FOODSHIFT 2030

DELIVERABLE D3.3

FOOD SYSTEM INNOVATION ASSESSMENT REPORT

Version 1.0

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Abstract (for public dissemination only)	The following document presents methods and obtained results from the evaluation of the current state of the food system within front-runner city regions.

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ia. Deliverable Documentation

This initial section provides clarity on submission procedures that were disrupted due to unavoidable circumstances.

ia. Delays and adjustments

Task 3.3. assumed the evaluation of the current state of food systems within front-runner city regions applying three complementary approaches. However, the implementation of all approaches for each of 9 FALs was challenging, due to the:

- Pandemic crisis and general collaboration uncertainty;
- Multiplicity of issues and tasks directed and accumulated at FALs after the first uncertain period of a pandemic;
- The specificity of the research methods resulting in uncertainties in their application of them at FAL levels;
- Different focus of FALs which influenced the choice of appropriate methods corresponding with FALs DNA and needs.

ia. Living document

Given the above delays and resulting inconsistencies that are compromising the soundness of the current version (Version No. 1), we decided to turn D3.3 into a 'living document' to be updated until February 2023 (Version No. 2). The format of a 'living document' appears suitable because it allows ongoing evaluation of the current state of food systems within front-runner city regions according to FALs' needs and availability.

Accordingly, the planned updated release of the *Food system innovation assessment report* (D3.3) will allow the complete picture of the food system to be presented following the DNA, focus, needs, and interest of FALs. Furthermore, the possibility to allow this evolving process towards completion allowed the WP3 researchers to meet the overall quality standards of the deliverable.

Version 1.0 is presenting results obtained from M5 to M31. Taking into consideration the 6 months delay, the analyses should be completed by M37 and the report Version 2.0 prepared in M38 (March 2023). Therefore, a general delay will extend the work of WP3, Subtask 3.3. (originally M5-M31) till M38.

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1. Introduction

T3.3. focuses on assessing the current state of the food system through evidence-based foodshed approaches. The foodshed assessments could provide the FALs with important information about the functioning of the food system in the participating city regions, including the demand for food, the area required to satisfy the demand for food, and the food production capacity of the city regions. The task is coordinated by WUELS and consists of three sub-tasks, led by SUSMETRO, WUELS, and ZALF by applying three complementary approaches:

- Metropolitan Foodscape Planner (MFP),
- City-Region Foodshed Assessment (CRFA),
- Metropolitan Foodshed and Self-sufficiency Scenario (MFSS) model.

2. Evaluating the current state of food systems within front-runner city regions: a methodological approach

The food system, according to FAO[1], could be defined as "*encompassing the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products that originate from agriculture, forestry, or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded*".

"The food system is composed of sub-systems (e.g. farming system, waste management system, input supply system, etc.) and interacts with other key systems (e.g. energy system, trade system, health system, etc.). Therefore, a structural change in the food system might originate from a change in another system; for example, a policy promoting more biofuel in the energy system will have a significant impact on the food system"[2].

The current food system should be resilient to different vulnerabilities such as climate change or pandemic emergencies. The weakness and uncertainty of current food systems were exposed by the covid-19 pandemic. The sustainability and resilience of the food system to different crises could be verified by the foodshed approach.

[1] FAO (2018) Sustainable food systems. Concept and framework. [availale online, 01.08.2022:] https://www.fao.org/3/ca2079en/CA2079EN.pdf
[2] Ibid.

Foodshed (also known as production capacity, local food production capacity, or local foodshed carrying capacity) is defined as a geographical area of the food supply that represents the food zone for urbanized areas and linkages established between peri-urban agriculture and urban consumption. It is a local area that produces sufficient food products to feed its population[3].

Three main types of foodshed analysis are distinguished: a) : local food self-sufficiency (or capacity) studies, b) food resource flow and c) hybrid analyses[4]. The majority of assessments focus on determining the potential of agricultural production capacity to meet the needs of the specific region's population[5,6] or to evaluate more specific issues as part of sustainability impact and ecosystem services. Food flow assessments examine distribution networks[7], present food origin (the place where the food comes from) which can be used as a basis for assessing the local potential and the system's resilience to crisis[8]. The hybrid foodshed analyses combine agricultural capacity and current food flow analyses[9].

2.1. Metropolitan Foodscape Planner (MFP 2.0)

The 'Metropolitan Foodscape Planner' (MFP) is a spatial-functional assessment that was developed as part of the EU project FoodMetres (2012-2015). MFP enables the quantification of the ecological footprint of agriculturally productive land required to sustain the annual amount of food demand of the urban population according to the diet recognized for that particular country or region. Unlike the classic ecological footprint assessment model (proposed by the Global Footprint Network), the land footprint is given in 'local hectares' rather than 'global hectares'.

[3] Świąder, M., Szewrański, S., & Kazak, J. K. (2018). *Foodshed is an example of preliminary research for conducting environmental carrying capacity analysis*. Sustainability, 10(3), 882.
[4] Schreiber, K., Hickey, G. M., Metson, G. S., Robinson, B. E., & MacDonald, G. K. (2021). *Quantifying the foodshed: a systematic review of urban food flow and local food self-sufficiency research*. Environmental Research Letters, 16(2), 023003. https://doi.org/10.1088/1748-9326/abad59.
[5] Zasada, I., Schmutz, U., Wascher, D., Kneafsey, M., Corsi, S., Mazzocchi, C., Monaco, F., Boyce, P., Doernberg, A., Sali, G., & Piorr, A. (2019). *Food beyond the city – Analysing foodsheds and self-sufficiency for different food system scenarios in European metropolitan regions*. City, Culture and Society, 16, 25–35. https://doi.org/10.1016/j.ccs.2017.06.002
[6] Kurtz, J. E., Woodbury, P. B., Ahmed, Z. U., & Peters, C. J. (2020). *Mapping U.S. Food System Localization Potential: The Impact of Diet on Foodsheds*. Environmental Science & Technology, 54(19), 12434–12446. https://doi.org/10.1021/acs.est.9b07582
[7] Karg, H., Drechsel, P., Akoto-Danso, E., Glaser, R., Nyarko, G., & Buerkert, A. (2016*). Foodsheds and City Region Food Systems in Two West African Cities*. Sustainability, 8(12), 1175. https://doi.org/10.3390/su8121175
[8] Moschitz, H., & Frick, R. (2020). *City food flow analysis. A new method to study local consumption*. Renewable Agriculture and Food Systems, 36(2), 150–162. https://doi.org/10.1017/s1742170520000150
[9] Vicente-Vicente, J. L., Sanz-Sanz, E., Napoléone, C., Moulery, M., & Piorr, A. (2021). *Foodshed, Agricultural Diversification and Self-Sufficiency Assessment: Beyond the Isotropic Circle Foodshed—A Case Study from Avignon (France).* Agriculture, 11(2), 143.

MFP 2.0 offers as the main outcome a spatial model of food landscape allocation, which distinguishes between (1) an urban core, (2) a recreational and natural buffer zone around this core, (3) a plant-based food production zone, including vegetables, fruits, grains, etc. for human consumption, and (4) a meat-based production zone, mainly including feed and animal husbandry areas[10]. The MFP 2.0 models these zones following the concentric rings model for the locational theory of von Thünen (1823).

Within the FoodSHIFT2030 project, MFP 2.0 uses a Geographical Information System (GIS) to handle spatial data layers, and non-spatial assumptions - such as current food habits of a particular community (Table 1) to determine the footprints of a selection of city regions.

Table 1. Datasets utilized in MFP 2.0.

Name of dataset	Description	Source
CORINE Land Cover 2018	European land cover map	https://land.copernicus.eu/pan-european/corine-land-cover
Natura2000 2020	European ecological network of protected areas	https://natura2000.eea.europa.eu/
Homogenous soil mapping units FSU 2019	A European map of predicted crop areas on farm structure units. 3rd-generation Homogenous Soil Mapping Units (HSMU) as modeled by CAPRI (Kempen et al. 2005) and Eurostat crop area data disaggregated to FSU's by CAPRI for 33 crops.	https://ec.europa.eu/jrc/en/research-topic/crop-yield-forecasting
LANMAP2	European landscape map	https://www.wur.nl/en/show/The-European-landscape-map.htm
The multi-ring buffer around the city start point	Concentric rings around the city center based on the Von Thünen model (1823) represent the urban ecological footprint of a food system	GIS data processing
Food Consumption literature	Figures on food and agriculture data (crops and livestock products) both at the European and local level	Available food (FAO, 2018) (kg/capita/year) plus local data on food consumption provided by FAL lab assistant

Source: *FoodSHIFT2030 article submitted to the 'Frontiers in Sustainable Food Systems' Journal by Arciniegas G. et. al*.

[10] Wascher, D., Zasada, I., & Sali, G. (2015). *Tools for metropolitan food planning - A new view on the food security of cities*. In book: *The Governance of City Food Systems* (pp.68-97). Publisher: Fondazione Giangiacomo FeltrinelliEditors: Mark Deakin, Davide Diamantini, Nunzia Borrelli.

MFP 2.0 allows quantifying the current state of the city region's food system, as well as the development of dynamic scenarios based on alternative food habits (e.g.. EAT Lancet diet). The results of MFP are to be presented and discussed with stakeholders during participatory workshops in which an interactive touch screen - the MapTable - can be used as the main interface between stakeholders and the food spatial data as well as the main means to allow the interactive modification of food-related land use (Figure 1).

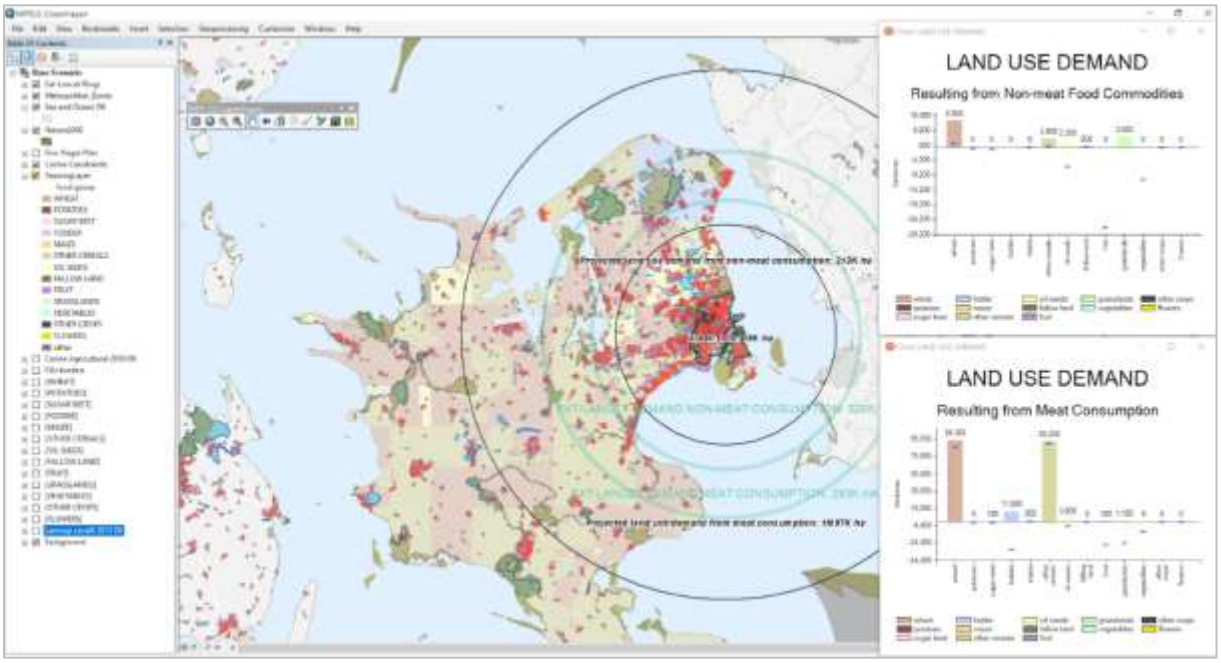


Figure 1: The main interface of the MFP 2.0 Tool is featured by a dynamic GIS. Source: *FoodSHIFT2030 article submitted to the 'Frontiers in Sustainable Food Systems' Journal by Arciniegas G. et. al*.

2.2. City-Region Foodshed Assessment (CRFA)

The City-Region Foodshed Assessment (CRFA) is based on the approach proposed by Hedden in 1929[11]. Hedden's approach allows for verifying the functioning of the entire food system and its impact on the environment and social communities. In this approach, the base for foodshed delimitation is 'food-flows' occurring between places of food production (food origin) and their consumer market. The foodshed boundary can be delineated by following the linkages between food origin and the food market. The delimitation of linkages, as well as the foodshed, is conducted using GIS tools. The initial step for foodshed delimitation – the food-flows analysis (Figure 2), allows the validation of local food system potential, which could boost the development of a more sustainable and resilient food system as part of long-term urban growth strategies or food policies[12].

[11] Świąder, M., Szewrański, S., & Kazak, J. K. (2018). Foodshed is an example of preliminary research for conducting environmental carrying capacity analysis. Sustainability, 10(3), 882.
[12] Ibid.

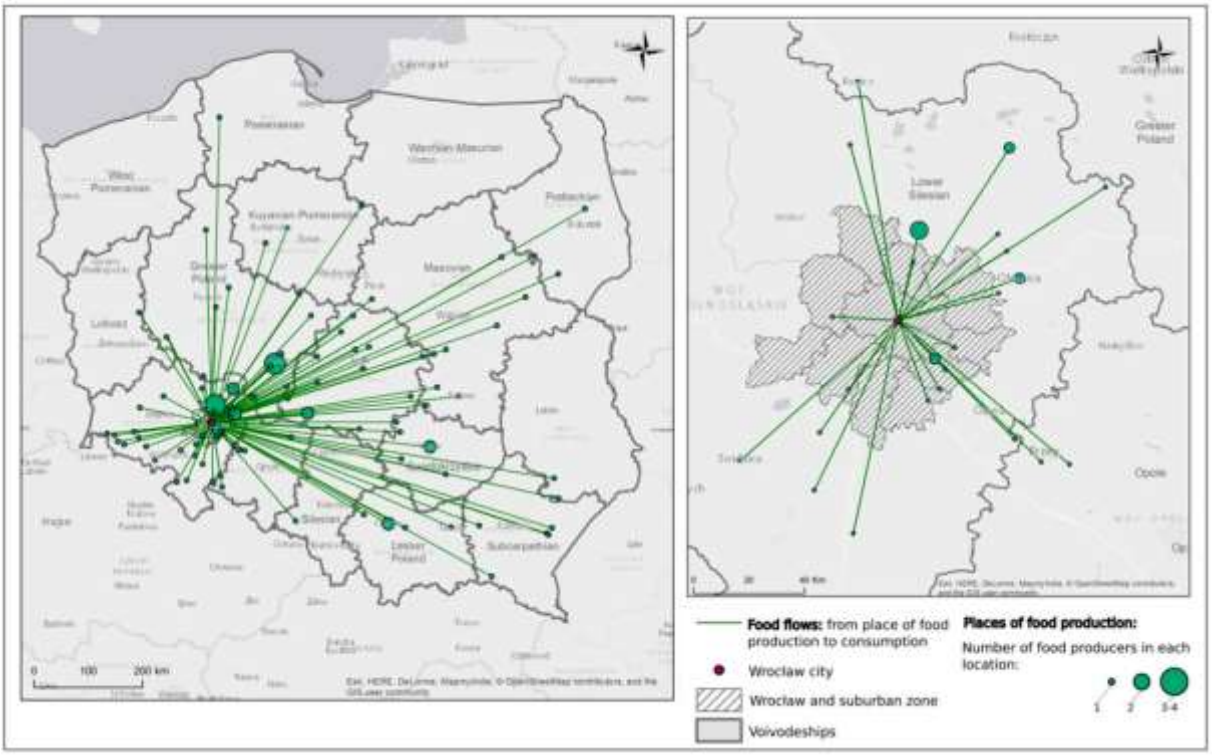


Figure 2: Food flow analysis. On the left side of the figure – Complete map of food flows based on the prepared database. On the right side of the figure – extracted nearest food flows based on natural classes. Source: *Świąder, M., Szewrański, S., & Kazak, J. K. (2018). Foodshed is an example of preliminary research for conducting environmental carrying capacity analysis. Sustainability, 10(3), 882.*

The first step of food flow analysis is the acquisition and preparation of relevant data. The data collection sheet (Table 2) includes information on the name of the producer; the address of the production site, street, number, postal code, the name of the town (food origin); the offered food groups, and (if obtainable) food product types. The most important aspect in the context of determining foodshed by the food flow approach is the food origin, however, more detailed information (food groups, types of food products) could be useful for analyzing local food system potential.

Table 2: Example of data collection sheet for food origin mapping.

No.	Name of the producer	Food origin (address: street, number, postal code, town)	Food groups	Food products	X	Y
1	Producer A	Grunwaldzka 55, 50-357 Wrocław, Poland	vegetables, fruits, eggs	tomato, cucumber, zucchini, cherries, eggs		
2	Producer B	Grunwaldzka 35, 50-357 Wrocław, Poland	eggs	eggs		
…	…	…	…	…		

The input data and/or existing databases, and services are provided by the FALs. Then, the addresses are used for obtaining coordinates (X, Y) and finally for geocoding of food

origin points using ArcGIS. Next, The food flows are drawn using a "Construct Sight Line" GIS tool. Sequentially, the calculated distances are the basis for extracting producers nearest to the city. Therefore, values of distances are divided into natural classes according to natural distribution using the graphical method. As the last step, the minimum foodshed boundary (based on extracted nearest food flows) using the "Minimum Bounding Geometry" tool is delimited.

2.3. Metropolitan Foodshed and Self-sufficiency Scenario (MFSS) model

The Metropolitan Foodshed and Self-sufficiency Scenario (MFSS)[13] is a quantitative food assessment model that provides an overview of the status of the food supply and demand for a specific proposed foodshed (Figure 3), and that incorporates different scenarios based[14] on shifting diets, production systems, and population growth[15].

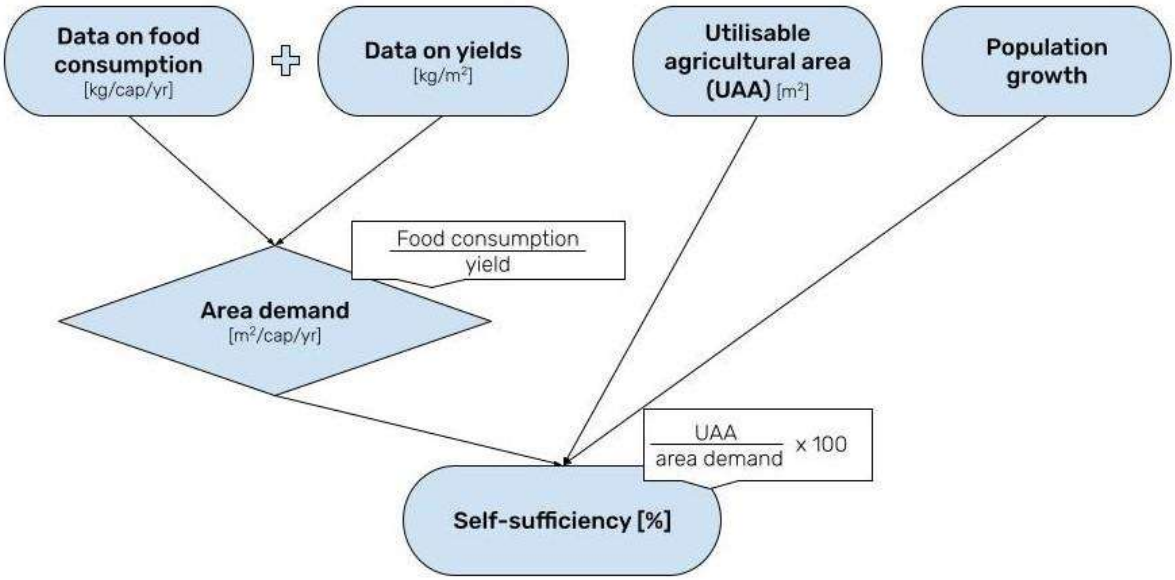


Figure 3: MFSS methodological approach.

The required input data for MFSS are the population, current dietary patterns, farmland available, land use cover, and regional yields. The result is the achievement of a potential

[13] Zasada, I., Schmutz, U., Wascher, D., Kneafsey, M., Corsi, S., Mazzocchi, C., ... & Piorr, A. (2019). Food beyond the city–Analysing foodsheds and self-sufficiency for different food system scenarios in European metropolitan regions. City, Culture and Society, 16, 25-35.

[14] Vicente-Vicente, J. L., Doernberg, A., Zasada, I., Ludlow, D., Staszek, D., Bushell, J., ... & Piorr, A. (2021). Exploring alternative pathways toward more sustainable regional food systems by foodshed assessment–city region examples from Vienna and Bristol. Environmental Science & Policy, 124, 401-412.

[15] Vicente-Vicente, J. L., Sanz-Sanz, E., Napoléone, C., Moulery, M., & Piorr, A. (2021). Foodshed, Agricultural Diversification and Self-Sufficiency Assessment: Beyond the Isotropic Circle Foodshed—A Case Study from Avignon (France). Agriculture, 11(2), 143.

self-sufficiency level for all products, or some of them, as a result of a matching process of the supply and the demand for a specific foodshed.

3. Evolving approach to engage FALs on city-region food system assessment

The assessment of the food system within front-runner city regions required the engagement of FALs to ensure the appropriate use of tools according to FALs' DNA, needs, and interest. Together with the WP3 team, we developed an action plan to obtain a matrix of interest in tools. During this process, we acquired information from FALs through different activities: presentations of tools during dedicated meetings, workshops, and Round Tables.

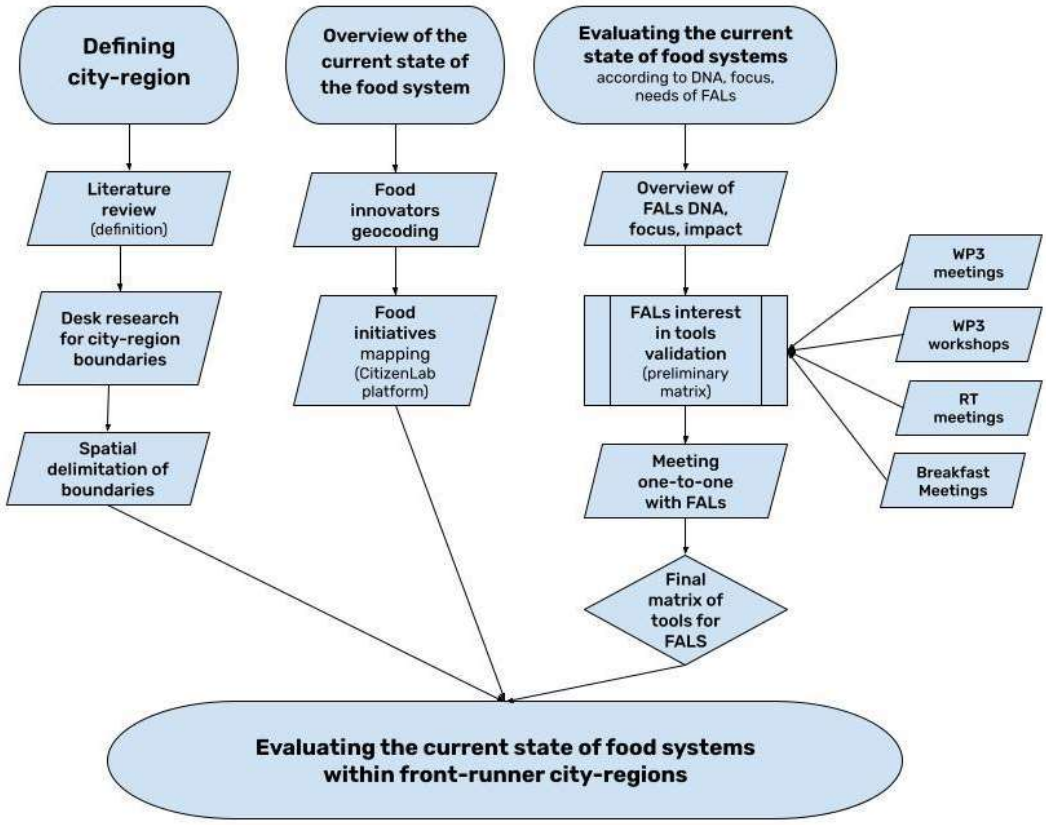


Figure 4: Actions and tasks connected with preparation for the current state of food system assessment.

Moreover, the case studies were presented on various occasions and during Breakfast Meetings to bring FALs closer to the methodology and the results which could be obtained

and offered. Therefore, we can mention a few stages bringing us closer to the assessment of the current state of the food system within city regions (Figure 4):

- Defining city-region (including literature review, desk research for city-regions boundaries; spatial delimitation of boundaries)
- Overview of the current state of the food system within city regions (including geocoding of food innovators and participatory mapping of food initiatives);
- Evaluation of the current state of the food system using foodshed approaches (including an overview of FALs' needs; validation of FALs' interest in tools; assessment).

3.1. Defining a city-region

3.1.1. Literature review

The first issue to solve concerned defining a 'city-region'. This was resolved during a collaborative brainstorming session preceded by a literature review by WP3 members.

3.1.2. Desk research

Having a definition of 'city-region', we decided to work on a bottom-up approach - the boundaries of city regions were obtained from strategic documents and/or scientific articles presenting the administrative boundaries of the selected metropolitan areas of the core cities. The bottom-up approach required desk research to identify and delimitate city-regions boundaries.

Meanwhile, an alternate study was conducted to verify differences in food self-sufficiency having a bottom-up approach and a top-down (Functional Urban Areas - jointly developed by the OECD and the European Commission).

3.1.3. Spatial delimitation of administrative boundaries for front-runner city-regions

Delimitation of the city-region boundaries for FALs required a few steps:

1. Finding digital image files (potential rasters) of city-regions boundaries from strategic documents and/or research papers.
2. Georeferencing retrieved rasters using ArcMap software.
3. Obtaining spatial data representing the metropolitan boundaries using Local Administrative Units (LAU) 2019 - geodatabase from Eurostat.

3.2. Overview of the current state of the food system within front-runner city-regions

Meeting the FALs' needs for implementing food system assessment tools can prove challenging, therefore an overview of the current state of the food system was done. The overview considered food innovators (information collected within the 'Food innovators casebook') and food initiatives.

Data obtained from the 'Food innovators casebook' were reviewed, addresses were updated, and then geocoded using ArcGIS software. Moreover, the participatory mapping exercise was conducted to obtain spatial data presenting other food initiatives (i.e. CSA, food hubs, community gardens) related to FALs' focus. For this purpose, one of the mapping modules of the Citizen Lab Platform[16] was used as an online tool for participatory mapping. The Citizen Lab Platform allowed for the preparation of a dedicated workspace for each FAL (Figure 5). The main advantages of Citizen Lab are its user-friendliness and simplicity of use for the user (See Appendix A). The exercise allowed to map different types of food initiatives according to FALs focuses, i.e.: urban farms, edible gardens in schools, community gardens, food hubs, food kitchens, agro-parks, CSA, CSA pick-up points, food space, community shops, food events.

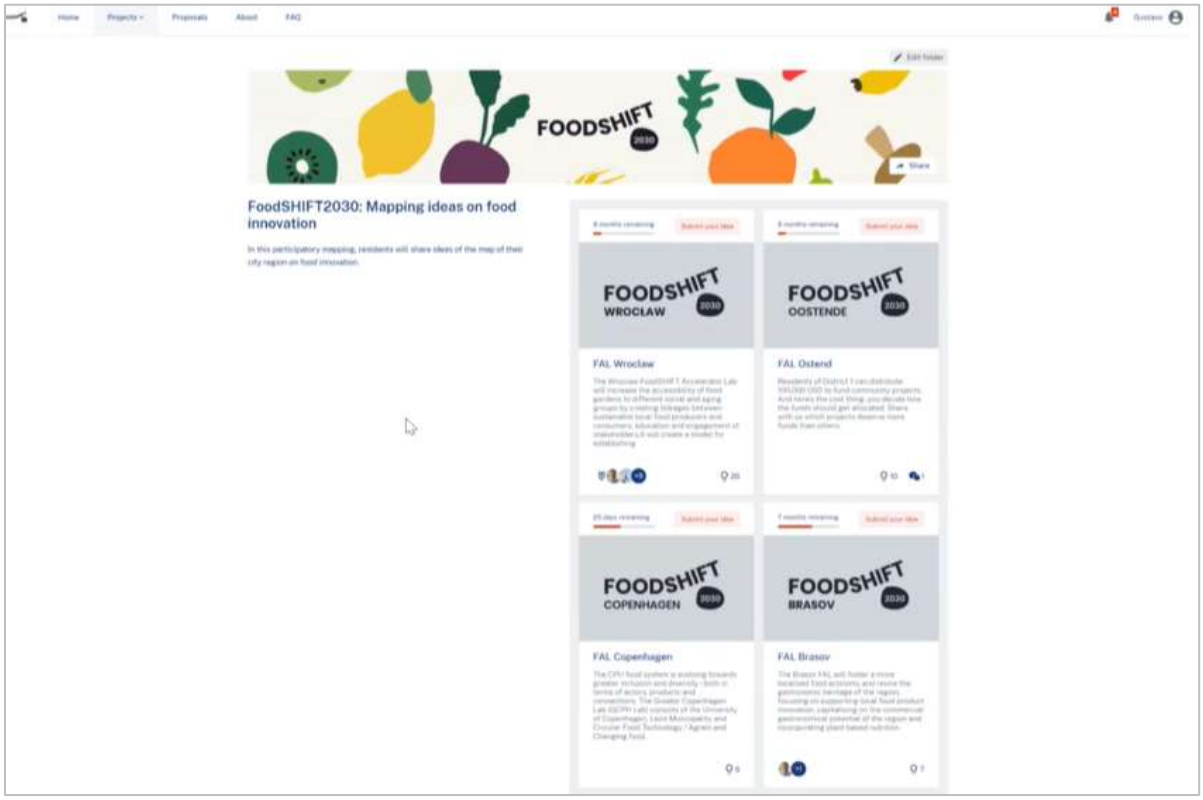


Figure 5: Working spaces created for each FAL within the FoodSHIFT2030 space in Citizen Lab.

[16] https://www.citizenlab.co/

3.3. Evaluating the current state of food systems within front-runner city regions according to DNA, focus, and needs of FALs

Simultaneously, the three subtasks on three complementary approaches:

- Metropolitan Foodscape Planner (MFP),
- City-Region Foodshed Assessment (CRFA),
- Metropolitan Foodshed and Self-sufficiency Scenario (MFSS) model.

were presented during RT1 – Kick-off meeting in Copenhagen, online Round Tables, WP3 workshops dedicated to tools, as well as tools and previous/first results presentations during Breakfast Meetings.

These workshops allowed to verify and inventories the FALs' interests in tools and to create an action plan of cooperation between WP3 and FALs. The research showed that most FALs are interested in at least one of the tools or see the possibility of applying them differently in the future. Subsequently, scheduled one-to-one meetings with the FALs allowed us to obtain the final matrix (Table 3) regarding FALs' interest in food assessment tools.

Table 3. Matrix for assessing FALs' interest in tools for foodshed assessment.

Tools	FALs								
	ATH	AVG	BRI	BRC	BER	BRV	CPH	OST	WRO
MFP									
CRFA									
MFSS									

- FAL interested in tool
- already implemented assessment for FAL
- possibility of application (in a different way) in the future

4. Results

This section provides an overview of the results obtained from the current state of the food system within front-runner city regions. As the assessment is an ongoing process, we present in this version the results produced so far, as well as previous results obtained from different research, not necessarily that related to the FoodSHIFT2030 project.

4.1. Defining a city-region

4.1.1. Literature review

The joint discussions led to the adoption of the city-region definition according to Professor Colin Crouch (Professor of Governance and Public Management at Warwick Business School, who has studied the City Regions for the OECD) as "metro-region" equal to "metropolitan area".

4.1.2. Desk research

The desk research for the bottom-up approach resulted in reviewing four strategic documents and 11 research articles describing metropolitan case study areas (Table 4). It allowed for georeferencing and then using LAU data for delimitation of the city-regions boundaries.

Table 4. Type of sources of metropolitan case study areas

No.	Metropolitan region	Source of city-region area:		Reference
		Strategic document	Research article	
1	Athens (ATH)		✓	(Rontos, Mavroudis, & Georgiadis, 2006)
2	Avignon (AVG)		✓	(Sanz Sanz, Martinetti, & Napoléone, 2018; Sanz Sanz, Napoléone, & Hubert, 2017)
3	Barcelona (BRC)		✓	(Catalan, Sauri, & Serra, 2008; Cebollada & Miralles-Guasch, 2010; García-Coll & López-Villanueva, 2018)
4	Bari (BRI)		✓	(Spanò, Leronni, Lafotezza, & Gentile, 2017)
5	Berlin (BER)		✓	Berlin-Brandenburg (Arlinghaus, Bork, & Fladung, 2008; Hersperger, Bürgi, Wende, Bacău, & Grădinaru, 2020)
6	Brasov (BRV)	✓	✓	(Brasov Metropolitan Agency for Sustainable Development, 2012; POPESCU & CORBOS, 2010)
7	Copenhagen (CPH)	✓		The Finger Plan (Stysiak, Jensen, & Mahura, 2015)
8	Ostend (OST)		✓	(Canters, Vanderhaegen, Khan, Engelen, & Inge, 2014)
9	Wrocław (WRO)	✓		Wrocław Metropolitan Functional Area (Instytut Rozwoju Terytorialnego, 2018)

4.1.3. Spatial delimitation of administrative boundaries for front-runner city-regions

The LAU spatial data, compatible with NUTS, were used as a reference for the delimitation of city-regions boundaries. The use of LAU allowed, on the one hand, to appropriately georeference raster images and, on the other hand, to delimit the boundaries of metropolitan areas according to a local administrative division (Figure 6). It was necessary for foodshed analysis, as well as for developing a food initiative participatory mapping workshop.

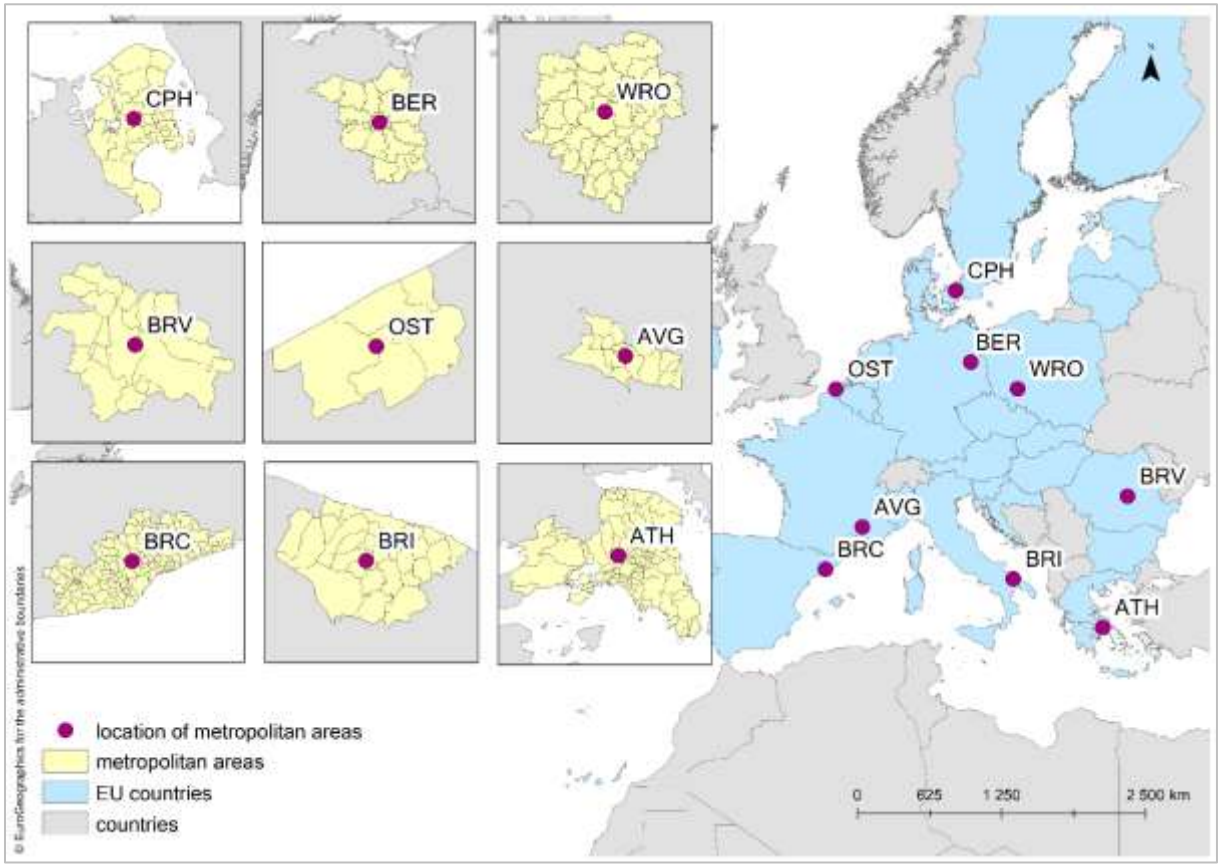


Figure 6: Metropolitan areas delimited based on a bottom-up approach.

4.2. Overview of the current state of the food system within front-runner city-regions

The results obtained using the CitizenLab Platform are divided into two parts: (1) input data presenting the overview of food innovators, and (2) output data – presenting complementary data (food initiatives) to describe the overview of the current state of the food system within front-runner city regions.

The first step of analysis presents the spatial dimension of food innovators collaborating with FALs within the FoodSHIFT2030 project. In cases of seven out of nine FALs: Avignon,

Bari, Berlin, Brasov, Copenhagen, Oostend, and Wrocław, the collaboration is more local-regional oriented, which might be confirmed based on density analysis of innovators' location. The cases of Athens and Barcelona (Figure 7) showed more decentralized results – the innovators are more split than in the case of other FALs.

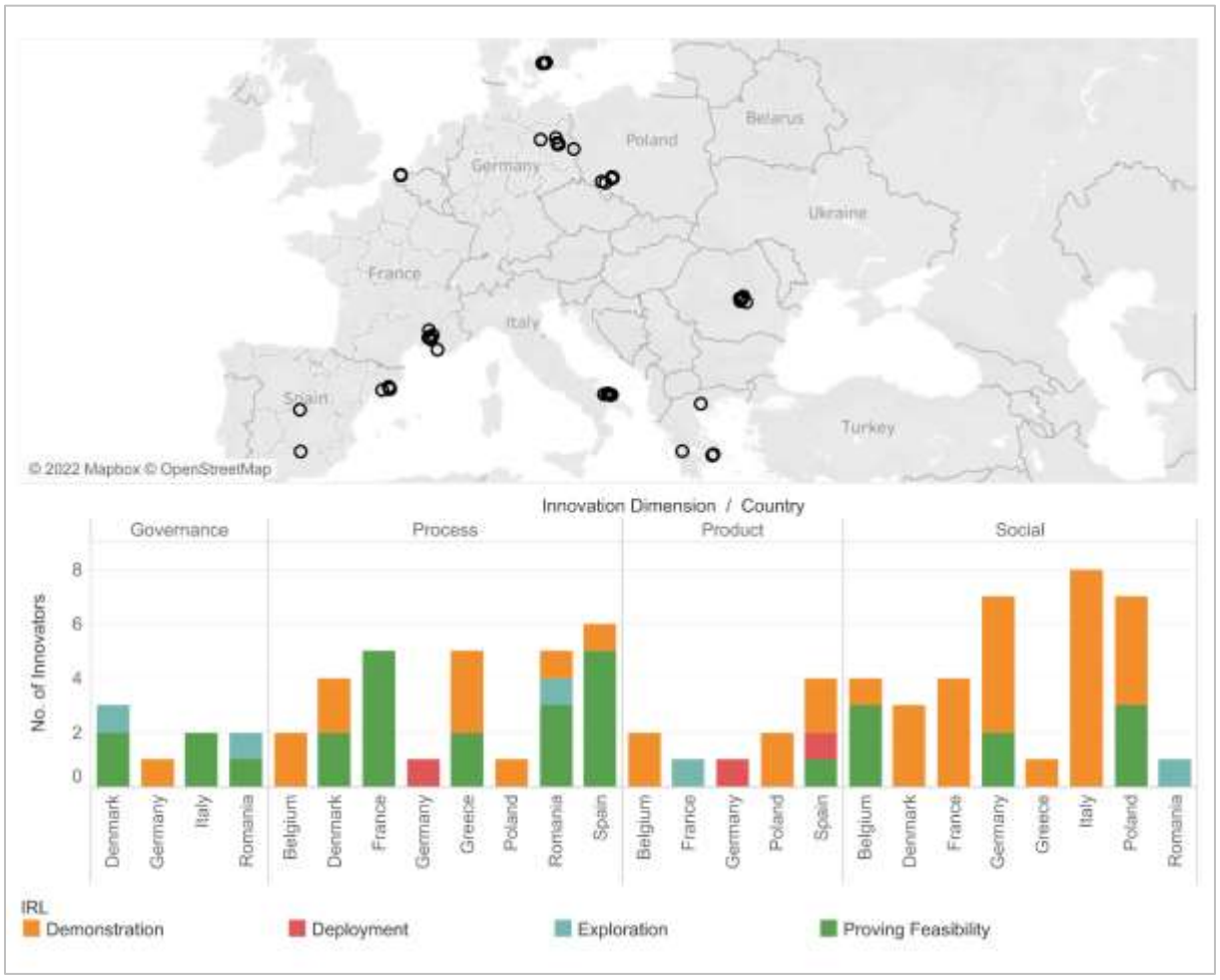


Figure 7: Food innovators and innovation dimension overview.

The main dimension of food innovators could be seen in the social aspect, eight out of nine FALs collaborate with innovators focused on this aspect, for most of which the Innovation Readiness Level (IRL)[17] level was determined as 'Demonstration'. The following are other aspects – process (8 out of 9 FALs; IRL level mostly as 'Proving Feasibility'), product (5 of 9 FALs, IRL level mostly as 'Demonstration'), and governance (4 of 9 FALs, IRL level mostly as 'Proving Feasibility'').

The data obtained during the workshop allowed for the mapping of 436 objects with 521 tags representing different food initiatives. This output database included two detailed

[17] The IRLs, which typically have nine levels, are used to determine the innovation's present maturity stage. (via "*Innovation portraits transforming the European food system*" [available online, 31.08.2022] https://foodshift2030.eu/wp-content/uploads/2021/11/FoodSHIFT2030-Innovation-Portraits.pdf

sets of data obtained from Berlin FAL (almost 200 community gardens tags) and Oostend FAL (more than 160 tags representing different food initiatives such as food hubs, farm shops, and CSA), plus data collected directly using the CitizenLab Platform. Therefore, as main types of food initiatives could be seen in Community Gardens, Food Hubs, and Fram Shops (Figure 8). These food initiatives may supplement the analyzed innovation dimension, especially the social one. The following types of food innovations could be represented by social (food) educational centers, food spaces, community farming, urban farm, school gardening, and food events. Therefore, there could be noticed that most of the food initiatives appearing in different FALs contribute to community building around food.

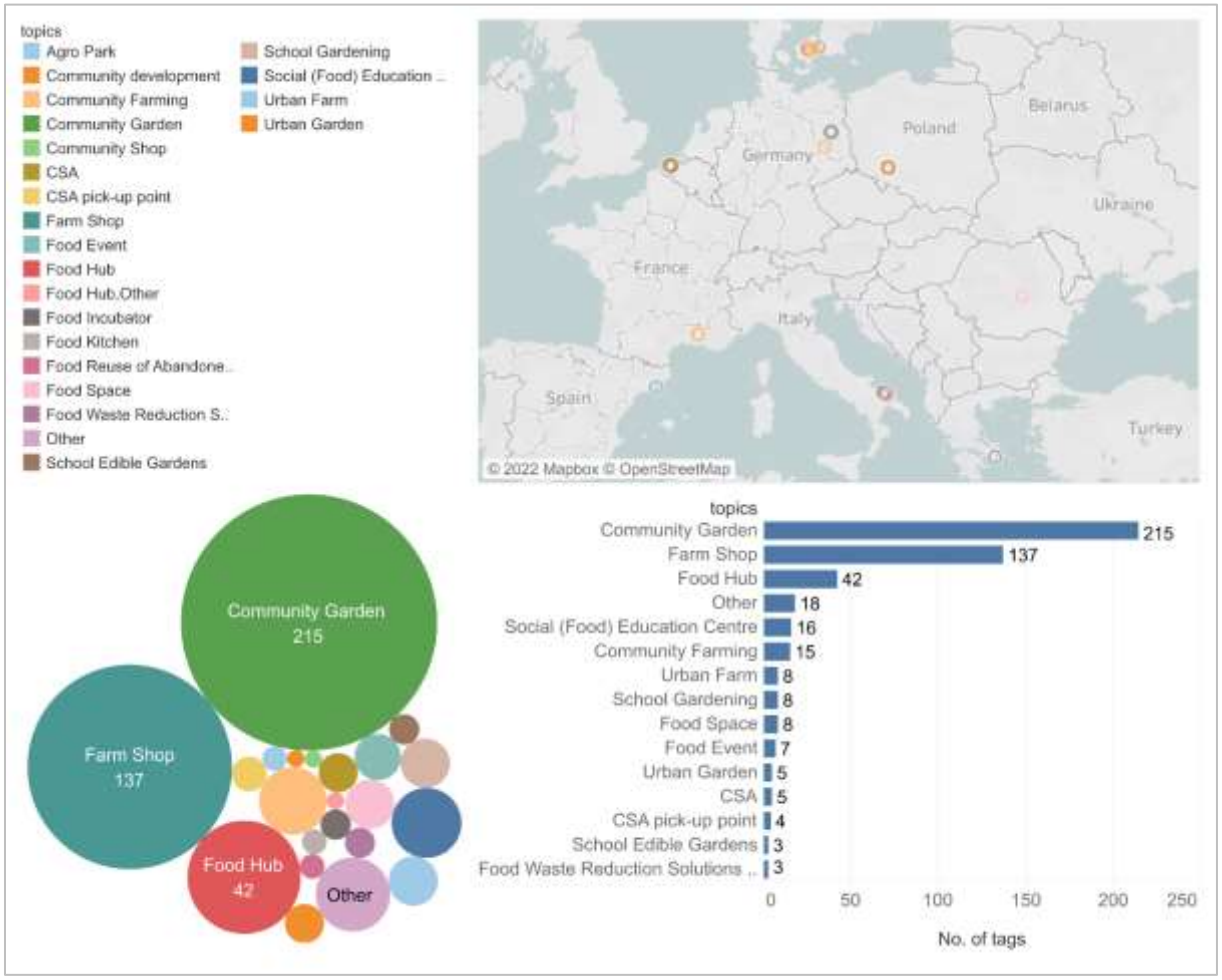


Figure 8: Food initiatives – spatial location and food topics.

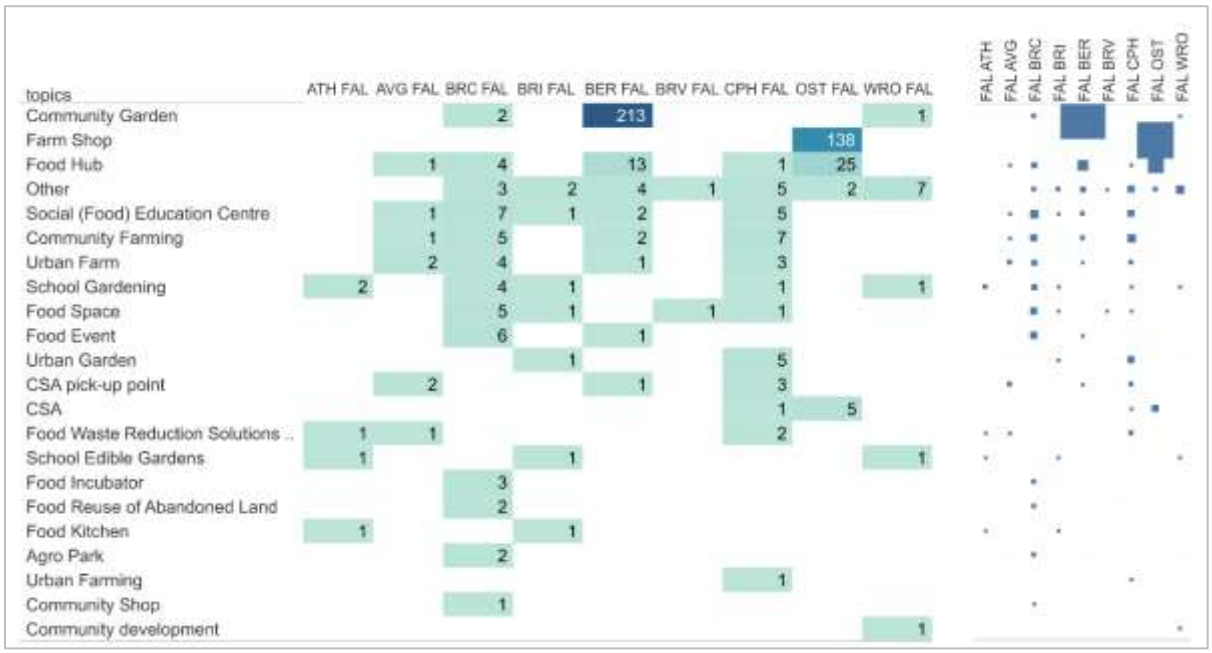
Results showed that each FAL could be defined by one or a few dominant types of food initiatives (Figure 9). The case of **Athens FAL** could be described by initiatives connected with school gardening and school edible gardens, which is consistent with ATH FAL's focus ("*Schools as sites of food experience and food system transformation*").

Avignon FAL, focusing on the "*capacity of public procurement to be a driver to envision a city food strategy*", identified food initiatives connected with CSA pickup points and food hubs, which is in line with one of AVG's focus ('*Increase partnerships with local, organic and "green" food suppliers and support hyperlocal retail'*).

Bari FAL is not strongly focused on one of a few specific initiatives, however, a few different food sites were indicated (ie. food space, food kitchen, food hub, school gardening, or social (food) education center). This wide range of food sites is well connected with BRI FAL's focus to build the capacity of the food system under the heading "Back to the land".

Barcelona FAL also verified different linkages within the existing food system, mainly connected with social (food) education centers, food events, community farming, and food spaces. Reaching different stakeholders of the food system will allow achieving one of the goals of BRC FAL's goals – "*creating local and global connections between new and existing initiatives and amplifying the voices of those working at the nexus of food and tech*".

Berlin FAL could be seen as one having a wide dataset presenting the existing food system. The main food actors/actions are connected with community gardens and food hubs. It is consistent with BER FAL's focus offering to develop a "*Food Hub for providing space for multiple functions, including direct trade of regional food, sharing, preparation, consumption, and co-learning/experimentation*".



topics	ATH FAL	AVG FAL	BRC FAL	BRI FAL	BER FAL	BRV FAL	CPH FAL	OST FAL	WRO FAL
Community Garden			2		213				1
Farm Shop								138	
Food Hub		1	4		13		1	25	
Other			3	2	4	1	5	2	7
Social (Food) Education Centre		1	7	1	2		5		
Community Farming		1	5		2		7		
Urban Farm		2	4		1		3		
School Gardening	2		4	1			1		1
Food Space			5	1		1	1		
Food Event			6		1				
Urban Garden				1			5		
CSA pick-up point		2			1		3		
CSA							1	5	
Food Waste Reduction Solutions ..	1	1					2		
School Edible Gardens	1			1					1
Food Incubator			3						
Food Reuse of Abandoned Land			2						
Food Kitchen	1			1					
Agro Park			2						
Urban Farming							1		
Community Shop			1						
Community development									1

Figure 9: Food initiatives at FALs level. The table on the left side presents a summarized value of tags assigned by each FAL in each topic. The table on the right side presents the main topics mapped/indicated by FALs.

Brasov FAL is developing a food system within their city region. However, a few stakeholders were presented as a free marketplace for local producers (fruits, butchers, etc) or shops with artisan and small-scale products. It goes in line with BRV FAL's focus – "*integrating traditional and local producers into an innovative and ambitious regional food system*".

Copenhagen FAL indicated different food initiatives such as community farming, urban gardens, social (education) food centers, and other initiatives as a digital platform providing direct distribution of fresh fruit and vegetables from local producers in Denmark, Sweden, Belgium, Portugal, Spain and Italy, organic farm brewery focusing on local cooperation and circularity, or Controlled Indoor Cultivation of Black Morel (Morchella sp.). Finding linkages between different stakeholders is consistent with CPH FAL's focus – "*reconnecting the city with its hinterlands by strengthening ties between food chain actors*".

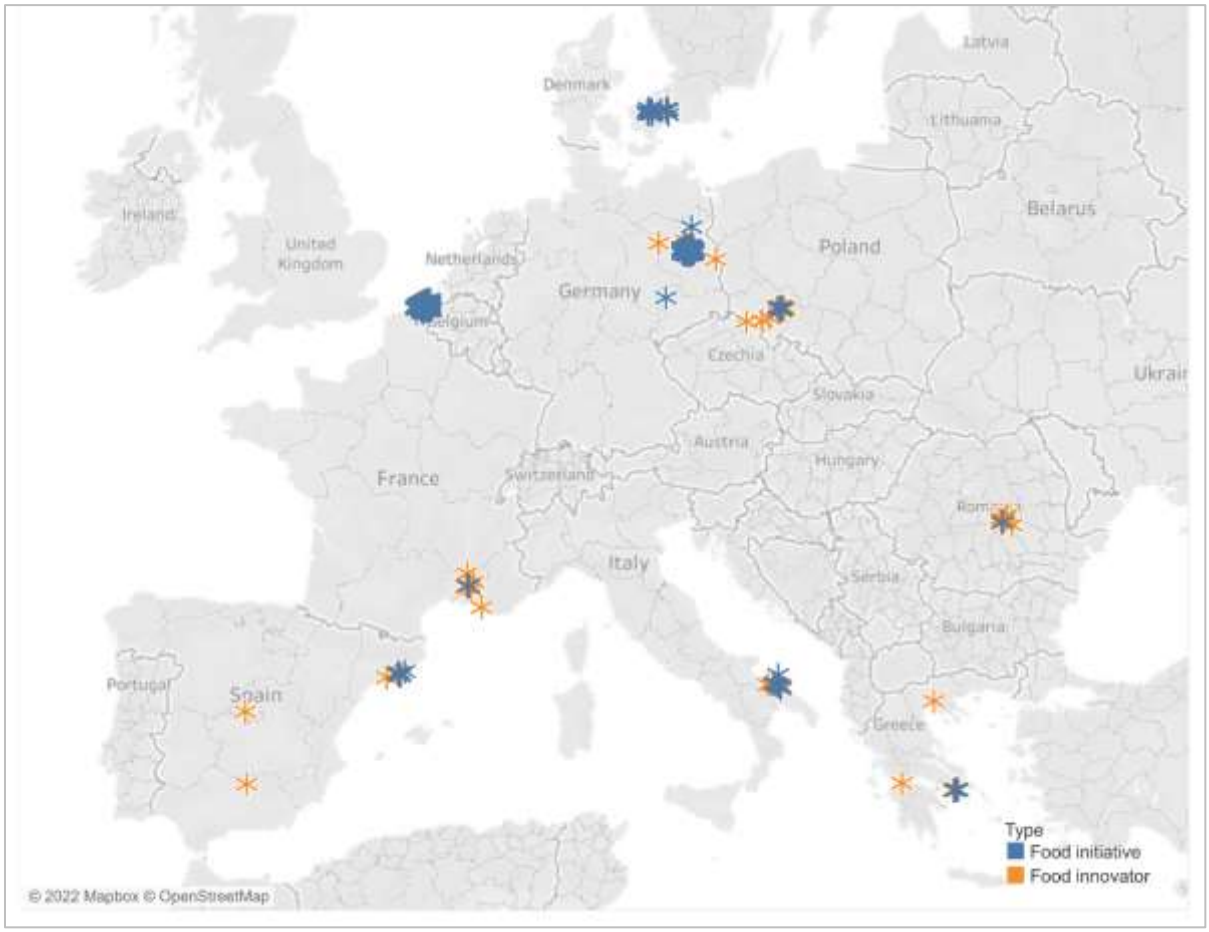


Figure 10: Food initiatives and food innovators identified at the FALs level.

Ostend FAL is linked to farm shops, food hubs, CSAs, and other initiatives as local farms with seasonal products. Indicated stakeholders could present the local potential of the existing food system, as well as strengthen the link between the local producers and the catering sector which is one of the OST FAL goals.

Wrocław FAL indicated a few initiatives connected with school edible gardens and community gardens, as well as other initiatives by mapping local food markets managed on land owned by the city. WRO FAL, similar to BRA FAL, is focused on reaching different food system stakeholders for "*strengthening of innovation potential of the local sustainable food system*".

In a conclusion, there could indicate that food initiatives have more local dimensions – appeared at the city level, compared to food innovators (Figure 10) which were more or less localized at the city-region or even national scale.

4.3. Evaluating the current state of food systems within front-runner city regions according to DNA, focus, and needs of FALs

The number of dedicated workshops, as well as one-to-one meetings between tool holders and FALs' representatives, allowed to obtain outcomes regarding FALs' interest in tool application (Table 5). As a result, 3 out of 9 FALs were interested in one tool implementation but in another aspect, 3 FALs were interested in the application of one of the foodshed tools, 4 FALs were interested in the application of 2 foodshed tools with a chance for enlargement to three tools application (BER and WRO – possible different application or recalculation using current data).

Table 5. Final matrix regarding FALs' interest in tools for foodshed assessment.

Tools	FALs								
	ATH	AVG	BRI	BRC	BER	BRV	CPH	OST	WRO
MFP									
CRFA									*,**
MFSS					*				

- FAL interested in tool
- already implemented assessment for FAL
- possibility of application (in a different way) in the future

**previously implemented assessment for FAL within different research, not within the FoodSHIFT2030 project; **willingness to repeat the analysis using current data;*

4.3.1. MFP

The assessment using Metropolitan Foodscape Planner (MFP) was already finalized for Copenhagen FAL. Two more analyses are conducted for Wrocław FAL and Berlin FAL.

The **MFP for Copenhagen City Region** was conducted based on three joint workshops. Two out of three workshops were carried out with the active participation of the Copenhagen City Region's FoodSHIFT Accelerator Lab, which included representatives from food consultancies, local governments, and researchers. In addition, one of the workshops was conducted in person for MSc students from the University of Copenhagen.

Based on food supply data (annual consumption per capita) for Denmark[18], using 2018 as the reference year, the evaluation of crop-based food consumption in Copenhagen was made. Danish food consumption data was adjusted with a factor that took into account differences in consumption patterns between the nation as a whole and the region around Copenhagen[19]. Using yield statistics from Statistics Denmark, the resulting estimate of Copenhagen's per-capita food supply was converted into land use (hectares per capita)[20]. Nuts yields were obtained from FAO as it is not included in national statistics. Quantitative estimates of land use for animal feeding were made using average yields and national feed use numbers[21,22]. The resulting area was modified to represent land usage connected to domestic consumption considering Denmark has remarkable net exports of pork and dairy (approximately 85% and 10% of production are exported, respectively) and small net imports of beef, poultry, and eggs.

Having food and land use datasets, it was possible to delimitate the urban core (15 000 hectares), as well as a ring for non-meat consumption, and a second ring for meat consumption. The results showed that plant-based consumption requires 213 thousand hectares to meet the needs of residents. The second delimited ring – meat-based consumption, reflects an area of 1 million 97 thousand hectares of productive land needed to satisfy current meat-eating habits (Figure 11).

[18] FAOSTAT(2021) *Food Balances* (2014-). https://www.fao.org/faostat/en/#data/FBS
[19] Pedersen, A. N., Christensen, T., Matthiessen, J., Kildegaard Knudsen, V., Rosenlund-Sørensen, M., Biltoft-Jensen, A., Hinsch, H.-J., Hess Ygil, K., Kørup, K., Saxholt, E., Trolle, E., Budtz Søndergaard, A., & Fagt, S. (2015, February). *Danskernes kostvaner 2011–2013*. DTU Fødevareinstituttet.
[20] Danmarks Statistik (2021), *Statistikbanken: GARTN1: Produktion af frugt og grønt efter område, enhed og afgrøde.* [available online, 12.10.2021:] https://statistikbanken.dk/gartn1 (Fruit & vegetable production)
[21] Danmarks Statistik, (2021). *Statistikbanken: Foder1.* [available online, 12.10.2021:] https://statistikbanken.dk/foder1 (Fodder Usage)
[22] Danmarks Statistik, (2021). *Statistikbanken: HST77: Høstresultat efter område, afgrøde og enhed.* [available online, 12.10.2021:] https://statistikbanken.dk/hst77 (Yield Averages)

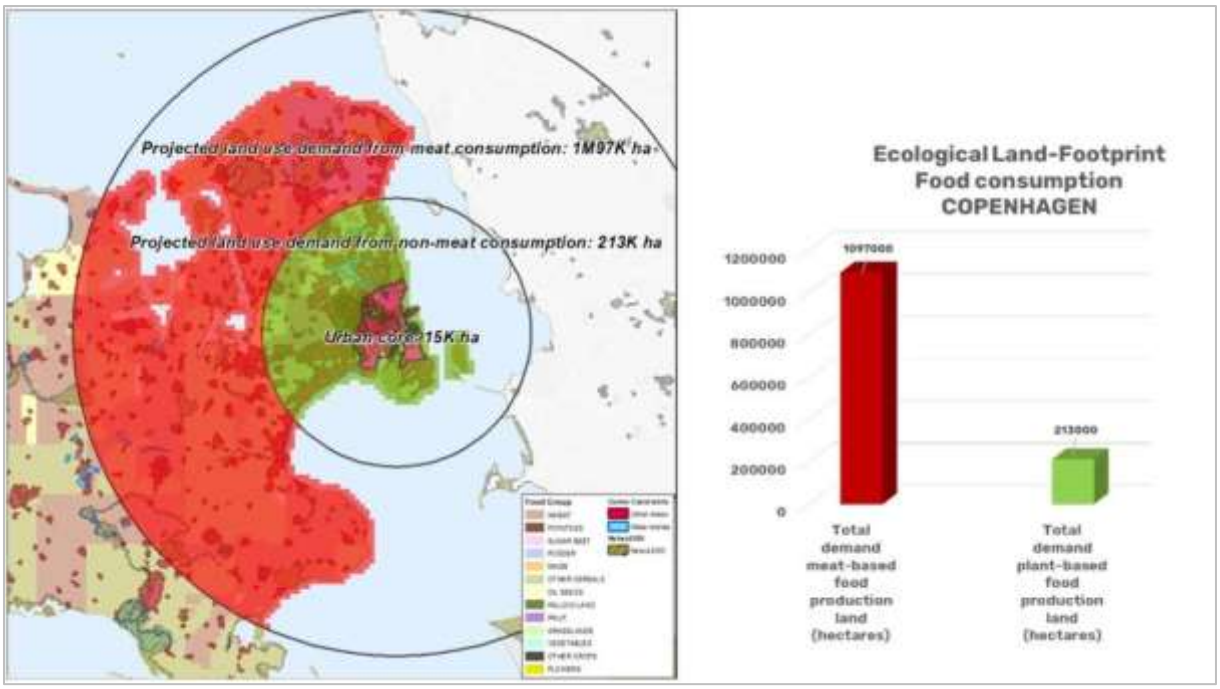


Figure 11: MFP status-quo results for CPH FAL.

The **MFP for Wrocław city** was conducted based on one in-person workshop for MSc students from the Wrocław University of Environmental and Life Sciences. The input data presenting the food habits of Wrocław inhabitants were obtained from Statistics Poland[23]. For MFP assessment mainly used data presented food consumption within the category "Data for cities with more than 500 thousand inhabitants" as Wrocław has 641928 registered inhabitants (state as of 31.12.2020). Only in a few cases (beef, pork, wines & meads, beer), the national average was used. The agricultural area demand (in m^2/kg of product) was adopted from Poore & Nemecek's[24] (2018) research as such information was selectively available and would not provide consistency for the results obtained.

The results showed that the area needed to sustain the annual food consumption of the average inhabitant living in Wrocław would be more than 3760 m^2. This individual value multiplied by 641928 inhabitants provides the result of more than 241 thousand hectares per year needed to sustain the current food habits of the Wrocław community. The results showed that delimited non-meat rings would have 58 thousand hectares, whilst meat rings would require 176 thousand hectares (Figure 12). It means, that only Wrocław community food habits should be satisfied by productive land use areas available further

[23] Statistics Poland. *Household budget survey in 2020.* [available online, 01.04.2022:] https://stat.gov.pl/en/topics/living-conditions/living-conditions/household-budget-survey-in-2020,2,16.html

[24] Poore, J., & Nemecek, T. (2018). *Reducing food's environmental impacts through producers and consumers*. Science, 360(6392), 987-992.

than the suburban zone of the city (the first ring of municipalities surrounding Wrocław city).

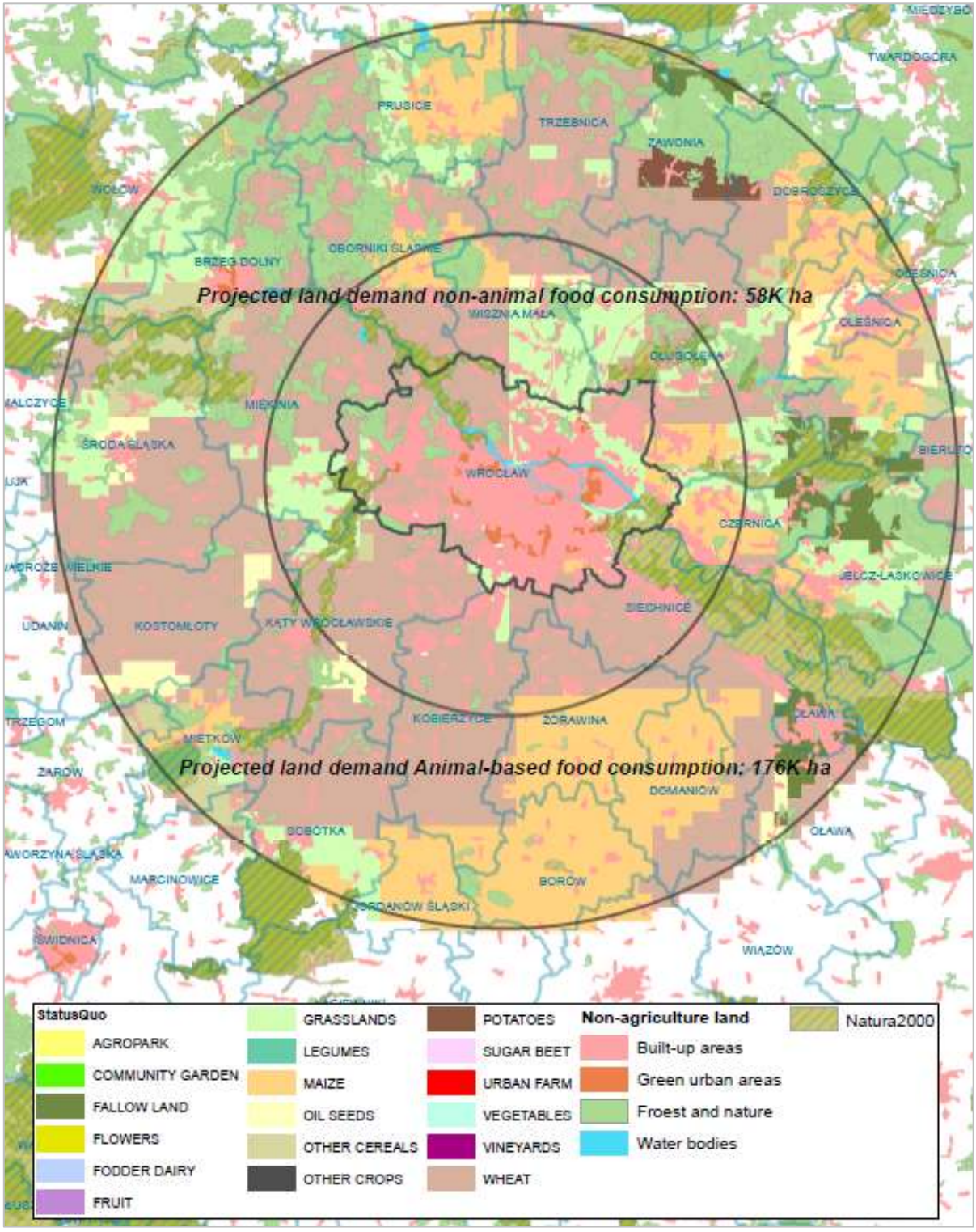


Figure 12: MFP status-quo results for WRO FAL.

Results from the MFP application showed the status quo of the current food system, as well as the tool's potential to find local food production sites that would be able to feed the city region in a more holistic, sustainable manner. Moreover, the obtained results could

be an input for food strategies developing toward a more resilient and regionalized food system that would be less vulnerable to crises.

4.3.2. CRFA

The City Region Foodshed Assessment is conducted for two FALs – Oostende and Wrocław. In the case of WRO FAL, the foodshed delimitation was previously made (Świąder, 2018) however there was a willingness to repeat the assessment based on the updated database.

The main source of data for **Ooostend FAL** was Korte Keten Kaart platform[25]. The collaboration with Oostend FAL resulted in obtaining 168 food origin of food products available in Oostend. Natural ranges are based on the principle of minimizing differences between data collected within a class and maximizing differences between classes. However, due to the convergence of collected food origin data - it was not possible to separate significantly different classes from each other. Therefore, all obtained food origins and delimited food flows were assigned to one class.

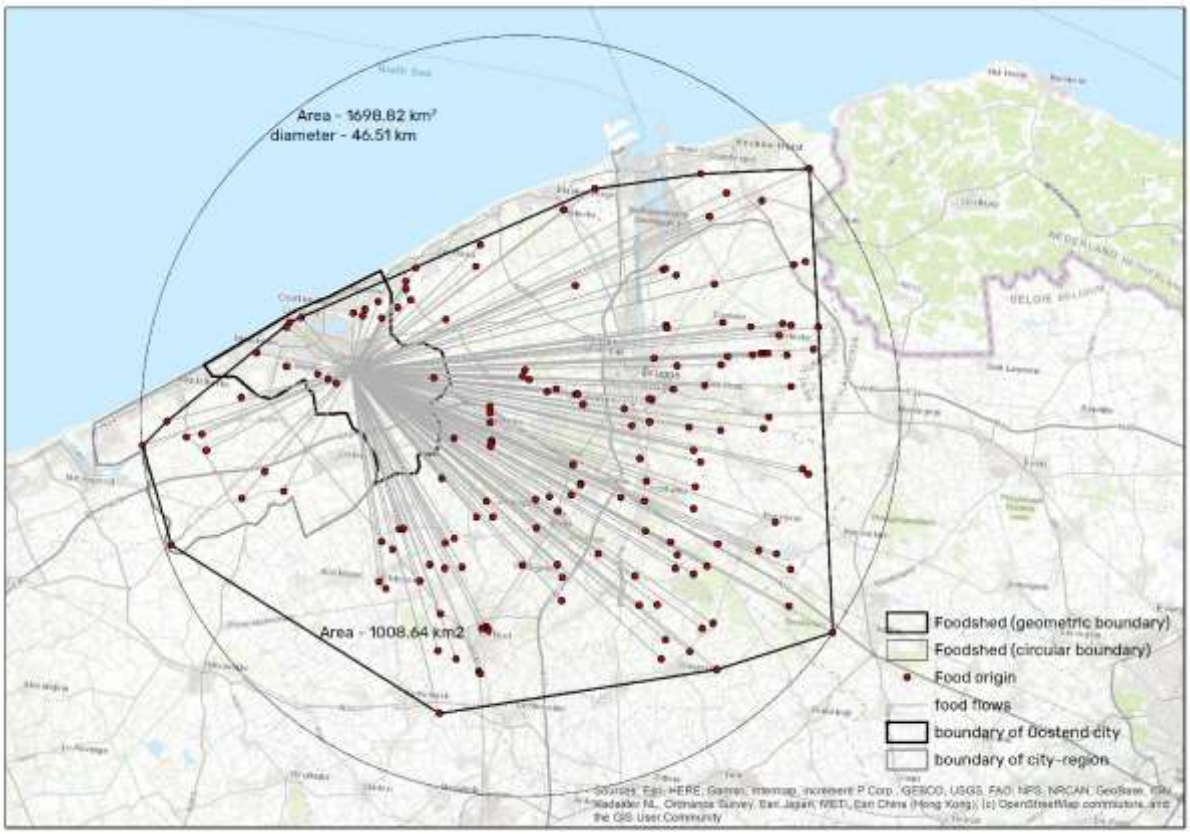


Figure 13: First results of foodshed delimitation using food-flow analysis for OST FAL.

[25] https://www.korteketenkaart.be/kaart

The foodshed was delimited using the "Minimum Bounding Geometry" tool creating features classes containing polygons that represented a specified minimum bounding geometry enclosing each input feature (food origins). There were delimited two types of geometry: (1) convex hull - the smallest convex polygon enclosing an input feature, and (2) circle - the smallest circle enclosing an input feature. The area of the foodshed delimited as polygon (using convex hull) has almost 1009 km2, wherein circular is almost 1700 km^2 and diameter of 46.5 km (Figure 13). The results presented the diameter as 46 km, and local food availability extent (radius) as 23 km is in line with the results obtained by Karg et al. (2016) noted that 50% of the metropolitan resident's food demands are met by an average radius of ca. 100 km[26].

Having geocoded food origins, the additional analysis for OST FAL was conducted (Figure 14). Therefore, areas of high and low occurrence of food origin were delimited using the "Hot Spot" statistical analysis.

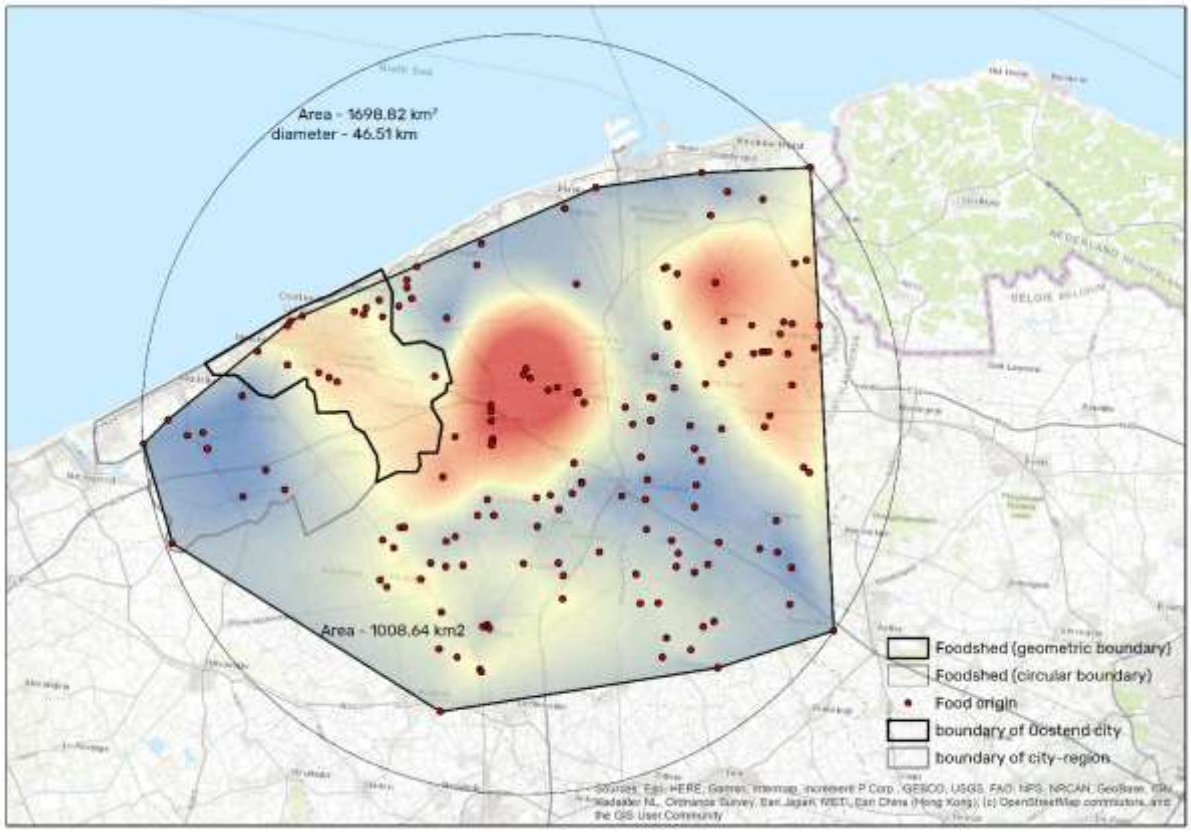


Figure 14: Hot-spot analysis of food origin for OST FAL. The high occurrence of food origin is marked by red color. The low occurrence is marked by blue color. The yellow color represents statistically insignificant locations.

[26] Karg H., Drechsel, P., Akoto-Danso, E., Glaser, R., Nyarko, G., & Buerkert, A. (2016). *Foodsheds and City Region Food Systems in Two West African Cities.* Sustainability, 8(12), 1175. https://doi.org/10.3390/su8121175

The designation of an area as a "Hot Spot" is expressed on a scale based on statistical confidence intervals, which makes the areas determined by this method statistically significant and the final visualization less subjective. The results showed that statistically significant areas of the high occurrence of food origins are located southeast of the Oostend city border. The second area with high occurrence is on the east of the delimited foodshed boundary.

In the case of **Wrocław FAL**, previous research[27] showed that the minimum boundary of the foodshed using the "Minimum Bounding Geometry" tool (convex hull type) had an area of 5663 km^2. This means 5.6 times the area of the foodshed delimited for Oostend. Moreover, the local food availability extent was quantified as almost 56 km. Similarly, as to MFP approach, the extent of food origins extent to the suburban area of Wrocław city - the municipalities bordering nearest Wrocław city (Figure 15). However, this extent is still considered sustainable - whereas the acceptable range of origin of local food is up to 100 km[28].

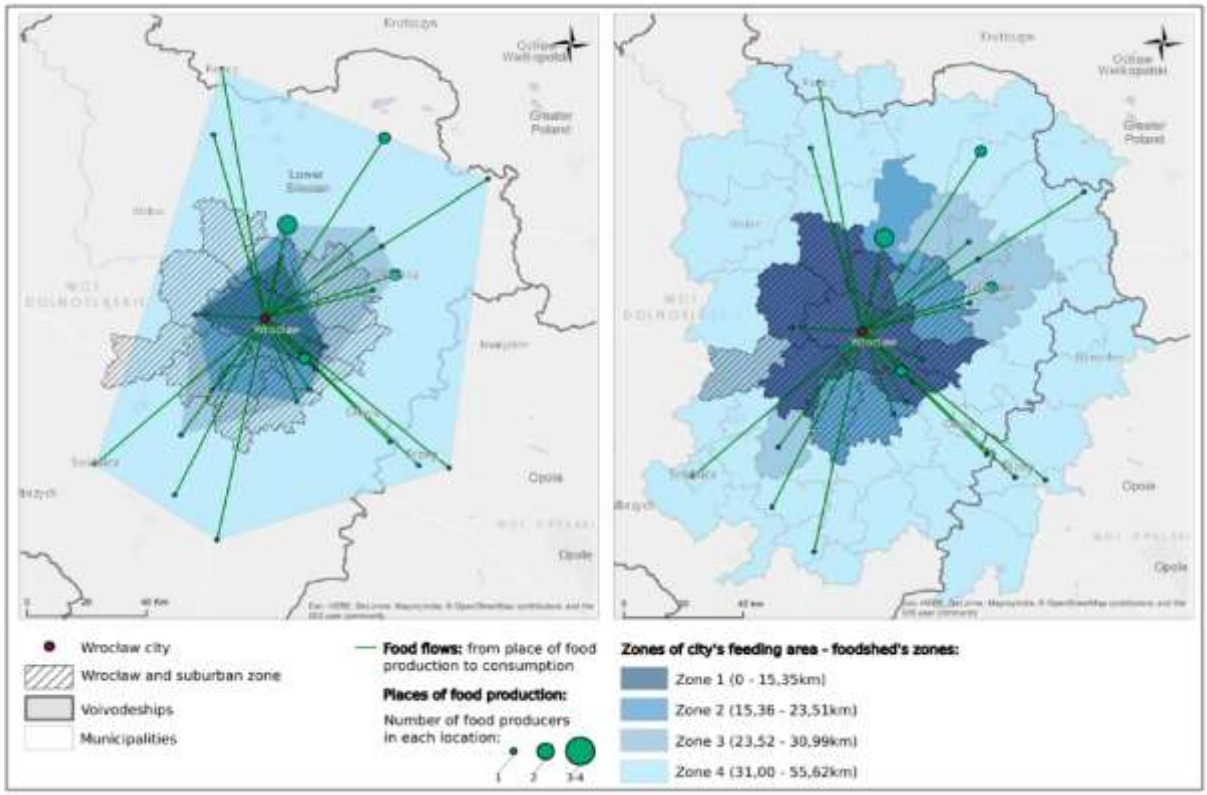


Figure 15: Foodshed delimitation for WRO FAL. Source: *Świąder, M., Szewrański, S., & Kazak, J. K. (2018). Foodshed is an example of preliminary research for conducting environmental carrying capacity analysis. Sustainability, 10(3), 882.*

[27] Świąder, M., Szewrański, S., & Kazak, J. K. (2018). *Foodshed is an example of preliminary research for conducting environmental carrying capacity analysis*. Sustainability, 10(3), 882.
[28] European Parliament (2016) Briefing, September 2016: Short food supply chains and local food systems in the EU [available online 20.08.2022]
https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/586650/EPRS_BRI(2016)586650_EN.pdf

4.3.3. MFSS

The Metropolitan Food Self-Sufficiency model was applied for all 9 FALs (Table 6) within a study comparing two different types of city regions: (1) metropolitan areas defined using the bottom-up approach, and (2) Functional Urban Areas (FUA). According to the Tercet - established by Eurostat to standardize and integrate FUA typologies, FUA is established by the city and its commuter zone. The spatial data representing FUA were retrieved from the GISCO service of the European Commission.

Table 6. Differences between the population of city regions.

	FALs								
	ATH	AVG	BRI	BRC	BER	BRV	CPH	OST	WRO
Population									
Core city	2 641 511	109 451	323 370	1 620 343	3 613 495	289 360	613 288	71 451	636 050
Metropolitan	3 711 920	207 325	1 053 496	5 106 916	6 156 743	443 956	2 053 445	130 055	1 232 924
FUA	3 632 388	330 250	744 564	4 991 133	5 259 363	401 516	1 919 370	130 055	885 638

The input data representing a population of city regions were obtained from EuroStat. The results showed differences between FALs, wherein the most populated area in Berlin – a core city with more than 3,5 million inhabitants. Following are Athens with more than 2,6 million inhabitants and Barcelona – with more than 1,6 million inhabitants. The next ones, with a population of less than one million, are Wrocław and Copenhagen – more than 600 thousand inhabitants. Successively may be listed: Bari (323 thousand inhabitants), Brasov (289 thousand inhabitants), Avignon (more than 109 thousand inhabitants), and Oostend (with more than 71 thousand inhabitants).

The population data, as well as food consumption (kg/capita/yr), harvest data (kg/ha/yr), and nutritive factors were used within the model, as well as the aspect of food waste and losses were included. Data showing food consumption and yields were obtained from the FAO database. The land use data representing agricultural land was obtained from Corine Land Cover 2018.

As results (Figure 16) showed, the greatest annual food consumption (excluding meat and other environmentally unfavorable food products) was verified for Brasov FAL (960,3 kg/capita) and Athens FAL (856 kg/capita). Between 700 and 800 kg of food consumption could be listed Bari FAL (779,3 kg), Wrocław FAL (764,6 kg), Barcelona FAL (742,6 kg), Copenhagen FAL (716,3 kg) and Avignon FAL (700,2 kg). Annual food consumption below 700 kg was noted for Berlin FAL (687,1 kg) and Oostend FAL (664,7 kg).

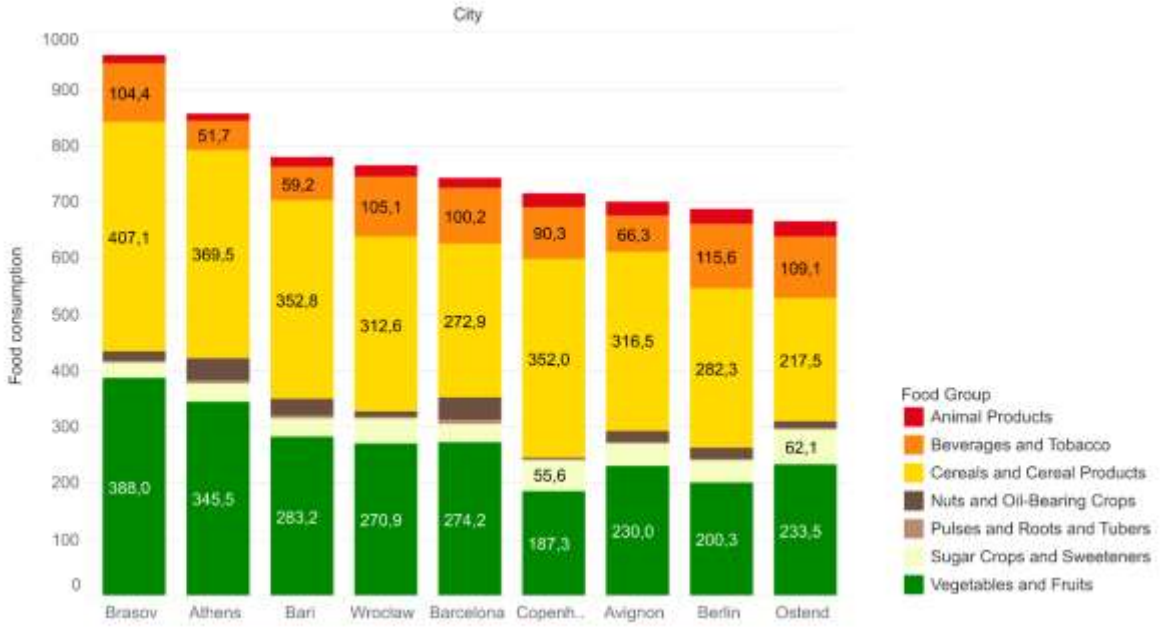


Figure 16: Annual food consumption in different FALs (kg/capita).

The food consumption data was combined with harvest data to quantify the average number of hectares needed to sustain food needs per capita (Figure 17). Therefore, the lowest land use needs were verified for Ooostend – 0.072 ha and Copenhagen – 0.078 ha. Between 0.1 and 0.2 hectares could be mentioned such FALs as: Berlin (almost 0.1 ha), Wrocław (0.116 ha), Avignon (0.156 ha), Brasov (0.159 ha) and Barcelona (0.183 ha). The highest area demands to satisfy FALs' food needs were quantified for Athens (0.240 ha).

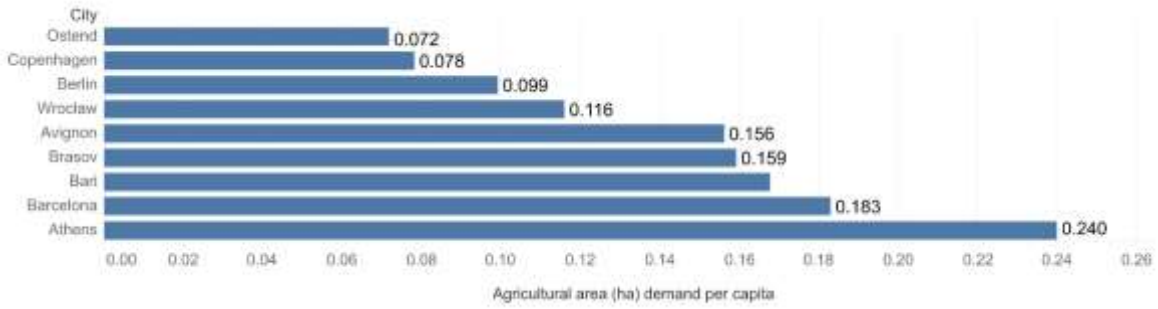


Figure 17: Number of hectares per capita needed to satisfy food consumption in each FAL.

These land use needs compared with available agricultural utilizable areas allowed to verify the food self-sufficiency within city regions (Figure 18). The greatest food self-sufficiency was quantified for Wrocław FAL in both cases: city-region as a metropolitan area (230%), and FUA (166%). The self-sufficiency could even grow in case of intaken calorie reduction. In the case of Berlin FAL, the FSS at the metropolitan area level could

reach 197% (according to current food habits) and 121% at the FUA level. The self-sufficiency above 100% for current food habits was also reached by Bari FAL (metropolitan area, 111%), and Oostend (128% at metropolitan level and FUA level).

Food self-sufficiency scenarios	Athens	Avignon	Barcelona	Bari	City Berlin	Brasov	Copenhagen	Ostend	Wroclaw
FUA local vegetarian diet (current calories)	4%	87%	4%	61%	121%	42%	80%	128%	131%
FUA local vegetarian diet (less calories)	4%	110%	5%	74%	153%	47%	107%	161%	166%
Metro local vegetarian diet (current calories)	6%	46%	5%	111%	197%	73%	63%	128%	230%
Metro local vegetarian diet (less calories)	7%	58%	7%	132%	250%	82%	85%	161%	292%

FSS
4% 292%

Figure 18: Annual food consumption in different FALs (kg/capita). The red color represents lower food self-sufficiency. The green color represents a higher level of food self-sufficiency.

The decrease in intaken calories would allow for an increase in FSS in Avignon FAL (110% at FUA level), Berlin FAL (153% at FUA, 250% at metropolitan area), Copenhagen FAL (107% at FUA), Oostend FAL (161% at FUA and metropolitan area) and Wrocław (166% at FUA, 293% at metropolitan area). However, the lowest SFF was quantified for Athens and Barcelona which may be evidence to intensify work on food policy to increase the resilience of the food system to current and unfolding crises (climatic, epidemiological).

4.3.3.1. MFSS – Avignon case study

The detailed MFSS analysis was conducted for **Avignon FAL**. The AVG FAL case study took into account the site-specific pedoclimatic, geographical, and socioeconomic conditions that are crucial for the development of local food supply chains. For this purpose, the model was applied to take into account the spatially detailed data on crops, soil type, and geomorphology The study was conducted for city-region Avignon within a predefined foodshed that comprises all the municipalities located within a radius of 30 km (distance proposed by the Senate of France) (Figure 19)

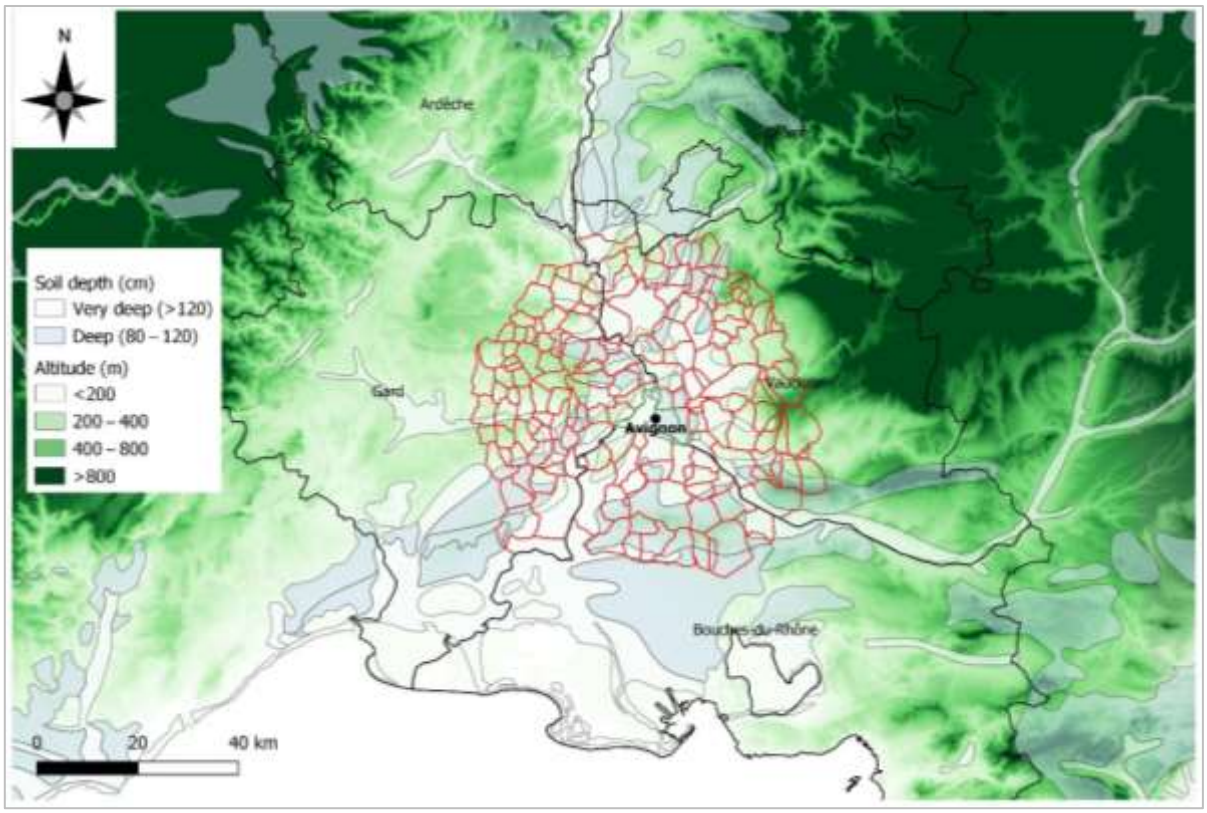


Figure 19: Municipalities belonging to the proposed foodshed for Avignon (red color), and the two variables used to identify the land suitability for commercial and animal products: altitude and soil depth.

The modeling provided to Avignon FAL showed that the initially suggested foodshed of 30 km is self-sufficient for many plant-based crops in the AVG case study. However, due to the geomorphology of the area, the area within the 30km is suitable for producing commercial plant-based products, whereas only some small areas suitable for extensive livestock farming (i.e. producing animal products) are within the 30km radius (Figure 20).

Therefore, the foodshed for animal products was expanded to a radius of 100 Km, accounting for enough land for extensive livestock farming. This resulted in values of self-sufficiency for animal products of 70%. Therefore, two radii were proposed, the first one, of 30Km, for producing regional plant-based products, and the second one, of 100 km, where the regional sustainable animal food products should come from (Figure 21)[29].

[29] Vicente-Vicente, J. L., Sanz-Sanz, E., Napoléone, C., Moulery, M., & Piorr, A. (2021). *Foodshed, Agricultural Diversification and Self-Sufficiency Assessment: Beyond the Isotropic Circle Foodshed—A Case Study from Avignon (France).* Agriculture, 11(2), 143.

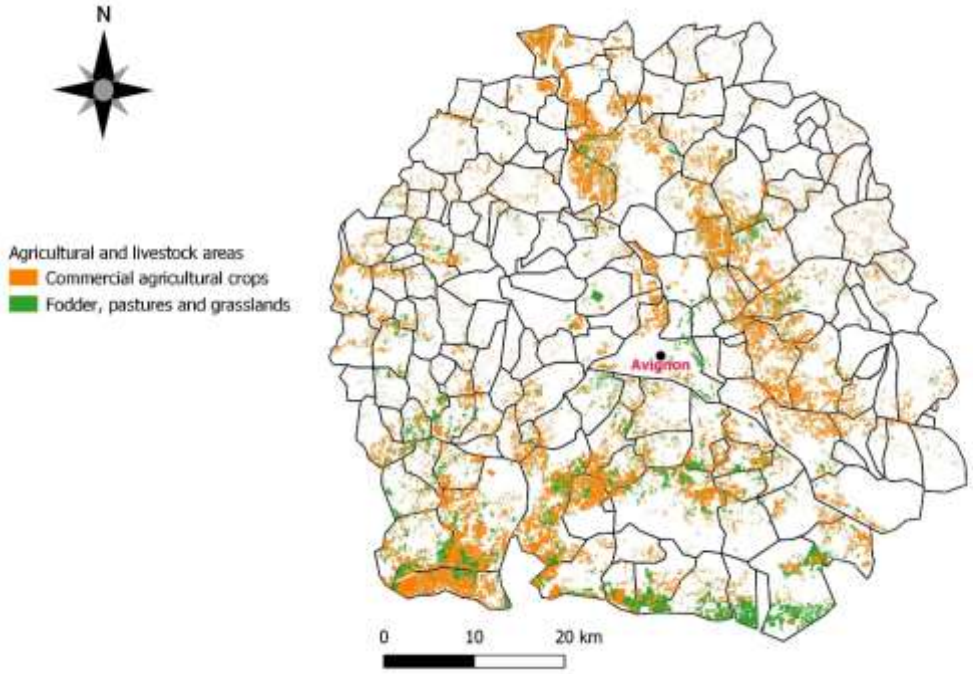


Figure 20: Available agricultural land for commercial crops and extensive livestock farming within the initially proposed radius of 30 km.

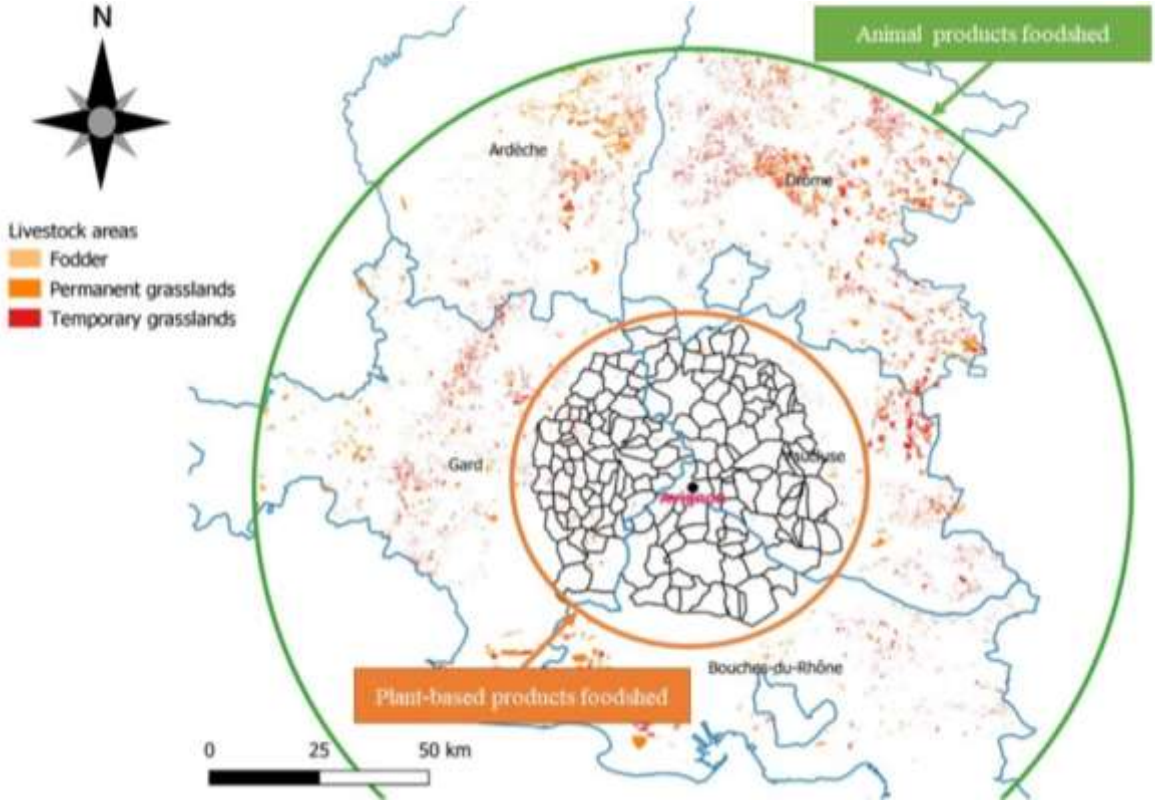


Figure 21: Summary of the foodshed assessment for Avignon.

As with the other methods – MFP and CRFA, the results obtained can be used as a good starting point for determining the extent of foodsheds and endeavor to understand the current state of the food system and study the different pathways to increase its regionalization.

In this case, a follow-up study on testing the “archipelago foodshed” for AVG has been already conducted[30], and workshops and other activities were developed with the stakeholders to disseminate and discuss the results.

5. Conclusions and further steps

All the analyses carried out so far to assess the current state of the food system in front-runner city regions can contribute to the discussion and creation of food strategies/policies.

The aspect of food policy is getting more and more attention which is connected with uncertainties due to the ongoing climate and epidemiological crisis. As the "overview" has shown, a very important aspect for all FALs is a community building around food, as evidenced by the many demonstrated food initiatives created for the community and by the community.

Preliminary results indicate that a food system assessment would need to be done by delimitation of two different types of areas providing food for cities – two different foodsheds (plan-based and meat-based).

The results obtained so far can show the potential of city regions in terms of available products, and food origins, within a range of 100 kilometers. The analysis can answer the question of to what extent cities are resilient to potential crises that could undermine food systems. For this purpose could be important research, equally in terms of food origins, but also food self-sufficiency.

Currently, the MFP analysis for Athens, Berlin, and Wrocław is in progress (Table 7). Two more MFP analyses for Brasov and Oostend are plannend. However, the CFRA assessment for Ooostend and Wrocław is also in progress.

[30] Mouléry, M., Sanz Sanz, E., Debolini, M., Napoléone, C., Josselin, D., Mabire, L., & Vicente-Vicente, J. L. (2022). Self-Sufficiency Assessment: Defining the Foodshed Spatial Signature of Supply Chains for Beef in Avignon, France. Agriculture, 12(3), 419.

Table 7. State of foodshed assessment implementation at FAL level.

Tools	FALs								
	ATH	AVG	BRI	BRC	BER	BRV	CPH	OST	WRO
MFP									
CRFA									*,**
MFSS		✓			*				

- completed
- ongoing
- planned
- possibility of application (in a different way) in the future

**previously implemented assessment for FAL within different research, not within the FoodSHIFT2030 project; **willingness to repeat the analysis using current data; ✓ case study implemented;*

As the work on the current food system assessment is still in progress, the final results will be submitted in the next version of the report (Version 2.0) according to assumptions: analyses prepared according to the interest, needs, and focus of the FALs.

Appendix A: The working space within Citizen Lab Platform.

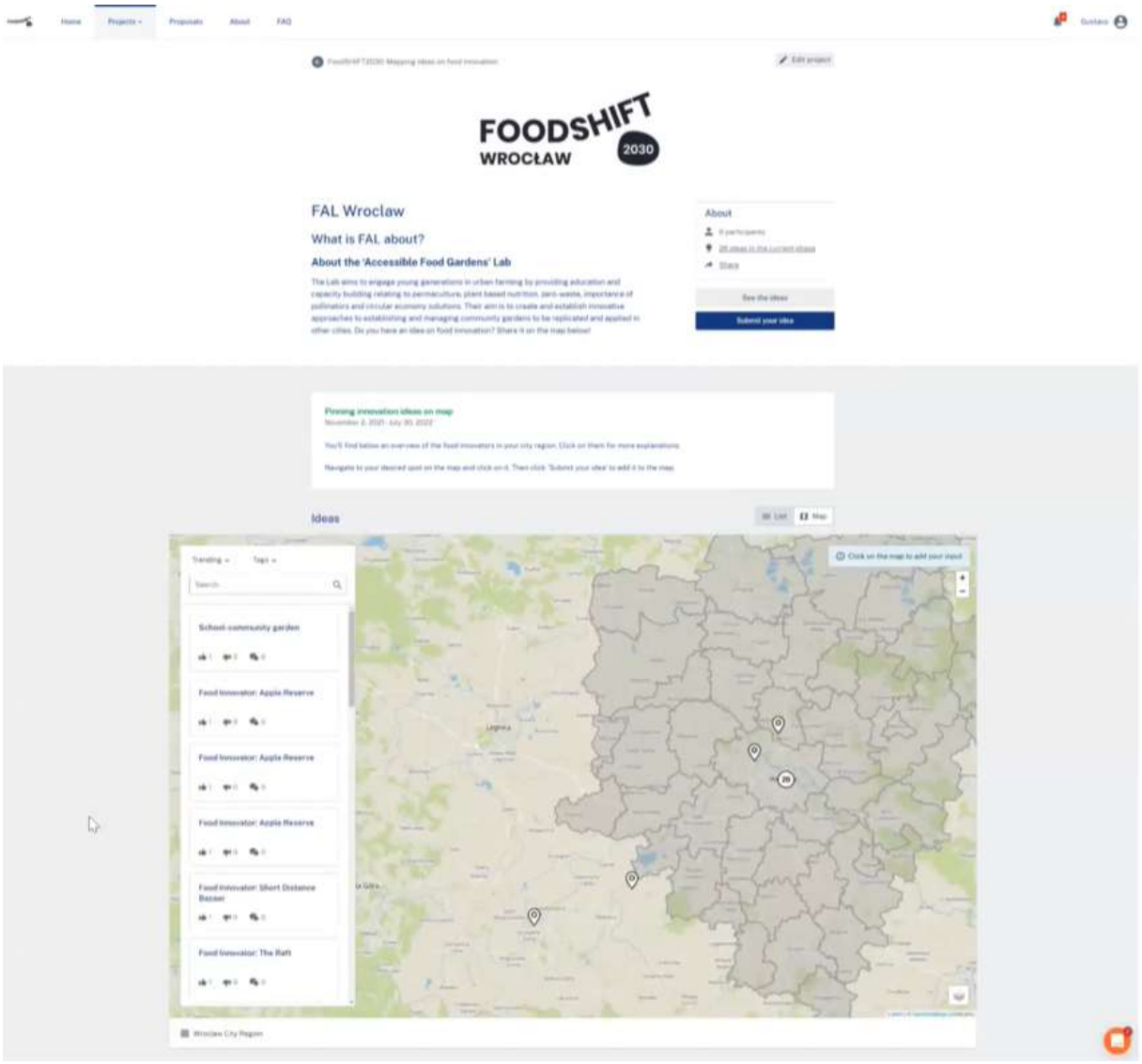


Figure A1: The example of FAL working space dedicated within the Citizen Lab Platform.

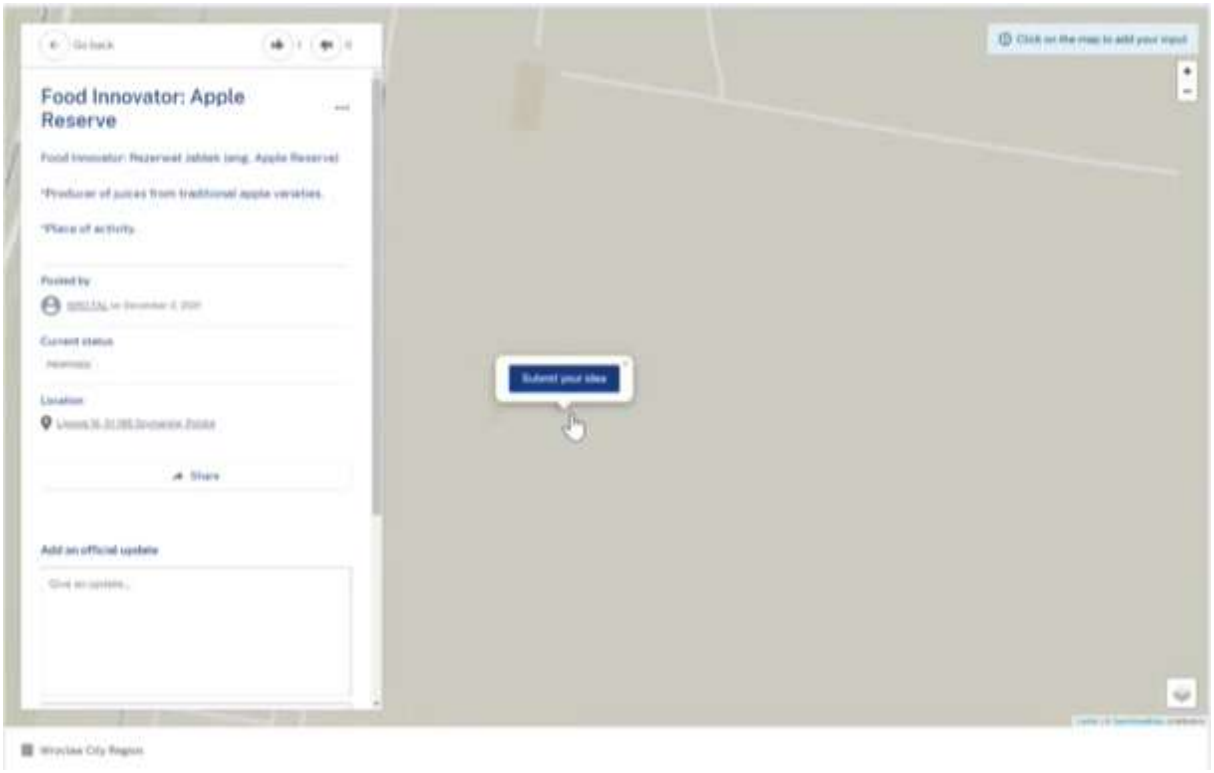


Figure A2: User-friendly mapping possibility.

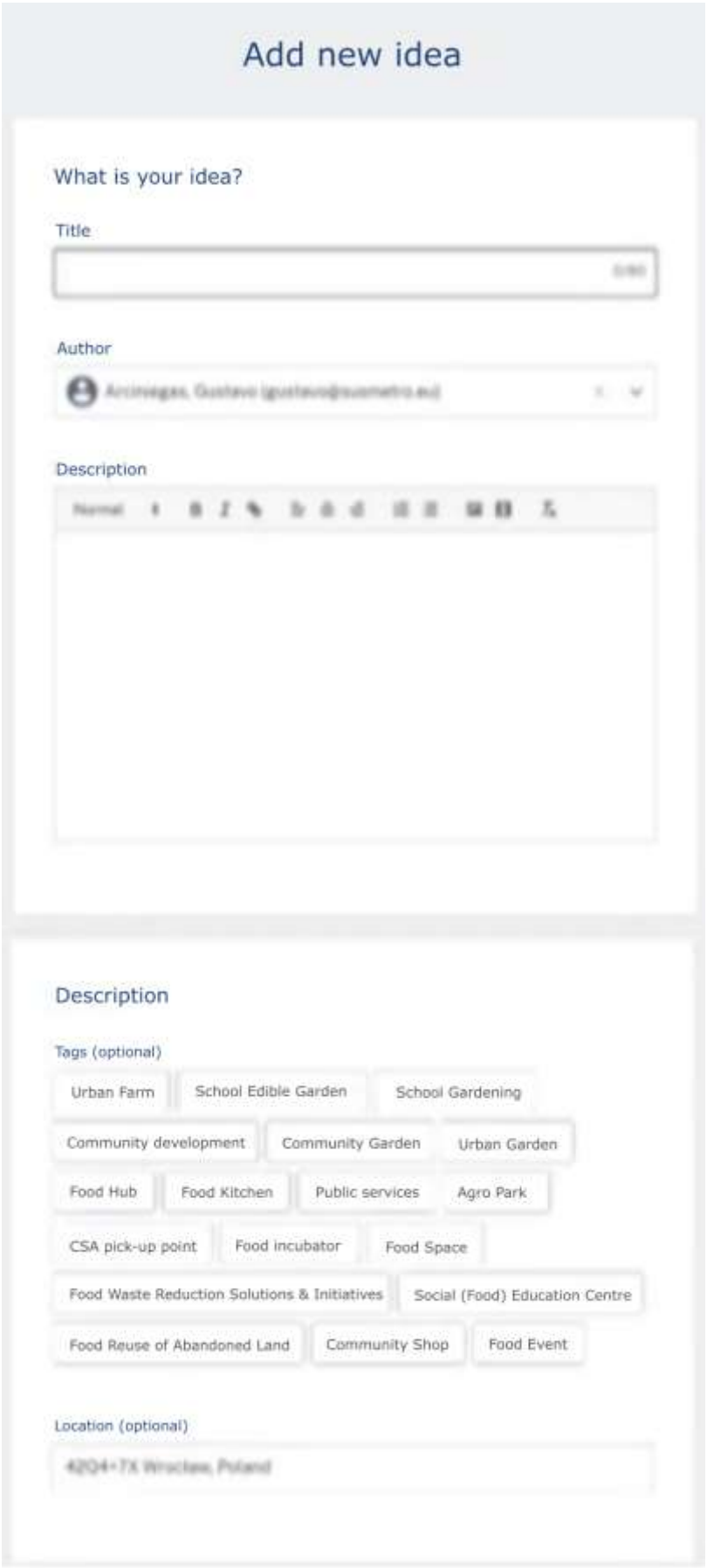


Figure A3: Adding points to Citizen Lab Platform.

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