needs within the state's boundaries. The method was the basis for the study carried on by *Hu et al. (2011), who* focused on the application of a linear programming model, in order to minimize the total geographic distribution among foodsheds in Iowa State at county-level, resulting in regional self-sustainability index and supply surplus (or deficit).
- A different approach was finally considered in the analysis made by *Kurita et al. (2009)*, who aimed to estimate potential intra-regional supply and demand in Tokyo mega-region at two different scale levels, through the match among population, land use information and supply/demand ratio.

For our aims and to facilitate analyses, foodshed has been conventionally broken down in two parts, on which governance has the role to control and steer evolutions and rules:

- a geographic and demographic component generating food demand and supply and linked to land use, urbanisation, road and railway network, soil fertility, climatic conditions, resource availability and quality, etc.;

- a socio-economic context, made of relations built up by different actors involved, such as growers, dealers, retailers, consumers, food industries, wholesales and large retail distributors.

2.3. Metropolitan Agri-Food System (MAS)

Literature regarding the definition and principles of Metropolitan Agro-food System (MAS) is relatively limited; several authors (*Beauchesne and Bryant, 1998; Gardner, 1994; Jarosz, 2008; Paul, 2013*) analyzed the role of agriculture in urban, peri-urban and metropolitan areas, and studied the possibility of growing there new and alternative agro-food networks (AAFNs) (*Murdoch et al. 2000; Renting et al. 2003*). Quoting from Castells, Smeets (2009) considers the spatial network concepts of 'spaces of place' versus 'spaces of flow' to characterize MAS regions. Castells defines a place as a locale where form, function and meaning are self-contained within the boundaries of physical contiguity…". Examples for spaces of place are:

- Cultural and natural heritage sites that are unique and region-specific
- Communities that are defined by their language, dialect and cultural traditions
- Production of good and services which are mainly based on regional resources

The 'space of flows', on the other hand, Castells considers to be based on three layers

- Layer of electronic networks forming the basis for information and communication streams within in the networks
- Layer of nodes and centres which locations follow primarily the functions of flow in the realm of decision-making (company headquarters, gated communities hotels, airports, etc) as well as the principles of efficiency and innovation in production and trade.
- Layer of the management and experts which follow the above, moving constantly between nodes and centres

However, researchers have not only studies metropolitan regions and agriculture in more detail, they also have used them to re-frame the discussion of what can be considered as rural and local. In 2005, the Dutch think tank TransForum put forward its vision of Metropolitan Agriculture as holding the key to *sustainable and largely self-supportive system-networks at the scale of larger metropolitan regions (Wascher et al. 2010).* The analysis proposed the following three main characteristics for Metropolitan Agriculture:

(1) spatial-functional entities with boundaries which are determined by system integration at the production level thereby defining what constitutes a metropolitan area;
(2) sustainable principles, among them the limitation of agriculture's ecological footprint by improved use of resources, conditions and infrastructure that are available in the area of demand;
(3) a multifunctional approach by covering society's material as well as immaterial demands (commodity and non-commodity goods and services).

Another important aspect of MA is the *co-existence of mono-functional industrial* agricultural systems on the one hand (namely 'Vital Cluster') and *multi-functional* agricultural systems within the same region, both affecting and driven by the strong presence of urban dynamics. Wascher (2012) has taken up the concept of MA for defining steering instruments for increasing the self-supply capacity and efficiency of metropolitan landscapes as a contribution for making urban agglomeration more sustainable.

Within the context of MAS, the above definitions by Wascher et al. (2010) provide some useful references as they address (1) the spatial context around cities reflecting the von Thünen approach, (2) point at the urban demand and socio-economic dynamics as being a driver, and (3) put forward the concept of sustainable innovation to guide policy and planning in metropolitan regions. The coexistence and the interaction of two main elements, different for features and dynamics, appears to be relevant: on one hand, urban agglomerations and on the other areas of lower density, closely bound and linked to the centre. Nevertheless, they cannot be considered as separated systems, but as two complementary sides of the food system itself (*FAO, 2011*), as relationships and interactions exist both between and within each of them. In the intermediate areas of urban fringe and peri-urban zones, a more suitability for the introduction of innovations (e.g. organic farming, urban agriculture, urban gardens) exists (*Beauchesne and Bryant, 1998*). However, notwithstanding observable interdependencies, identifiable elements are subject to different dynamics and are also the basis of a "continuum" between rural and urban areas, resulting in competition for natural resources (*FAO, 2011*). These relationships have been recently investigated to provide a spatial description of the "internal structure" of a metropolitan region, through the application of a specific methodology to represent Rural-Urban Regions (*Zasada et al., 2013*).

From a spatial point of view, the MAS represents the city, or a conurbation, and the land around it needs for food production. The MAS is then an agri-food system characterized by a high level of complexity in terms of actors involved, logistics, and for large quantity and variety of processed products.
Geographical dimension and supplying capacity of MAS in relation to its food demand depend on the criteria by which the region is identified. For the purposes of our analysis in the FOODMETRES, two criteria have been defined:

- MAS may be identified with reference to concepts used in the geographical and planning analyses, such the characterisation of urban sprawl (*Glaeser and Kahn, 2003; Deng et al., 2010*), central place theory (*Christaller, 1933*), accessibility (*Alonso, 1964; Litman, 2003; Halden et al., 2005*), mobility and transports (Wascher et al. 2010), etc.;

- The dimension and the shape of MAS is defined on the basis of capability of agricultural land around the city to satisfy all, or part, of population's food demand. This capability varies according to several factors, such as food products, seasonality, convenience to produce one commodity over another one and agricultural productivity, this latter depending also on productive inputs and specific agro-climatic variables. The geographic dimension is variable with the balance of demand and supply within a specific context. Food demand and consumption are strictly related to the amount of population living in and being depending from the system, then, of course, a MAS big enough to satisfy all food needs of the city is equivalent to the 'foodprint'.

Characteristics and feature of MAS and chains insisting on are better and more minutely described in D3.1.

2.4. Local Agri-Food System (LAS)

Global markets are the main way for the commercialization of agricultural products, which are allocated to consumers via the agro-food industry, wholesale channels and distribution sector. It is reported that in Western European countries only 20% of production is marketed locally (*Committee of the Regions, 2011*). However, global systems are responsible for negative externalities and inequalities (*Allen and Wilson, 2008*) and it is then necessary to consider the local component, as well, when a foodshed is analyzed, enclosing the aspect of a closer proximity between consumption and production, and the underlying relationship with spatial dimension and local food system (*Peters et al, 2008*).

Within a MAS, in fact, small and local businesses, more or less interrelated with each other, emerge from the relationships among different actors on a territory, and may be intended as Local Agro-food System (LAS, *Feenstra, 1997; Henderson, 1998; Lacy, 2000; Hinrichs, 2003*). This is based on complex relations among agricultural production, processing, distribution and consumption in a given place (*Dunne, 2004*), and may represent alternative to global and globalized systems and their issues (*Allen et al., 2003; Clancy and Ruhf, 2010; Halweil and Prugh, 2002; Hassanein, 2003; Helenius et al., 2007; Hinrichs, 2003; Kleppenburg et al., 1996*), but do not necessarily constitute an opposition to them (*Hinrichs, 2003; Jarosz and Qazi, 2000; Watson, 1997*), as a clear demarcation is not always observable (*Blay-Palmer and Donald, 2006; Ilbery and Maye, 2005*). However, it is possible to state precisely the meaning of Local Agro-food Systems, as

> *"Organizations of production and services (agricultural production units, agribusiness, commercial, services, catering) associated with their characteristics and operations to a specific territory. The environment, products, people, their institutions, know-how, their eating habits, their networks of relationships combine themselves in a territory to produce an agro-food system in a given spatial scale" [CIRAD-SAR, 1996].*

Though the authors embark on a spatial delimitation and a geographically defined context (*Kneafsey et al., 2013*), the debate about the concept of "local" is still open and a shared definition is far from being achieved. Here the discussion shares similar definition uncertainties with the debate about urban and metropolitan regions in general. Zasada et al. (2013) provides an overview of the existing delineation approaches. More often a radial distance is offered to fix the spatial boundaries of a LAS (*Smith and Mackinnon, 2007; Winterton, 2008*), but a distance as that considered by the American *Food, Conservation, and Energy Act* of 2008, known as Farm Act, (*Martinez et al. ,2010*) to name "local" a food product (over 640 km), totally loses sense in European context. The concept assumes importance in relation to the specific context it refers to and emerges as a function of socio-economic, political and environmental processes and features (*Qazi and Selfa, 2005; Winter, 2003;*

DuPuis and Goodman, 2005). The boundaries of what is assumed to be "local" also depends on the consumers' perception that may vary across locations, among consumers and products (*King et al., 2010; Martinez et al., 2011*): a community (*Berry, 1977*) or a region with precise characteristics of people and place (*Barham et al., 2005*), the desire of freshness, food quality and safety, the support to local economy and traditions, the reduction in transportation and processing, the closeness to home or region ("grown in my state", *Pirog, 2003*), a lower cost, a closer relationship with farmers. Local food is defined as a product grown, produced, and processed in the locality or region where it is marketed (*King et al., 2011*), and in this sense it is often referred as a Geographic Indication (*Giovannucci et al., 2010*). Labels, certifications and standards (e.g. organic farming) can play a role as local credence attributes, as well, due to the implication of a connection to land and protection of natural resources (*Giovannucci et al., 2010*). However, geographic indications refer to a territoriality of production, whereas they are marketed on a much larger, sometimes global scale.

Under the wider name of LAS it is possible bring back a constellation of movements, concepts and related definitions, such as alternative food systems (*Goodman, 2003; Watts et al., 2005*) and Alternative Agro-food Networks (AAFNs, *Murdoch et al. 2000; Renting et al. 2003*), which embody community's food security (*Anderson and Cook, 1999; Pelletier et al., 2000; Bellows and Hamm, 2001*), civic and democratic agriculture (*Bellows and Hamm, 2001; DeLind, 2002; Hassanein, 2003*), alternative or shortened food chains (*Renting et al., 2003; Ilbery and Maye, 2005*), the 'quality turn' (*Ilbery and Kneafsey, 1998; 2000; Morris and Young, 2000; Goodman, 2003*). In recent years AAFN have been developing, especially in Western Countries, also as a deviation from an agri-food system mainly based on productivism (*Whatmore et al., 2003*), industrialization, and standardized processes (*Allen et al., 2003; Clancy and Ruhf, 2010; Halweil and Prugh, 2002; Hassanein, 2003; Helenius et al., 2007; Hinrichs, 2003*). However, it must be considered *"alternative and conventional food networks not as separate spheres, but as highly competitive and relational to one another in and through space"* (*Sonnino and Mardsen, 2006, p. 306*), whose evolution as well is driven by several factors depending on specific contexts, in some cases even contradictory (*Jarosz, 2008)*.

In their meaning of shortened food chains, AAFNs may be defined by a spatial proximity and a reduced number of links between producer and consumers (*Kneafsey et al., 2013*), in *"a critical process of reconnection"* (*Ilbery et al., 2005, p. 117*). This difference in contrast to agribusiness and traditional channels is emphasized by different features of the farm system, in terms of both farm dimension and farming methods (*Jarosz, 2008*). The existence of particular food purchasing venues contributes to attribute them further characteristics; new and/or innovative forms of LAS, for instance food cooperatives, farmers' markets, community supported agriculture (CSA), public catering, box schemes, direct sales, fair trade, imply a commitment to all the components of sustainability along the entire chain, as examined in several studies on sustainability potential of AAFNs (*Marsden et al. 1999; Ilbery and Maye, 2005; Iles, 2005; Pretty et al. 2005; Seyfang, 2006*).

Despite most of the attention of public opinion and researches is focused on shortening food chains, LAS is undoubtedly also made by traditional chains, which involve big operators (e.g. food industry, wholesalers, department stores). Normally, in fact, only a little part of food chain belongs to the 'local' area, as well as a little part of products come from the region. In this case it should be deepened the chance to improve the efficiency of the food chains, increasing the share of local supplies, or to bring back into local area some steps/nodes of the chain.

2.5. Conceptual framework of agro-food systems and chains in the territory

Agro-food Systems (AFS) are strongly territorially based and derive from the interaction of the spatial dimension with the from-production-to-consumption steps. The conceptual framework of the different chains within the different types of agro-food systems is proposed in figure 1. For our purposes, and as previously stated in D3.1, the FOODMETRES research project focuses on two main aspects of the whole agro-food system, both located and coexisting in a wider territorial context (dashed circle): a metropolitan component and a local one. The development of alternative networks with a more local collocation and often targeted to a more limited territory leads to a food supply that has to meet a lower demand and it is linked to the area of its own production. These systems, however, are not to be considered as stand-alone units, but rather as contexts interconnected and interacting with the wider global system for all the steps along the supply chain, ranging from production to processing and distribution of the products. They however operate in a smaller territorial context than the GAS, including steps of the chain common to both of them, but they differ each other for a different intensity of flows (differently sized arrows) connecting supply to demand within their own boundaries, whether they delimitated.

According to main features of different AFS (see also D3.1), typological models or food chains included in the MAS are those of Agricultural district (Milan case study) or AgroParks. LAS, instead, consists of a set of more shortened food chains, located in the territory in which a local supply matches local demand (e.g. directs sales and collective purchases).

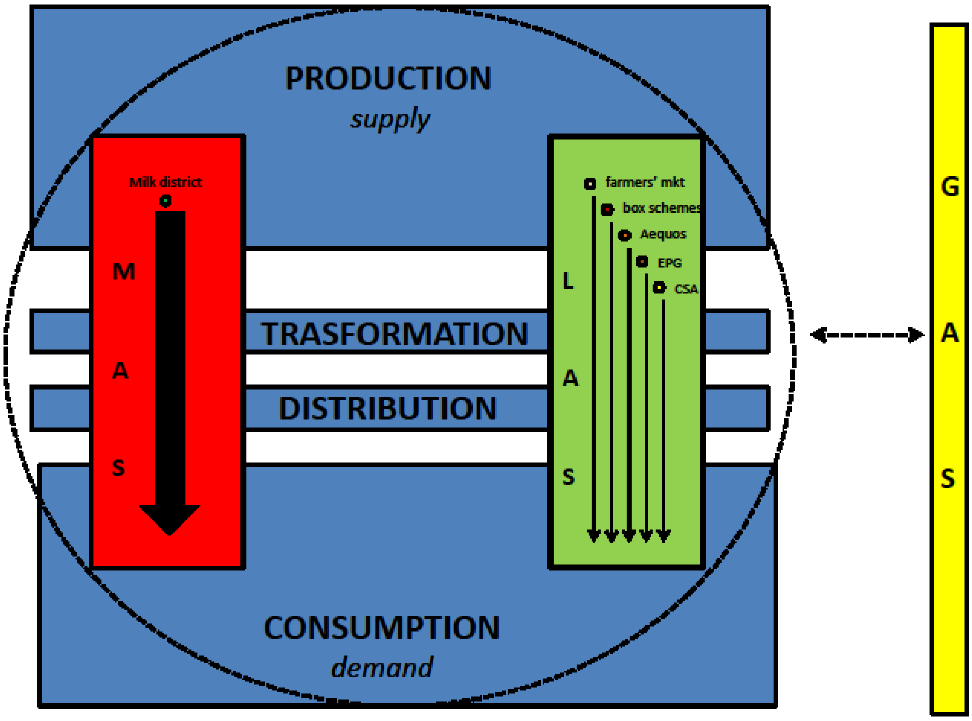


Figure 1: conceptual scheme of agro-food systems and chains,
with some examples taken from Milan case study.

2.6. Economic relations in agro-food systems

The structure of a food chain is traced back to its main elements, components and features:

- Actors involved (number and roles);
- Relationships amongst them that are reflected in their
- Location in a particular food system (LAS, MAS or GAS);
- Distance among actors (space and/or nodes along the chain)

Individual actors of an AFS are the set of subjects involved in food chains: producers, wholesalers, transformers, intermediaries, distributors and consumers. Each of them has its own goals, either conflicting or at least affecting the overall performance of the chain (*Aramyan et al., 2007*). Then, the development of an AAFN or new food chains is due to motivations of both direct actors and stakeholders. In this sense AAFNs and SFCs are innovations in local farming systems that respond to different reasons and require the contribution of various stakeholders, as well. In the LAS, producers and consumers are driven to choose joining an alternative food chain by economic and non-economic reasons.

A shortened food chain, with a reduced number of intermediaries, implies higher margins and value added for the producer and interesting saving for the consumer. For instance, it is demonstrated that in farmers' markets producers benefit positive economic results, obtaining significant revenues

(*Brown, 2002*), especially from the sale of organic products (*Govindasamy et al., 2003*), whilst this initiative also represents a good chance to sell the exceeding production, avoiding wastes, with a higher margin of gain if compared with large retail distribution.
Secondly, producers focus their attention on SFCs also according to non-economic motivations. Farmers and producers are driven by social reasons, as opportunities to meet people (*Huges and Mattson, 1995)*, create stronger relationships with consumers and the territory (*Feenstra, 1997*), and support local system and economy (*Renting et al., 2003*). Some other motivations concern with cultural affiliation and "altruism", helping "ethical" agricultural productions linked to fair trade (*Sanchez-Hernandez, 2009*), while from an environmental point of view, they tend to adopt more sustainable agricultural techniques (*Battershill and Gilg, 1998*), also to respond to a greater variety and a higher food quality requested by consumers (*Goodman, 2003*) and to reduce food miles (*Weber and Matthews, 2008*).

Agro-food Systems are affected by changes related to new models of consumption, modern forms of retail, technical progress and the introduction of international regulations, in other words to innovations, something new and/or original able to improve the existing system. Innovations in food chains derive from the pressures of different subjects; the behaviours of actors and stakeholders affect overall dynamics of the chain (*Luning and Marcelis, 2005),* therefore a relationship between actors and innovation exists. In particular, we can hypothesize that:

- producers and commercial intermediaries are mainly interested in promoting product and process innovation in order to improve their margins,
- consumers push for the introduction of social and process changes, able to respond to their request for food with specific characteristics,
- while governance innovation is peculiar of government, which can decide to introduce new strategies or regulatory instruments even under the pressures of specific actors. This is the case where its possible to distinguish different dynamics regarding the introduction of the innovation. For example, governance takes up innovative initiative for one or few subjects and develops schemes and incentives to encourage a broadening of the innovation (e.g. regulation on farmers' market in Italy). But at the same time an innovation could determine a redefinition of the governance.

Once introduced, innovations could lead to a modification in the relationships among the elements of the system (*Meulenberg and Viaene, 2005*). Actors as well adapt themselves to the new condition and respond to it implementing possible further innovations. The internal governance of alternative networks, explicit or implicit, strong or weak, establishes the typology of relations among the main actors and the process that consolidates consumers' trust, essentially through the approaches of "relocalization" and "certification". These relations can be traced back to three main types (*Renting et al., 2003; Mardsen et al., 2000*), where spatial proximity between producers and consumers prevail (*Jarosz, 2008*):

- face-to-face AAFNs consist in a direct purchase by the consumer from the producer and imply a direct personal interaction between actors, consolidating the concepts of authenticity and quality;
- proximate AAFNs go beyond the direct interactions; they introduce relations of proximity and refer to the sale of products both in the area of production and close to it, also including intermediary actors;
- extended AAFNs extend the selling area outside the boundaries of production location through the use of labelling and certification systems to maintain the connection among producers, consumers and points of production. Quality certifications, with specific regards to the place of origin, are able to promote rural development (*Renting et al., 2003*) and PDO/PGI schemes are considered a basic type of AAFNs (*Sánchez-Hernández, 2009*).

Several studies underline the positive effects of short and local food chains in improving social interactions and trust (*Sinnreich, 2007*), sense of community (*Chiffoleau, 2009; DeLind, 2011*) and increased knowledge leading to behavioural change, in North European and American contexts (*Torjusten et al., 2008; Cox et al., 2008; Saltmarsh et al., 2011*). AAFNs and innovative food chains have been demonstrated to lead to economic benefits, both at farm-level (*Pearson et al., 2011; Sage, 2003; Alonso, 2011*) and a wider level, as an incentive to rural development (*DuPuis and Goodman, 2005*). Finally, sustainability as a whole is therefore affected by single results.

According to the features and definitions of LAS, MAS and GAS described above and in D3.1, main actors involved in food supply chains can be localized from the point of view of the systems in which they mainly operate (fig.2).

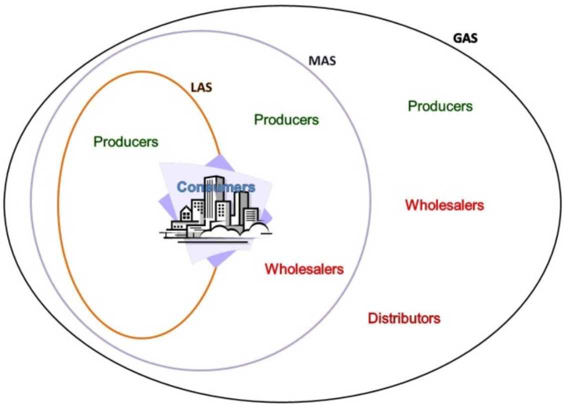


Figure 2: localization of main actors of a food chain

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 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.

With particular regards to LAS, as defined in FOODMETRES, food chains are typically rather short with little number of elements; then, some specific short food chains (to be developed in D5.1) are identified. Though for our purposes shortened food chains are entirely part of the LAS, some of them show a potential for up scaling in other agro-food systems. CSA and Ethical Purchasing Groups were initially aimed to a closer social cohesion and a more set in the local context, but more often they are spreading in other contexts, since they became systems through which consumers request food products with specific characteristics (e.g. organic products), not necessarily produced in the LAS.

Food chains are grouped in two main categories, according to main actors involved and their spatial distribution:

- direct sale. The outline and the classification of food chains into specific categories, is made more complex by many variations leading to intermediate forms between different chains that do not easily fit into a specific group;
- non-local food chains, where actors involved operate also in MAS and GAS.

On these bases, hereafter a graphical representation is proposed, with particular regard to the location of the main actors and their relationships.

2.6.1. Direct sale

In general terms direct sale connects directly a producer to one or more consumers without other intermediaries, even commercial. According to our purposes producers come from a local context (figure 3), but sometimes they could act within a MAS or even a GAS, affecting consequently logistics and impacts.

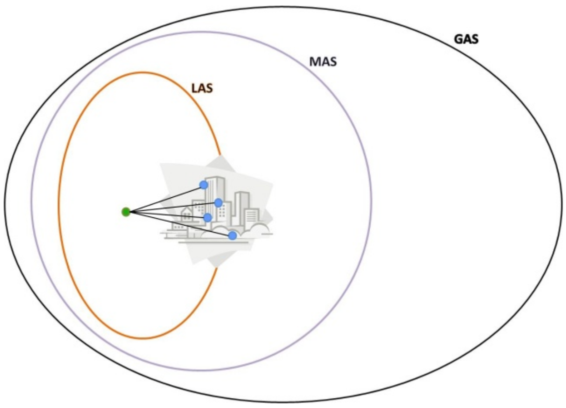


Figure 3: direct sale general scheme

Different forms of direct sale inside the LAS (fig.3) exist to which correspond different modalities for logistics and movement of both actors and products:

- "on farm sales": consumers move to farms where they buy food products supplied;
- "on-line sales": sales are made on-line;
- "off-farm sales": consumers reach the point of commercialization that does not coincide with the site of production or farm.

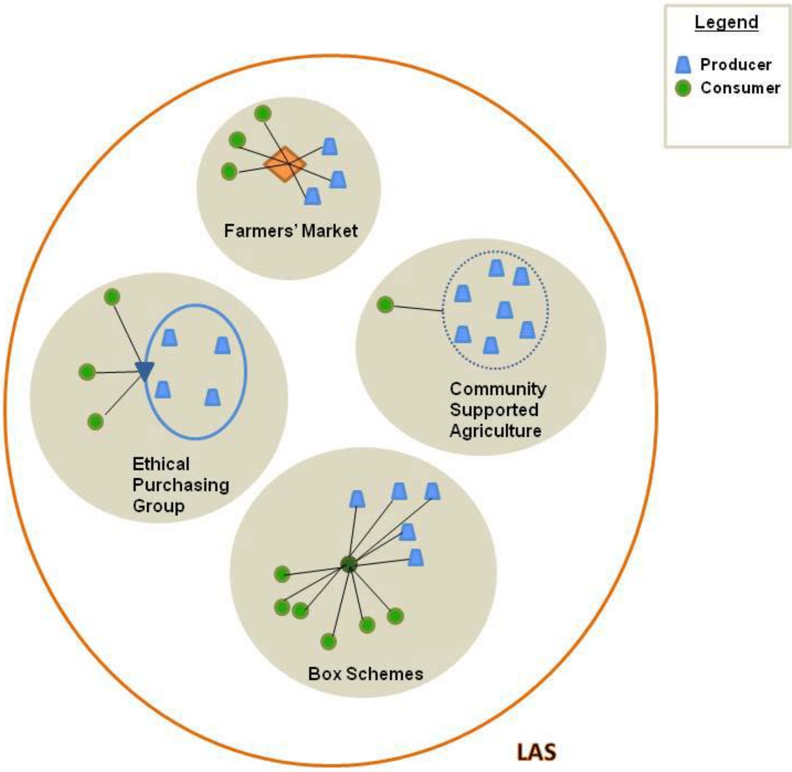


Figure 4: forms of off-farms sales, placed in the LAS.

On-farm sales

An *"on farm sale"* implies that the consumer moves to the farm that sells mainly its own, but not only, food products, where these latter can be bought on site (e.g. farm shops, vending machines at farm), or after a self-collection (e.g. pick-your-own).

On-line sales

"On-line sale" represents a typology of direct sale operated on-line: it allows a direct connection between producers and consumers, without, however, they meet personally.
It is divided into two forms of sales practices:

a) the former can be considered a real form of direct selling, in which the farmer offers its products online through its own sales structure (e.g. from farm website);
b) the second one implies an intermediary, such as a website unrelated to the farm that proposes products on line from different farms; this kind of sale can be included in the non-local food chains, since the website can act as a collector of productions also not strictly local, and not necessarily made in the LAS.

From a logistical point of view, it can occur that producer, once collected the orders of consumers, either

1. delivers ordered products, either in person or by carrier, at consumers' home, according to a logistics optimization; it means that producer or distributor makes several deliveries in the same area at one time or

2. delivers ordered food products in a collection point or at a distribution site, while consumers move there to take them.

Off-farm sales

In sales outside the farm, the handling of products, from the production site to the site of sale or commercialization, is needed. Several examples of shortened food chains are part of this category (figure 4):

- *Vending machines* (e.g. for raw milk, vegetables products, rice) located in one or more spots in a city, or town. Consumer moves to the machine, but also the producer has to consider logistical aspects: its replenishment, the availability of products, the optimization in transporting products from farm and n transport costs and then an optimal location of the machine(s).

- *Farmers' markets*: physical places where both consumers and producers converge to and meet personally one another. The greater are spatial distances from producers to the market, the more complex is logistics. This would imply the need to consider further systems, in addition to the simple transport, which enable an optimal conservation of the products.

Consumers move there; impact are related to distance between consumers and vending sites, resulting in a more/less transport costs, fuel consumptions and emissions.

- *Community Supported Agriculture* (CSA) represents a direct partnership between consumer – or a group of consumers – and a producer. Consumers subscribe to one or more shares of the harvest, supporting financially agricultural activity and assuming both costs and risks related to the activity itself. CSA implies a strong relationship between producers and consumers. It is a direct relationship because no intermediaries are involved. In addition the consumer plays a new role, quite similar to a co-producer, able to address producers' choices to cultivate a crop rather than another or produce something rather something else, according to needs and requests in terms of food products, and guaranteeing the producer a certain gain even in case of harvest failure.

- *Box schemes*. This form of direct sale can be made both by traditional and non-conventional channels (i.e. on-line channels). Producers supply directly consumers – or a group of them – at agreed intervals, with a box of mixed products consumers subscribe to, without, typically, they are able to select the content of the box, even if in some cases, this option is available and consumers can add products to a predefined box or select its entire content. Products are often from several farms. In this case the chain needs the presence of a further actor, a subject who collects required products, assembles physically the boxes and then distributes and delivers boxes to consumers. This role can be played by a producer, who is also a collector, or by a service structure for producers, such as a self-managed structure, an association, a consortium.

- *Ethical Purchasing Groups* (EPGs). They are the operative elements of the system for purchasing goods collectively. Several consumers (individuals, families, groups of consumers) gather together in informal structures and cooperate to buy food and goods directly from producers. Direct connection between producers and consumers then exists, but it is not always a physical connection. In fact, from a logistics point of view, food products are conveyed to a collector, normally a consumer or a representative of the group, and then sorted according to the orders. Then consumers go to their own reference structure, or their representative, and pick up their products.

2.6.2. Non-local food chains

Large-retail distribution

Large-retail distribution represents a food chain traditionally set outside the local context (fig. 5), as deriving from medium-sized and large farms. It is a long food chain, in terms of both distances and nodes. Producers and consumers do not meet themselves personally. Producer does not approach consumer, but vice versa: it is rather the consumer who goes to the store or the distributor, perceived to be the subject closest to the producer.

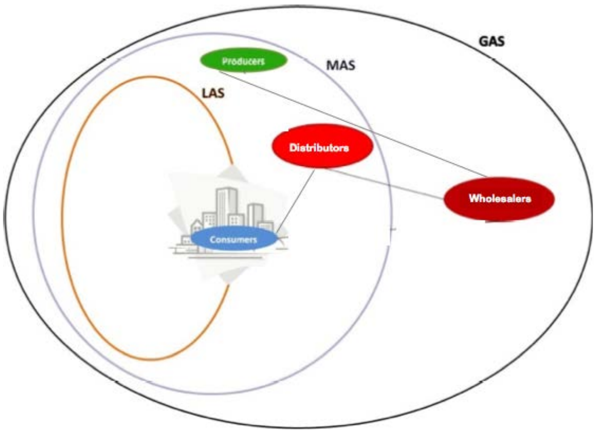


Figure 5: general scheme of a large-retail distribution system

Such a long food chain is complex, resulting in more complex logistics, as (raw) food products undergo several steps through wholesalers, transformers, processors and distributors before arriving at the consumer. The product is therefore strongly moved along the whole chain. However, some experiences of different large-retail distribution yet exist. It is this the case of distributors that supply directly from local producers, but it does not necessarily mean that also nodes along the chain are reduced, as consumers are still connected to producers through large distribution:

1. cooperative of producers: consortium that groups them and manages the relationships with large-retail distribution, which is responsible for the sale of their products;
2. sale of fresh and local products at service stations;
3. single local producers allowed selling their products on the shelves of retailer, subject to agreements with the distributor itself; products are expected to pass through one or more intermediaries before arriving to distributor.

4. On-line sales made by websites that doesn’t necessarily collect and sell only local farms product (see 2.6.1).

Integration between consumers, producers and institutions: public procurement and public catering

Food chain related to public procurement and catering deals with the service of preparation and delivery of meals at large scale, for collective consumers (e.g. schools, canteens, hospitals, etc.). This is a form of dialogue and effective integration between consumers’ communities and producers, with substantial involvement of public institutions, typically municipalities. This kind of agreement between the two groups is mediated by public institutions and allows the optimization of the objectives of both groups: producers and consumers.

These initiatives need the intervention of public administrations or government of private entities, grouping a large number of consumers, which decides to entrust a catering or Procurement Company for the distribution of meals. The catering company responsible for the service may decide, in agreement with involved users, to source products with certain characteristics (e.g. organic food, local products, quality products, etc.). Thus it is not the individual consumer who directly choices products, but the wider administration of the group of which it is part. Public procurement can be realized by the interaction of different actors along the chain: the longer it is, the more complex is logistics. In any case a flow of products occurs, in a path comprehending several steps, from producers to distribution and the relationship between producers and consumers is totally indirect.

Table 1: Types of sales classified for food chain types, as also used in the Impact Assessment (D5.1)

	Consumers As (co) producers	Producers-consumers partnerships/ cooperatives	Producers' direct sale to individual consumers	Sale to intermediaries
Urban Gardening (for commercial purposes)	X			
Consumer-producer-partnerships (incl. CSA, EPG)		X		
Direct sales/marketing on-farm to the private consumer (incl. farm shop, PYO, vending machine)			X	
Direct sales/marketing off-farm to the private consumer (incl. box scheme, online sale)			X	
Sales to regional enterprises like retail or hospitality industry (single producer or cooperative)				X
Sale to public procurement and public catering (single producer or cooperative)				X
AgroParks / Metropolitan Food Clusters (MFC)				X

3. Territorial approach to define the MAS

3.1. OECD approach

OECD approach allows getting to an administrative definition of metropolitan areas as functional economic places. It is essentially based on the combination between demographic information and travel-to-work flows at NUTS3-level, even if more often socio-economic dynamics, nor metropolitan areas, coincide with administrative boundaries.
The wider area can be subdivided into three main sub-areas, still maintained as conceptual and methodological framework in a recent revision of the methodology (2012), to overcome administrative limits and favour a more easy comparison among OECD-countries:

- Urban high-density clusters, i.e. densely inhabited urban cores, contiguous one another or highly interconnected;
- Interconnected urban cores part of the same functional areas, included in a polycentric structure according to the share of population commuting to work from a core to another;
- "Hinterlands", or areas outside the strictly urban core that represent work-catchment areas of urban labour market.

According to the numerousness of population within the whole identified area, a classification is proposed (*Brezzi et al., 2012*), into whose latter category it is possible to recognize all FOODMETRES case study regions (cfr. Appendix I, table 4):

- Small urban areas: less than 200,000 people;
- Medium-sized urban areas: 200,000 – 500,000 people;
- Metropolitan areas: 500,000 – 1.5 M people;
- Larger metropolitan areas: more than 1.5 M people.

3.2. LISA approach

Most of foodshed analyses and metropolitan delimitations are based on a specific area defined by administrative boundaries, or other starting assumptions not calibrated on the potential food demand and supply. A tool to spatially identify a "dense core" of a wider metropolitan area where the most of food demand is generated can refer to operative models of spatial autocorrelation. LISA (Local Indicators for Spatial Association) approach (*Anselin, 1995*) allows to spatially weighting territorial variables representative of a phenomenon and its support by a GIS-based software package GeoDA enables to return results graphically.

As *Corsi et al.* (2013) and *Sali et al.* (2014) have already described for Milan Metropolitan Region, the application of this kind of analysis allows isolating a more densely-populated core, as the territorial basis the quantitative dimensions of food demand and supply are estimated on, and consequently the geographical extension of agricultural area needed to satisfy specific food demands.

The attribution of the weight to the variable is a critical point of the analysis, as on this phase it depends a different result: *contiguity-based weight* defines the closeness among variables according to a common boundary (e.g. *queen contiguity-based* and *rook-contiguity based*), while *distance-based* weight calculates and associates the closeness starting from the distance among points or centroids of polygons (e.g. *distance-band*, *k-nearest neighbour*). The choice between these typologies has to be taken according to the characteristics and the features of each specific case study area and results they want to obtain.

The repeatability of the method in different contexts allows producing cluster maps that aggregate in four colour codes the degree of autocorrelation and the match among values of the variables. For our purposes it has been decided to consider the denser core as the set of clusters including high-dense and low-dense municipalities bordering in turn to other ones densely populated (red and violet clusters), whose main features are summarized in table 4 (annex I). Spatial analysis results have been defined for each case study region in FOODMETRES, as shown in figure 14.

3.3. Accessibility approach

One of the most critical issues in the field of Agricultural Food Systems (AFS) is the difficulty to delineate the different sub-systems in terms of explicit spatial boundaries. As demonstrated in the introduction to this report, the level of abstraction increases in terms of their geographic-functional space: while LAS regions are still relatively easy to identify – though data availability at the European level is difficult, too – , GAS is the most challenging and often restricted to some spatial specifications for selected commodities. MAS regions, on the other hand, are often portrayed as Thünen-style concentric circles or boundary-less zones around urban agglomeration centres (Smeets et al. 2004; van Steekelenburg 2011; Tress et al. 2004). However, the functional distances to supply and demand can vary substantially due to topography and the transportation network surrounding an urban agglomeration. As such, distance expressed in travel time to a MAS-region but be considered as a proper variable when defining urban-rural relationships (Eupen et. al 2012).

Taken the food demand of a city as identified in this report (see Section 5) into consideration we have undertaken a GIS-based assessment of the required amount and location of 'local hectares' of agricultural areas required for feed the urban urban population at the heart of a metropolitan region.

The assessment procedure that we have applied is as follows:

- Starting point of assessing transport distances is the centre location of the capital urban centre of the metropolitan region, thus the very city centres of London, Berlin, Rotterdam, Ljubljan and Milano (because this approach is based on European data sets, we have not undertaken this assessment for Nairobi yet)
- We then used the European data on the traffic network which differentiates hierarchies of road systems. For our assessment we used the primary (highway) and secondary (provincial roads) as references for the accessibity of regions. Rather than using euclidian distances, we opted for real travel time distances, taking into account the different spatial extension of these cities. This led us to the establishment of six accessibility levels at 0.5 hours intervals:
- These accessibility parameter allowed to identify four types of agricultural areas, namely ara ble lands, permanct crop, pastures and hetrogenous agricultural lands.
- We further excluded protected areas, forests, settlement areas and water bodies from this search.

Applying the above approach allows to identify the metropolitan potential for land-based food supply as one of the criteria developing sustainable food chain strategies at the regional level.

4. Analysis of supply

Food supply can be referred to land use and available agricultural area in a specific territory or in relation to the amount of obtained raw products (quantities or productivity). This does not mean, however, that these productions still remain confined within particular boundaries, as rather food products move in the global market. This condition restricts the possibility to limit food supply to the local sphere, as it is more precisely affected by all the components of commercial balance, from productions and stocks, to imports and exports.

In this project, or at least at this stage, supply analysis does not aim to monitor flows of food and agricultural products – step that would be certainly made easier by labelling and traceability systems particularly efficient – but rather to assess and indicate the productive potential of a metropolitan region and its sub-areas, suggesting the extent to which a specific territorial unit can satisfy its needs and potentially those of its close areas.

4.1. Agricultural land around the city

The city, the urban conurbation or better the metropolis represents the central core of a metropolitan region the surrounding areas gravitate on. Typically these urban hinterlands, characterized by a lower density than urban centres, are part of the rural domain, where agricultural production and related activities dominates. Dimensions of supply, in terms of the amount of cultivated area, vary according to the boundaries of the territory used as a "benchmark" for its calculation. As a consequence and with regard to what previously explained on spatial delimitation of case study area, an overview on agricultural land is given in table 2. The productivity of which depends on the actual land use. Once more it is demonstrated that the core identified with the LISA approach is the densest area of the metropolitan region, as characterized by an extension of productive areas averagely equal to 10% of that in the OECD region.

Table 2: analysis of supply in case study areas, according to the different territorial boundaries identified

Case study area		Utilized Agricultural Area (ha)	Arable land (ha) (%)	Grassland (ha) (%)	Permanent crops (ha) (%)
Berlin	*OECD*	1,325,873	1,033,360 (77.94)	287,630 (21.69)	4,724 (0.36)
	LISA	n/d	n/d	n/d	n/d
	ACCESSIBILITY	75,394	62,706	4,031	175
	0.5 hours	473,206	369,031	15,813	2,963
	1.0 hours	1,347,425	1,050,800	60,400	4,750
	1.5 hours	2,750,763	2,147,813	1,39,500	5,850
	2.0 hours	4,651,119	3,680,763	2,40,050	10,956
	2.5 hours	6,987,906	5,518,638	4,10,994	15,613

	3.0 hours				
London	*OECD*	1,123,125	735,734 (65.51)	369,973 (32.94)	112 (0.01)
	LISA	5,189	1,708 (32.92)	3,351 (64.58)	0 (0.00)
	ACCESSIBILITY	121,819	57,450	3,719	94
	0.5 hours	874,019	503,769	19,038	94
	1.0 hours	2,114,125	1,372,319	24,213	744
	1.5 hours	3,366,088	2,295,319	45,138	750
	2.0 hours	4,773,738	3,306,613	55,263	944
	2.5 hours	6,047,850	4,082,500	64,450	1,050
	3.0 hours				
Ljubljana	*OECD*	850,335	184,076 (21.65)	51,661 (6.08)	365,342 (42.96)
	LISA	154,841	14,019 (9.05)	1,560 (1.01)	19,414 (12.54)
	ACCESSIBILITY				
	0.5 hours	71,806	11,050	48,844	31
	1.0 hours	217,863	17,325	149,844	2,644
	1.5 hours	491,706	50,881	340,819	10,081
	2.0 hours	1,021,731	199,225	639,231	24,556
	2.5 hours	1,779,469	439,519	1,035,219	41,356
	3.0 hours	2,576,669	695,450	1,431,013	53,088
Milan	*OECD*	489,243	377,836 (77.23)	91,747 (18.75)	31,982 (6.54)
	LISA	56,358	43,517 (77.22)	11,335 (20.11)	1,455 (2.58)
	ACCESSIBILITY	191,163	173,969		125
	0.5 hours	804,044	679,850	12,756	14,906
	1.0 hours	1,541,031	1,175,406	96,575	34,838
	1.5 hours	2,256,838	1,566,588	305,475	93,081
	2.0 hours	3,012,163	1,982,575	541,956	128,831
	2.5 hours	3,801,313	2,434,850	805,906	149,156
	3.0 hours			1,071,319	
Rotterdam	*OECD*	183,390	82,387 (44.92)	92,246 (50.30)	82 (0.04)
	LISA	33,177	15,891 (47.90)	16,644 (50.17)	0 (0.00)
	ACCESSIBILITY	74,556	20,063	1,056	0
	0.5 hours	347,944	96,581	36,588	1,344
	1.0 hours	890,406	251,156	259,369	4,506
	1.5 hours	1,711,813	495,119	584,825	6,831
	2.0 hours	2,969,044	970,388	962,438	14,169
	2.5 hours	4,467,238	1,890,044	1,293,044	15,531
	3.0 hours				

Agricultural and/or cultivated areas, due to their production potential, are able to and could directly supply cities with food products, as urban centres are not completely self-sufficient. To better deepen this issue, for our purposes, total agricultural land, as surveyed in national statistics, has been assumed to be entirely devoted to wheat (*Sali et al., 2014*), in order to determine the maximum productive potential of each territorial unit. This simplification does not consider the real land use, nor their real potentialities to be converted to the cultivation of reference product or to produce it.

A more accurate analysis should be take into account also the extent of production area of a certain crop per kg of meat/milk/eggs, as developed and proposed for this project by Zasada: the actual food supply has been considered, on the basis of regional agricultural situation, and indicates both how much is actually produced and on how much agricultural area, also taking into account fodder demand in (conventional) livestock farming through the application a fitted model (*Woitowitz, 2007*).

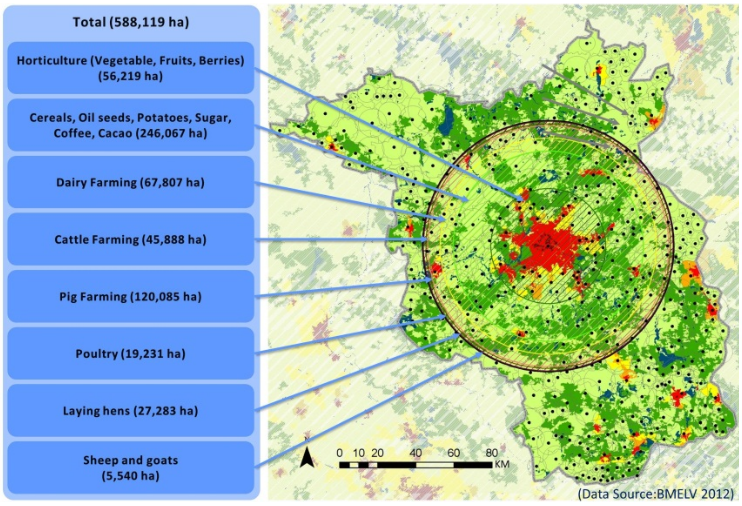


Figure 6. Commodity-specific cultivation area demand Berlin-Brandenburg.

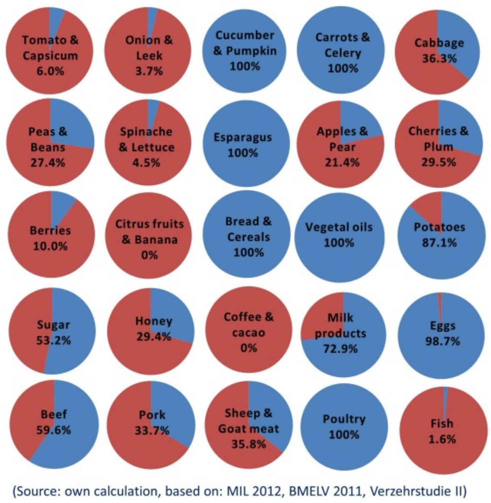


Figure 7. Commodity-specific coverage of regional demand by regional supply

Figures 6 and 7 shows the result of a commodity-specific demand-supply calculation for the Metropolitan area of Berlin-Brandenburg (Zasada et al., unpublished) with (i) comparing the actual food consumption with the actual food production as well as (b) with the calculation of the required area to cover the entire food demand in the region. However, the estimation of supplied quantities is only on theoretical nature, as many commodities need to be imported anyway.

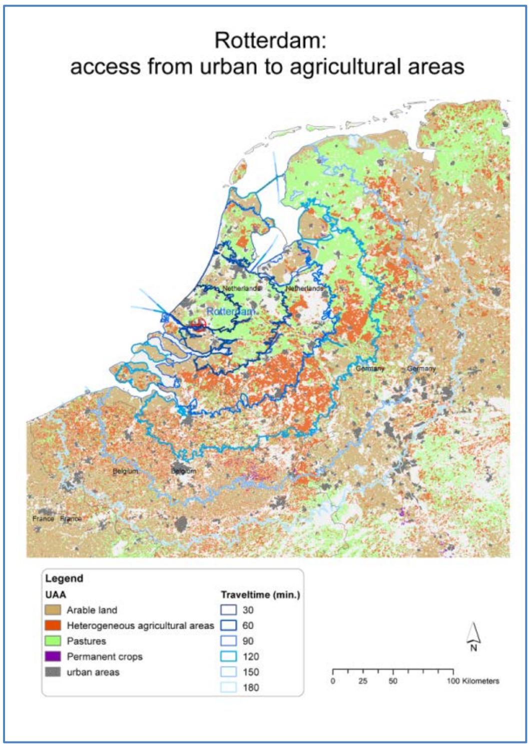


Figure 8. accessibility map for Rotterdam

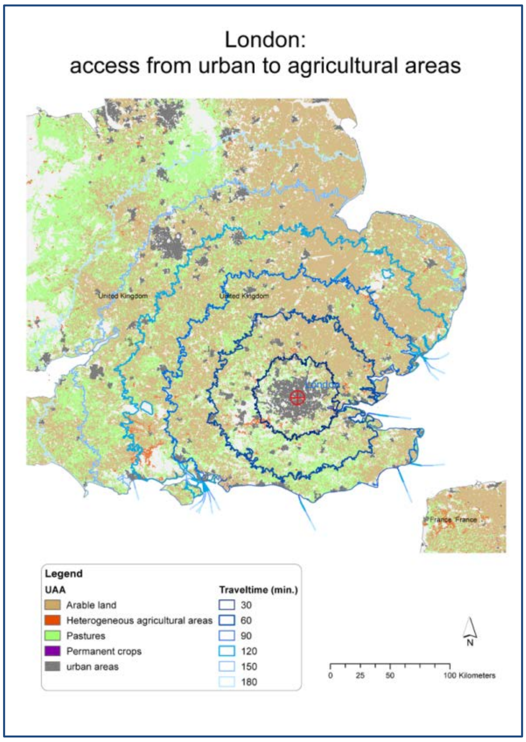


Figure 9. accessibility map for London

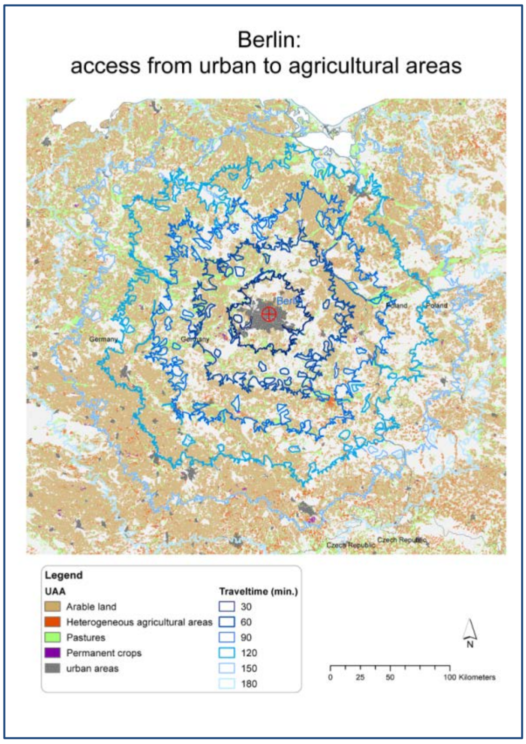


Figure 10. accessibility map for Berlin

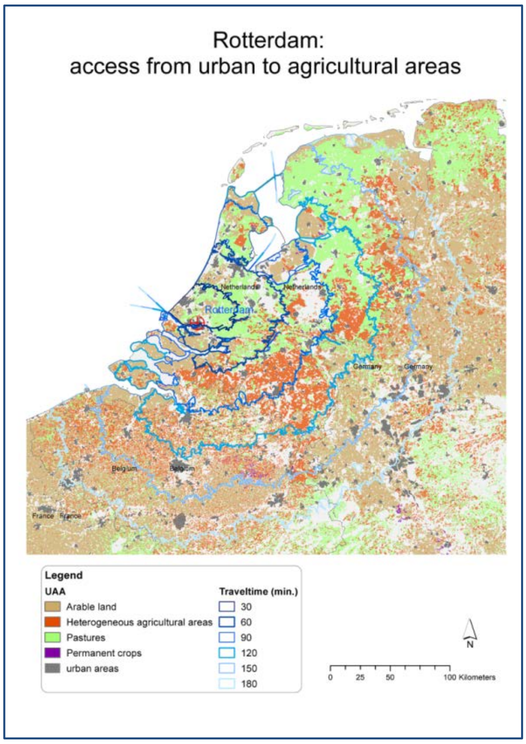


Figure 11. accessibility map for Rotterdam

5. Analysis of demand

Analysis of demand can be traced back to two main aspects, both quantitative and qualitative analyses and reviews. With particular regard to the qualitative point of view, the demand can be analyzed in relation to consumers' preferences and requirements for food with certain specific characteristics. In recent years, the request of alternative food production has more and more been increasing due to several factors and concerns that strongly influence the public opinion in their thoughts and habits. People are asking for diverse and distinctive food (*Darby et al., 2008*), they are more and more concerned with sustainability, quality and health (*Kirwan, 2004; Seyfang, 2008; Kneafsey et al., 2008*) and they are afraid of food scandals have occurred over the years, e.g. BSE or avian influenza. Several factors have become important drivers for consumers' food decision (*Gracia, 2013*), the most relevant price and other quality issues, such as sensory, health, process and convenience (*Grunert, 2006*). For 96% of consumers the quality of the product is the most important determinant attributes for buying products, followed by its price (91%) (*Eurobarometer, 2012*) and environmental impact (84%) (*Eurobarometer, 2013*), while the least important factor to consumers is the brand name of the product (46%).

These particular features are those consumers perceived to be the main attributes of local food. Nowadays, it represents an interesting market opportunity for the importance more aware consumers give to the reduction of environmental impacts (*Brown, 2003; Zepeda e Leviten-Reid, 2004; Hein et al., 2006; Roininen et al., 2006; Chambers et al., 2007; Hunt, 2007; Conner et al., 2010*) these products are thought to ensure, to food safety and quality (*Murdoch et al., 2000; Brown, 2003; Zepeda e Leviten-Reid, 2004; Hein et al., 2006; Roininen et al., 2006; Chambers et al., 2007; Hunt, 2007; Roheim et al., 2007; Conner et al., 2010*), to an increased social and economic justice and a strengthened social embeddedness (*Cranfield et al., 2008)*, through a support to local farmers, economies and communities (*Kirwan 2004; Seyfang 2008; Kneafsey et al. 2008*), finally resulting in a total agreement that there are benefits to buying local food (*Eurobarometer, 2011*).

These perceptions reflect on consumers' behaviours to make food purchases. On these bases, consumers' willingness to pay (WTP), especially for local food, is also driven by freshness and corporate image concerns (*Darby et al., 2008*), requiring a need of transparency in the production process, consequent to recent food scandals. Moreover WTP for local attributes and environmental-friendly strategies have been growing, due to an increased demand for organic products and the local political support for environmental-friendly food, even in terms of production processes in accordance with nature conservation criteria (*Wirthgen, 2004*): 55% of citizens in the EU-27 agree that green products are good value for money and a stronger share believe that these products can make a difference to the environment (89%), while 77% are willing to pay more for them if truly environmental-friendly. For environmental reasons more than 70% of EU citizens are willing to change their food habits, towards a less protein-based diet, replacing beef or pork with poultry or fish (*Eurobarometer, 2013).*

Several empiric works for the assessment of WTP for local fresh food products have been carried out, especially in North American contexts (*Giraud et al., 2005; Schneider and Francis, 2005; Bond et al.,* *20008; Husvedt and Bernard, 2008; Hu et al., 2009; James et al., 2009; Carpio and Isengildina-Massa, 2009; Yue and Tong, 2009; Campbell et al., 2010; Costanigro et al., 2011; Wolf et al., 2011; Hu et al., 2012*) suggesting the WTP an extra premium for locally grown products. Similar studies set in European areas are however more scarce. In this regard they are reported the works of *de Magistris et al. (2012)*, based on food miles issue, *Gracia et al. (2012) and Gracia (2013).*

Similarly, the agricultural WTP has been widely analyzed for organic food, as well, according to different food items and characteristics (*Gil et al., 2000; Johnston et al., 2001; Loureiro et al., 2001; Loureiro and Hine, 2002; Wier and Calverley, 2002; Krystallis and Chryssohoidis, 2005; Loureiro and Lotade, 2005*), demonstrated how consumers are willing to pay for them a price premium, even over 30%.

5.1. Population and food habits

Food habit surveys provide information resulting from the combination between qualitative - *what is consumed?* – and quantitative - *how much is consumed?* – aspects of food consumption. It particularly varies according to geographical area and country, economic, social and cultural aspects, population diets, available food items. FAO statistics (*FAO, 2010*) give a first response to this issue, summarizing and making easily comparable daily consumption for countries all over the world. With particular regard to countries of partners involved in the FOODMETRES project, a first overview is given on main nutrients consumption (table 3), food categories (fig. 12) and food items (figs. 13-15) mainly contributing to daily caloric intake.

Table 3: dietary energy, protein and fat consumption (2005-2007) (*FAO, 2010*).

Country	Case Study area	Proteins [g/person day]	Fats [g/person day]	Energy [kcal/person day]
Kenya	Nairobi	58	47	2,060
Slovenia	Ljubljana	101	121	3,220
Netherlands	Rotterdam	105	136	3,243
United Kingdom	London	104	145	3,442
Germany	Berlin	99	143	3,530
Italy	Milan	112	156	3,657

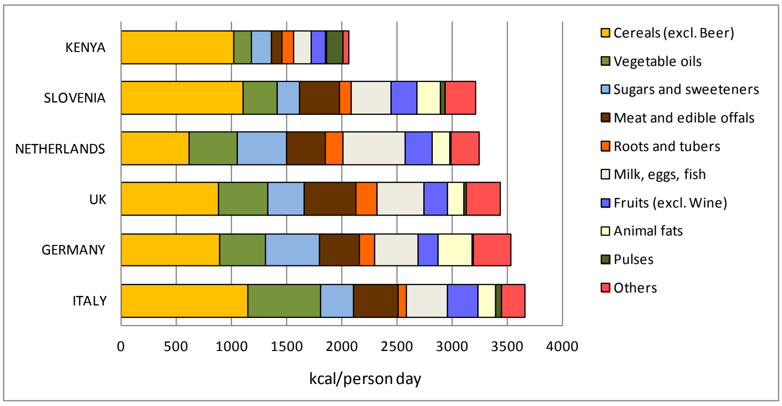


Figure 12: share of dietary components in total energy consumption (*FAO, 2010*).

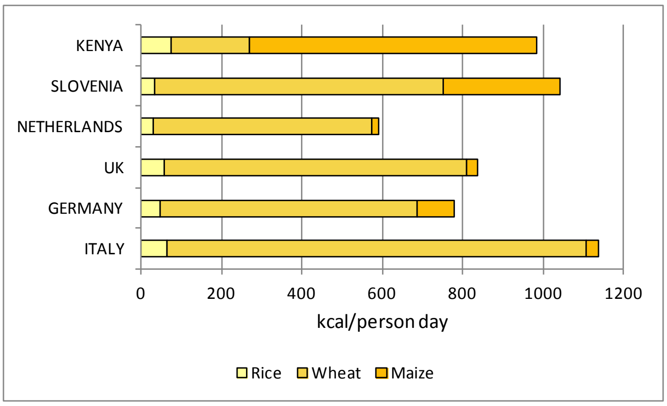


Figure 13: consumption of major cereal products (*FAO, 2010*).

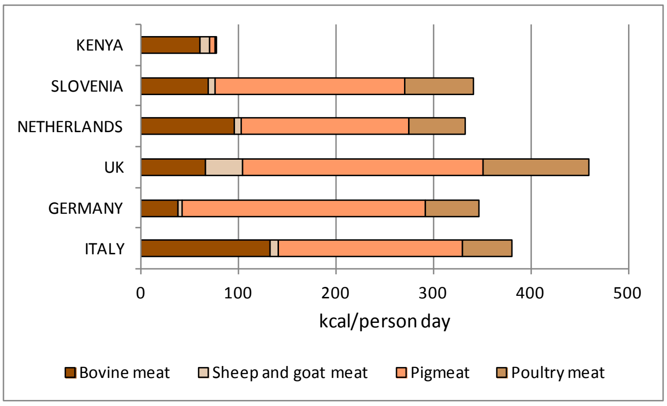


Figure 14: consumption of major meat products (*FAO, 2010*).

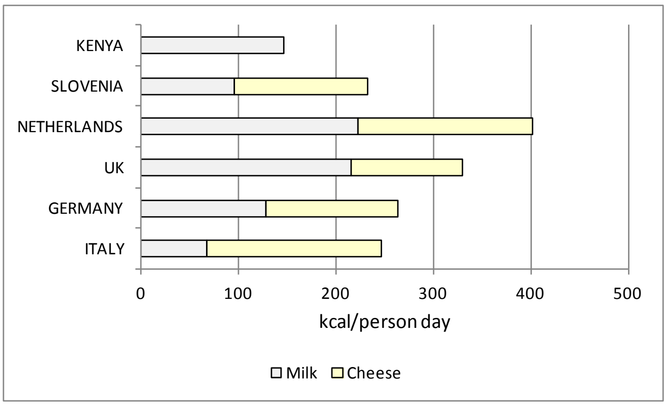


Figure 15: consumption of major dairy products (*FAO, 2010*).

At a more detailed level for EU Countries, and then for the most of the FOODMETRES case study regions, a data source on food consumptions is given by Comprehensive European Food Consumption Database. Data availability is however limited to on-line available version (*"Chronic food consumption statistics", EFSA, 2011*) that collects results of National surveys on dietary habits in a range of European Countries, possibly not including countries of interest (e.g. Slovenia), for which it is necessary to retrieve the data directly from national statistics. Data are broken down per food category and subcategory, but it is possible to compare case studies on food consumption relative to adults only, as shown in figure 16.

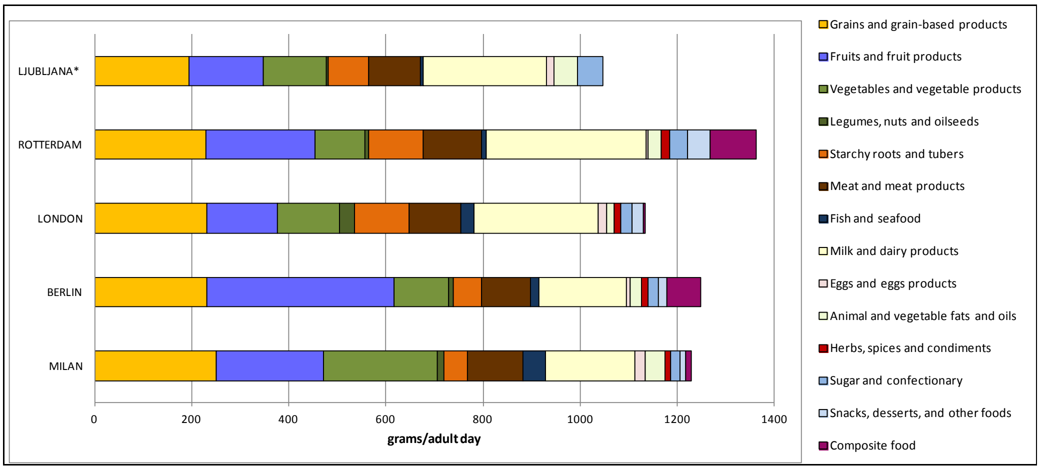


Figure 16: food consumption, adults only. *Source: Statistical Office of the Republic of Slovenia

5.2. Food consumption: estimation models

The lack of quantitative data on the amount of food demand leads food consumption survey to play a role as their proxy. Daily pro capita food consumptions can be standardized through their conversion in calorie intake, in order to estimate the extension of agricultural area, devoted to a "reference product", needed to produce calories to satisfy total caloric intake expressed by population, as proposed by *Sali et al.* (2014). The authors refer in particular to agricultural land dedicated to wheat, since it is usually used in literature as a benchmark product: in 1815 David

Ricardo, in his *Essay on the influence of a low price of corn on the profits of stock*, one of the most important classical economic book, considered it as the "representative product" to build his theory.

Alternatively, a similar approach is that of the above mentioned "food supply-area demand model" proposed for Berlin-Brandenburg Federal State (Zasada et al., unpublished). On the demand side, it is based on the actual food demand, in terms of type and amount of food categories consumed by people, extrapolated to the number of people; it also includes and considers the fodder demand for animal husbandry, food loss and waste in the different stages of the supply chain as well as the weight loss during processing *(FAO, 2011; European Commission, 2010; Buzby and Hyman, 2012*). While this latter method can be applied for all our case study regions, the estimation of the demand would need to be updated with other (national, regional, world) food consumption surveys, as different sources show significant differences in consumptions.

5.3. Supply-demand analyses

On the basis of what described in paragraphs P and P, three similar but conceptually different approaches have been identified (fig. 17), can be replied where data needed available, adopted or modified accordingly.

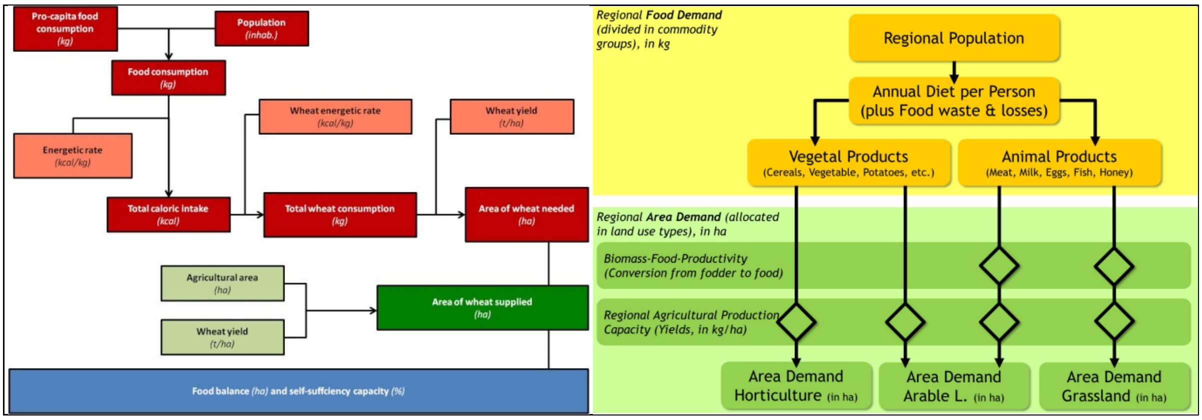


Figure 17: different approaches for supply-demand analysis

I - Can supply meet demand? To what extent?

The comparison of demanded and supplied quantities in different case study regions, no matter they expressed, has led to the estimation of a simplified food balance, resulting in the identification of areas within them where a productive surplus or deficit occurs. The region analyzed from time to time has thus been subdivided according to the degree of its self-sufficiency capacity (fig. 18, left), i.e. the percentage ratio between supply and demand expressing the extent of a territorial unit to meet its own food requirements. The analysis of the spatial distribution for each individual locality provides indications about their food self-sustainability and the possibility to satisfy urban demand through proximity agriculture.

II - How much area to feed people?

The second methodology refers to a model to derive the amount of agricultural area needed to feed a certain number of persons, without considering demand of water and other natural resources required for food production. It can be estimated even subdivided per commodity, capita, municipality or aggregated for a defined area; a buffer around each unit of analysis (fig. 12, right) shows the required agricultural area taking the share of agricultural land-use into account, suggesting if it can be more or less easily supplied within its own or regional boundaries and by local or proximate agricultural productions.

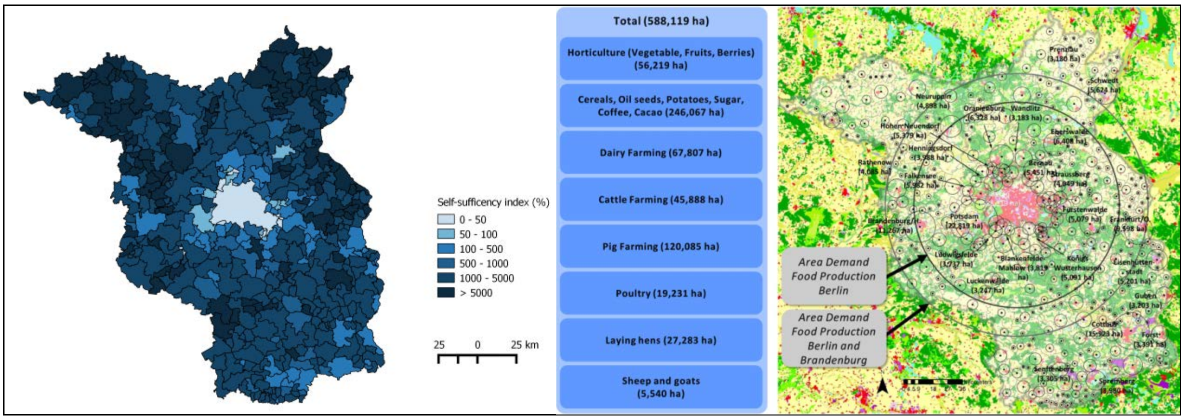
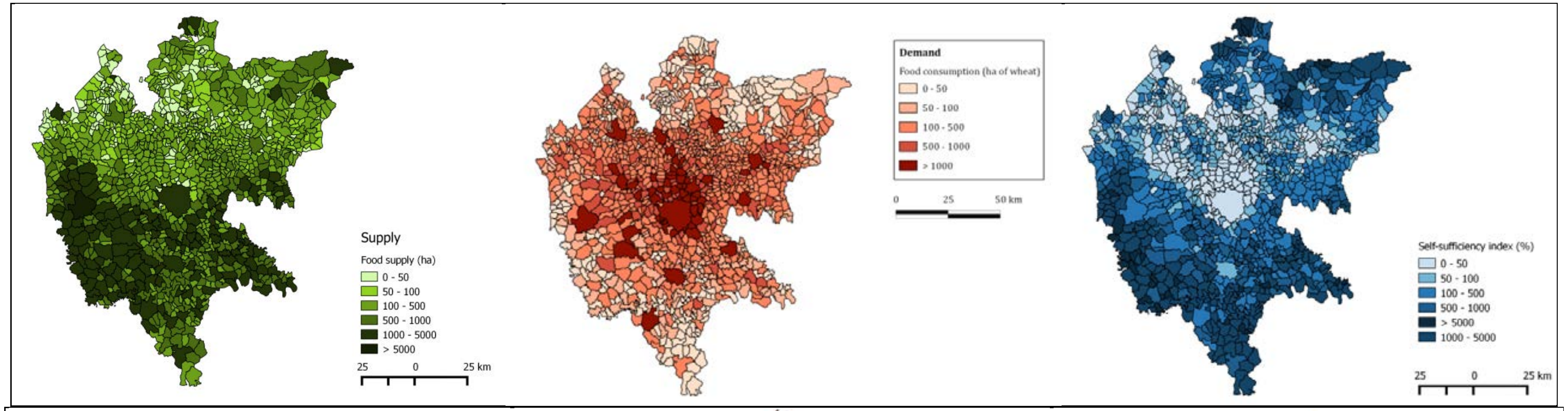


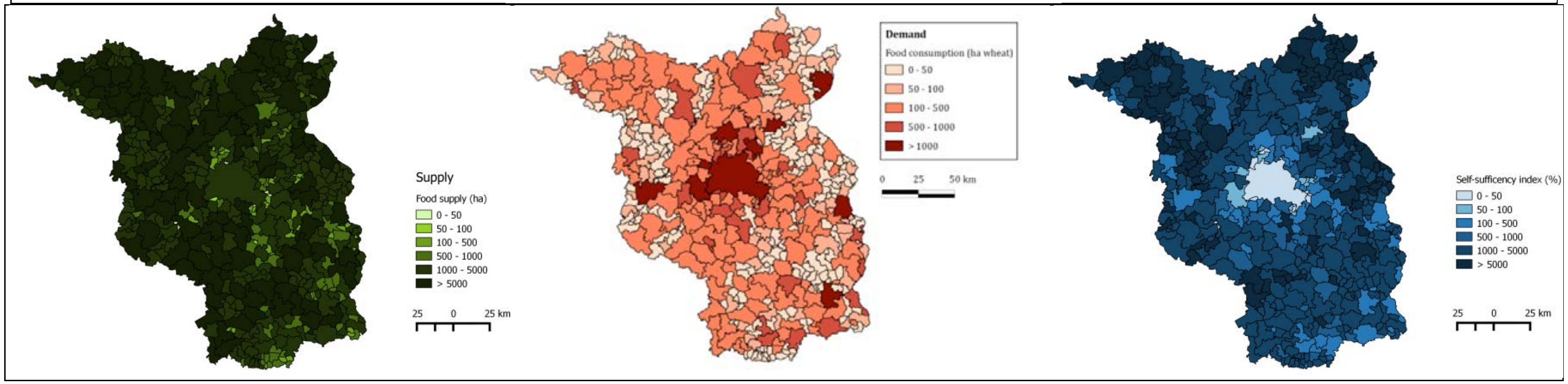
Figure 18: capacity of supply to meet demand in Berlin-Brandenburg metropolitan region (left) and area demand for the city of Berlin and the Federal State of Brandenburg, subdivided into individual commodity groups (right).

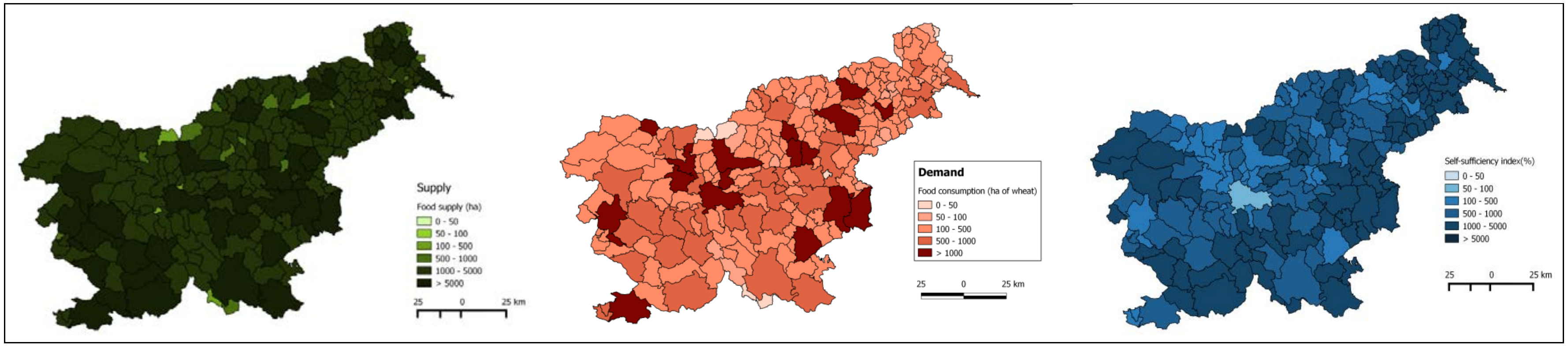
II – Where are the areas of production and how far from the city center??

The third approach identifies and quantifies the total amount of utilized agricultural area, arable land, grassland and permanent crops and maps them in order to define the accessibility that is a fundamental assumption to assess the potential supply for specific food short regional food chains.

Undoubtedly the first method, replicable in all the case studies and more easily interpretable, will be the model on which the subsequent analysis will be based, but some considerations arising from the two other approaches allow us to adjust and better address some specific aspects.


Supply
Food supply (ha)
0 - 50
50 - 100
100 - 500
500 - 1000
1000 - 5000
> 5000
25 0 25 km
Demand
Food consumption (ha of wheat)
0 - 50
50 - 100
100 - 500
500 - 1000
> 1000
0 25 50 km
Self-sufficiency index (%)
0 - 50
50 - 100
100 - 500
500 - 1000
> 5000
1000 - 5000
25 0 25 km


Supply
Food supply (ha)
0 - 50
50 - 100
100 - 500
500 - 1000
1000 - 5000
> 5000
25 0 25 km
Demand
Food consumption (ha wheat)
0 - 50
50 - 100
100 - 500
500 - 1000
> 1000
0 25 50 km
Self-sufficency index (%)
0 - 50
50 - 100
100 - 500
500 - 1000
1000 - 5000
> 5000
25 0 25 km


Supply
Food supply (ha)
0 - 50
50 - 100
100 - 500
500 - 1000
1000 - 5000
> 5000
25 0 25 km
Demand
Food consumption (ha of wheat)
0 - 50
50 - 100
100 - 500
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25 0 25 km
Self-sufficiency index(%)
0 - 50
50 - 100
100 - 500
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25 0 25 km

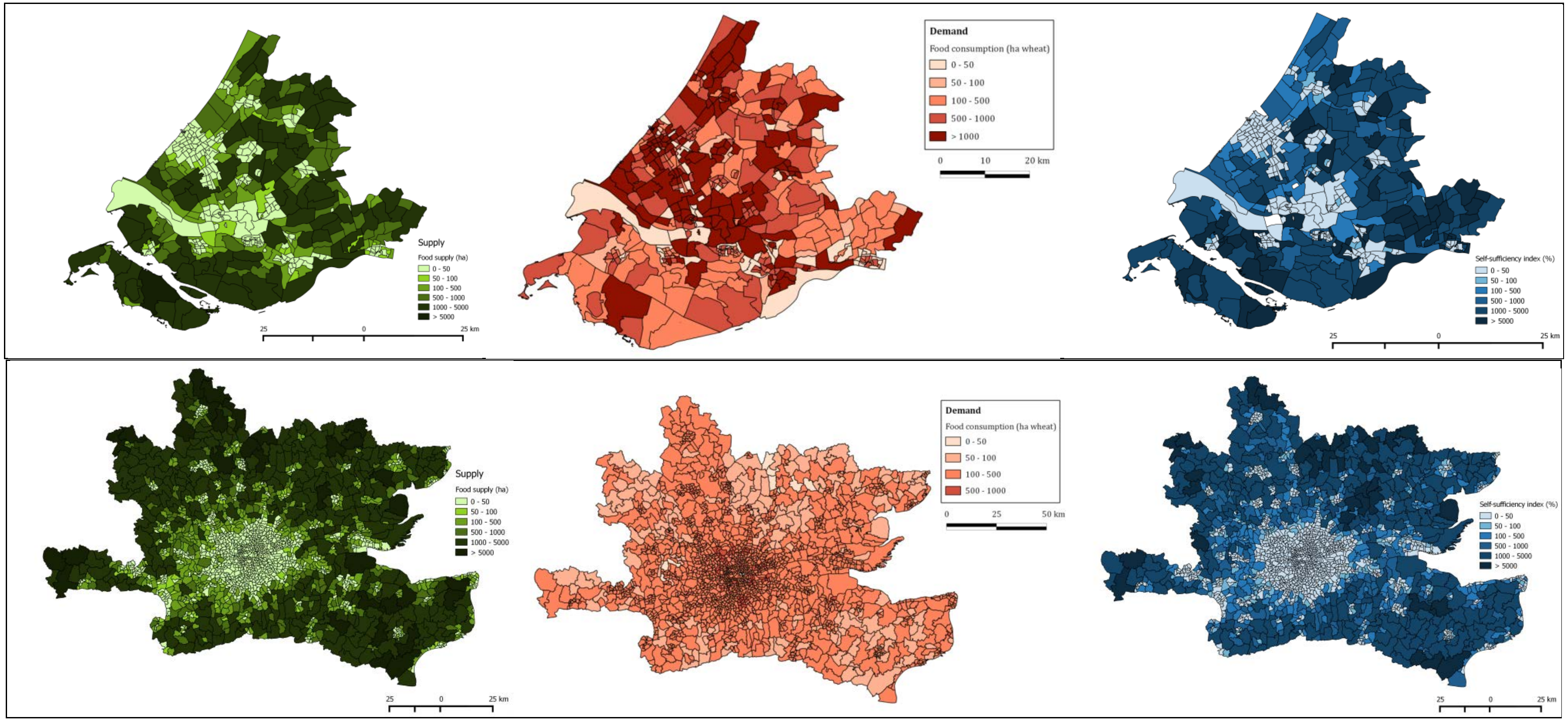

Figure 19: supply-demand analysis – results in case study regions (from National statistics and CORINE LAND COVER 2006)

6. Conclusion and suggestions for application

The present report gives very important suggestions for the development of the project at general and case study level.

The review analysis of LAS, MAS and GAS with the consistent description of the AFNs completes the definition given in the D 3.1 and is connected to D 5.1. The integration of definition and analysis will be very useful for the development of the next project output, in particular for the D 2.2 which will study economic implications and relationships between demand and supply in the current conventional food chains and the contribution of AFNs to the sustainability of innovative food chains.

The main result of the present report is the spatial analysis at case study level. Firstly the identification of the dense core of the metropolitan regions thanks to a simple, replicable and scientific based model provides interesting information in terms of localization of demand and clustering functional to the planning and governance of short regional food chains, which is the objective of the D 2.3.

The results of the LISA model in the five case studies emphasize the spatial features that distinguish the different metropolitan contexts in terms of concentration degree, compactness and relevance of the dense core in comparison with rest of the metropolitan region.

The second and most relevant level of results is the quantification of the food balances in the case study. Even this second spatial analysis is a replicable model based on data available for each case study and extendable to other European countries. In fact the quantification of demand relies on the EFSA database that collects national consumption surveys and supply analysis makes use of data on agricultural land and potential wheat yield, both available in every areas.The maps of figure 19 explain the innovative contribution of this analysis that identify the areas where demand is concentrated, the areas where we can find the potential production and finally the degree of self-sufficiency. As in the LISA model even in this case the maps show significant and distinct features of the case studies. This allow the adjustment of the future analysis in order to answer to actual local needs and limits.

The methodology, although resulting from the inevitable simplifications, provides interesting results and allows further and more refined elaborations such as the accessibility analysis and the local production identification in Berlin metropolitan region.

The spatial definition of demand, supply and self-sufficiency doesn’t give any information about the Metropolitan Footprint Analysis and Sustainability Impacts Assessment, but contribute to the knowledge of the potential opportunities to create, develop, strengthen and govern innovative, alternative, sustainable short food chains.

Annex I: Results of spatial autocorrelation

Table 4: comparison among case studies between OECD metropolitan region and the dense core from LISA approach.

Case study area	LAU2 (n.)			Population (.000 inhabitants)			Area (.000 km²)			Density (people per km²)	
	OECD *[a]*	***LISA*** *[b]*	***a/b*** *(%)*	***OECD*** *[a]*	***LISA*** *[b]*	***a/b*** *(%)*	***OECD*** *[a]*	***LISA*** *[b]*	***a/b*** *(%)*	***OECD***	***LISA***
Berlin	*420*	*39*	*9*	*6,037*	*4,188*	*69*	*31.5*	*2.9*	*9*	*198*	*1,467*
London	*1,943*	*540*	*28*	*15,855*	*6,933*	*44*	*16.3*	*1.1*	*7*	*970*	*6,076*
Ljubljana	*210*	*15*	*7*	*2,050*	*440*	*21*	*20.2*	*1.5*	*8*	*102*	*286*
Milan	*1,163*	*260*	*22*	*7,892*	*4,536*	*57*	*13.1*	*2.1*	*16*	*602*	*2,165*
Rotterdam	*442*	*184*	*42*	*3,552*	*1,949*	*55*	*3.0*	*0.8*	*29*	*1,168*	*2,185*

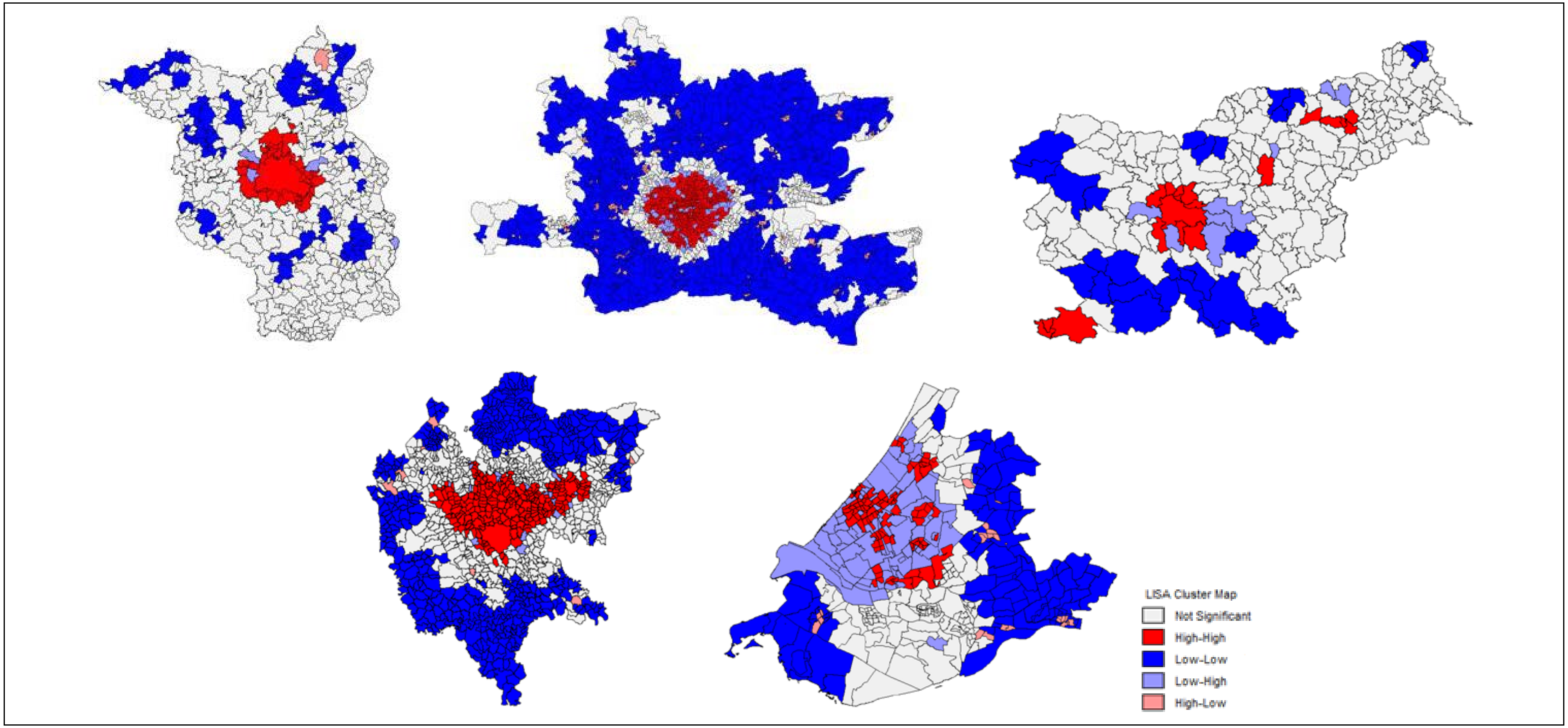

Figure 20: LISA cluster maps of case study regions.

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