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Meeting the growing appetite of cities – delivering an evidence base for urban food policy

Sigrid Wertheim-Heck[1]*, Jessica van Bossum[2], Melika Levelt[2]

[1] Aeres Hogeschool / Stadhuisstraat 18,1315 HC Almere, the Netherlands

[2] Amsterdam University of Applied Sciences / Weesperzijde 190, 1097 DZ Amsterdam

E-Mails: s.wertheim-heck@aeres.nl; j.j.van.bossum@hva.nl; m.levelt@hva.nl

* Author to whom correspondence should be addressed; Tel.: +31 6 33876825

Abstract: The growing appetite of cities is one of the greatest future challenges. There is no set menu for meeting this appetite, but a trend is observed in which city authorities focus on region-based food provision. Regionalism is motivated by the importance of increased self-reliance. Besides, regional food systems, are associated with more sustainable production and reduced carbon footprints, the reconnection of consumers with production, and the increased uptake of whole foods in urban diets. However, the question remains to what extend region based food systems may become self-reliant? How may they contribute to improved sustainability and healthy lifestyles? With the Dutch city of Almere as a case in point this paper provides a food flow data-based analysis of the opportunities and limitations of regional based food system approaches. The paper sets off with defining the concepts of sustainable self-reliance and regionalism. Next, it describes the methodology of measuring and mapping the actual food flows. We combined secondary, publicly available, with primary quantitative and qualitative datasets, involving regional businesses, urban policymakers, and residents. Our study uncovers the coinciding disconnect and interconnectedness of local, regional and global food systems. The regional scale offers opportunities for tackling many food related challenges, however, sustainable urban food security demands connections beyond the regional sphere and beyond the food domain. To assess the effects of the policy options available at the local and regional level, a solid evidence base is essential. This paper advances the development of evidence-based methodologies to monitor and inform food system policies.

Keywords: resilience, city region food system, mapping food flows

1. Introduction

The growing appetite of cities is one of the greatest future challenges. It refers to the continued population growth and urbanisation worldwide and the related problems of 1) increased environmental impact of food supply

- feeding urban populations already accounts for 20 to 30% of global greenhouse gas emissions (Aleksandrowicz et al. 2016)- and 2) increased uptake of unhealthy ultra-processed food high in salt, sugar, saturated and trans-fats (Monteiro et al., 2013) - associated with increases in obesity and related epidemic in non-communicable diseases (NCDs) (European Commission 2018a). There is no set menu for meeting the appetite of cities and resolving the related problems concurrently, but a global trend is observed in which city authorities focus on increasing region-based food provision as a solution.

This trend towards city region food systems (Jennings et al. 2015, RUAF 2017) is motivated by reasons of resilience, health and environment. Firstly, there is belief in the importance of reducing the dependency on international trade. Establishing a more direct link with the agricultural hinterland is regarded a resilience strategy in mitigating global food security risks resulting from international trade barriers, natural disasters and climate change, scarcity of natural resources and environmental disasters which may lead to price increases and, worse, shortages. Secondly, the rising burden of NCDs is urging drastic food system interventions to improve the dietary intake of citizens for increased wellbeing and reduced healthcare costs (European Commission 2018b). A more regionally oriented food supply is argued to reconnect consumption and production resulting in the re-valuation and increased uptake of whole foods in urban diets, providing counterweight to the consumption of ultra-processed foods. Thirdly, city region food systems are motivated by environmental considerations. Shorter supply chains are associated with a reduction in carbon emissions - reduced resource-intensive processing and transportation – and more sustainable production methods. (Blay-Palmer et al. 2015, FAO 2018).

In short, the transformation towards a more resilient, healthy and sustainable food systems is to a large extent sought in regional production, shorter supply chains, and more conscious food consumption. Localized, and specifically plant-based, whole food diets are argued to offer health benefits, to reduce greenhouse gas emissions and biodiversity loss, and to stimulate local economies (Abatekassa & Peterson 2011, Bloom & Hinrichs 2016; Brunori et al. 2016, Edwards-Jones 2010, Feldmann & Hamm 2015, Ostrom et al 2017, Tilman and Clarke 2014, Trivette 2015).

The extent to which the benefits ascribed to re-localization can be achieved greatly depends on the local context of the metropolitan region at hand. For each context, three central questions arise: 1) Do the assumptions around the positive impact of re-localization food systems hold true for the given metropolitan area? i.e. can re-localization, indeed contribute to urban food security and resilience in the given metropolitan area, in terms of improved health, environmental sustainability, social, spatial and economic impacts? 2) To what extent is a re-localized food system achievable, given the current food production and distribution systems in meeting the current food demand of urban consumers? If so, 3) How can this re-localization be realized, taking into account the drivers and barriers for all actors in the food chain from farm to fork?

To answer these questions, a thorough understanding of the food system is required, but comprehensive datasets and integrated insights into this highly complex system are largely absent. The available evidence is scattered and fragmented. Cities seeking for food system transformations (FAO 2018) design strategies and interventions framed along a rather dichotomized debate in which alternative food networks (AFNs) - such as farmers' markets, community supported agriculture and food buying groups -, are presented as an alternative to the 'globalised' conventional food system (Blake et al., 2010; Blättel-Mink et al., 2017; Carolan, 2017; Forssell & Lankoski 2015). However, current interventions aiming to transform the food system in the direction of a more regional orientation are lacking a solid evidence base. This paper addresses this knowledge gap, by advancing the development of evidence-based methodologies to monitor and inform food system policies.

2. An evidence base for food system transformation

In obtaining a solid understanding of the food system and its impacts on urban issues, one must understand the nature and quantity of food being produced, moved, consumed and wasted in that system (the 'flows') and the actors realising these flows. A literature review on methodologies for mapping food actors and food flows (van Bossum, 2017) uncovered a limited but growing number of studies exploring metropolitan food system, ranging from small-scale qualitative exercises to more data-driven mappings. Urban metabolism studies mapping food or organic flows at the metropolitan level (Voskamp et al. 2016, Billen et al. 2011, Barles 2007) do not provide insight into the actors shaping these flows, nor into the detailed composition of these flows themselves. Other studies at city level (Barron et al. 2010, Carey 2011, Edwards and Mercer 2010) start from mapping these actors, and then making assumptions about their role and share in the food flows by combining macro-economic data on food supply with interviews and surveys at the local level. Further, studies, like in The Netherlands, focus on specific aspects of the food system like urban food demand (Van Dijk et al. 2017), or approach the food system analysis by focusing on a single product, or specific sustainability aspects of the food system (Sukkel et al. 2010). More recent studies and inventories focus on resilience, offering case-by-case mappings of neighbourhoods and cities (Zeuli and Nijhuis (2017) or the Toronto Food Council's Food by Ward map (http://tfpc.to/food-by-ward). All these studies have in common that they offer one-off snapshots of the food system. Isolated aspects of the system to consider when developing a regional food system are extensively being studied, but more integrated, holistic and longitudinal perspectives are lacking. The limited and fragmented availability of data at city, metropolitan or regional level, combined with a lack of access to (often privately held) data on food flows and food actors, appear to hamper more holistic approaches to city-region food system analysis.

This paper, elaborates and reflects on the attempt to develop data-driven methodologies to support policymakers in their food policy decisions. building on the Evidence-based Food System Design project[i] within the Amsterdam Metropolitan Area (AMA) in The Netherlands. In doing so we address both methodological and applicability questions: (1) How to develop holistic food actors and flows mappings that are replicable overtime and transferrable to other contexts? (2) How can these mappings be put to use for urban food policy development?

In the next section (3), the paper goes in-depth on the methodology of measuring and mapping. We describe the methods devised and tested for gathering reproducible and refreshable data on food system actors and flows with the aim to gain longitudinal insight into the landscape of food actors and shifts over time. These data constitute a key part of the evidence base for urban food policy; enhancing the assessment of opportunities, supporting decision-making and enabling the creation of feedback loops to monitor and evaluate the impact of interventions. Given the host of potential data to be gathered, we took the mapping of the actors in the food system as our starting point. In section 3 we thus first elaborate on food actor identification and mapping. Next (section 4) we present how the food flows between the actors where assessed and mapped. We delve into three case studies where we tested different methods for surfacing data on the food flows in distinct parts of the food supply chain. With the Dutch city of Almere as a case in point the paper then (section 5) continues with a food flow data-based analysis of the opportunities and limitations of regional based food system approaches. In the concluding section of this paper (section 6), we reflect on the applicability of the methodologies the methods used, outlining their strengths and shortcomings in terms of informing urban food policy, and pointing at further avenues for research and application.

3. Mapping the actors in the food system

Insight into the food actors is the first step in obtaining data-driven insights into any food system. Without knowing who these actors are - their role in the food supply chain and where they are located - it is impossible to devise effective and efficient intervention strategies. 'Food actors' are defined by their direct role in the physical food flows, identified by their physical representation as junction in the food chain: primary producers, food processing industries, food logistics companies, wholesalers, retailers, food service establishments, consumer households and enterprises collecting and/or processing food waste.

The dataset of all food actors in the AMA included data on the role and significance of these actors in the food supply chain as well as their physical location, to enable geographical mapping and spatial analysis. Relevant data sources were identified through web research and contacting municipalities, research and consultancy institutes and, through snowballing, others with potential access to such data. Sources included the Chamber of Commerce, the Netherlands Food and Consumer Product Safety Authority (NVWA), the National Information System on Employment (LISA) and municipal/provincial Establishment Registries. All sources were assessed against a number of data-inclusion criteria: Frequency of updates, completeness, accuracy, continued availability over time, accessibility and cost. A last requirement was that the data could be made available and accessible to policymakers, researchers and other parties working on transitions in the food system. After all: what good is an evidence base if that evidence is inaccessible to those who need it?

Based on these requirements, a choice was made to use data from the Establishment register, managed and maintained by various municipal and provincial bodies (the 'registrars'). The register contains data on all commercially active establishments in a given geographical region, classified by NACE codes (a standard classification of economic activities across the EU). The register is based on data from the Chamber of Commerce, which was cleaned, enriched and verified by the registrars according to a national protocol. Thus, although the datasets are obtained from different sources (in the AMA case: the provinces of Noord-Holland and Flevoland and the municipalities of Amsterdam and Haarlemmermeer), they allowed comparison. The individual Establishment Registries feed into a national database (LISA). Access to that database is limited by its high cost, and carried the additional drawback of being less up-to-date.

The datasets, were each first cleaned (i.e. incorrect data and errors were removed/resolved) and next combined using R script. R was chosen as coding language due to its versatility for manipulating and analysing data, but also its potential for visualising results and creating maps. The resulting dataset was analysed for missing values and quality defects. Where possible, these were resolved through contacting the Registrars. Data on secondary economic activities (i.e. when a company is a player in de food chain but not as its primary activity and thus is not included in the Establishment Registries) were obtained from data from the Chamber of Commerce; geocoding, where missing in any of the datasets, was done using the Google API (application coding interface), and data on the physical establishments were pulled, through an API from the Addresses and Buildings Database. The next step was to filter on food-related activities. For some economic activities, this was obvious from the NACE code (for example, restaurants or supermarkets). For others, such as 'logistics' and 'waste flow processing' this was not possible, and algorithms were written to filter out the obvious misfits. The remaining food unspecified businesses were examined one by one to verify their role in the food supply chain.

Finally, results were visually mapped, while anonymity was maintained by deploying sufficient location inaccuracy and classifying actors into pre-defined employment size categories. Further actors that do not play a

role in the physical (and thus geographically relevant) food flows were excluded from the map; like online businesses without physical infrastructure, and event caterers and market salespeople who are usually registered at their home address.

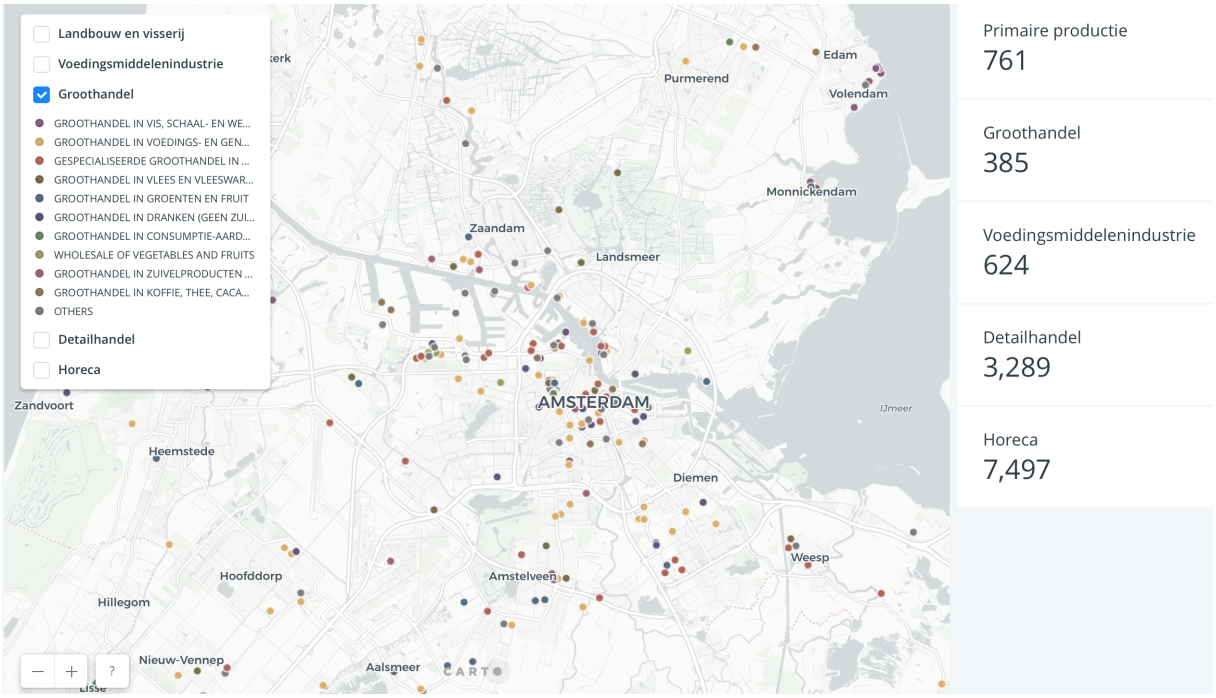

Figure 1: Screenshot of food actor web map

Although, the accuracy of the dataset can be further improved, the visualisations enhance the accessibility of the food system data. Besides, the visualisation of the limited dataset proved valuable in stirring meaningful dialogues among stakeholders and generating valuable questions for further research and analysis, some of which will be described in the next section;

4. Mapping food flows in the Amsterdam Metropolitan Area

Over 40.000 food actors were identified within the AMA. Since the project did not allow for mapping all flows between those actors, the food flow mapping proceeded in two consecutive steps. First, we identified data sources providing an overall picture of the food flows. At a national level input-output data are available. At the regional level, we attempted to distil food flows from traffic data, by converting vehicle counts on the major transport axes into and out of the metropolitan area into estimates of agro-food volume.

While useful for assessing the overall share of food in logistics and road use, the resulting food flows did not provide the required reliability (due to the many assumptions involved) and detail regarding origin and destination of food and was thus of little value for urban food policy design. However, it did uncover large differences between the different parts of the food supply chain in terms of logistics and demonstrated how the distribution system is structured. The agro-sector is dominated by bulk flows over land and over water and is largely internationally oriented. The retail sector is concentrated in four buying consortiums. Routing physical food flows via regional distribution centres to supermarkets. The food service sector, on the other hand, is highly fragmented. The five largest wholesalers hold 60% of this market; the remaining market share is divided among the ~10.000 other

wholesalers and the 1500 food producers. As such, food service flows are much more dispersed than flows in other parts of the supply chain and require a different approach in collecting data.

Second, to get a more fine-grained insights into the food flows at the regional level, we selected three case studies for developing and testing different methodologies for obtaining data on food flows. Each of these cases, covers a different municipality within the AMA (Zaanstad, Amsterdam and Almere) and focuses on a different part of the food chain. Methodologies range from micro-level consumption analysis at retail and household level (Almere) to logistics flow modelling (Amsterdam). The rationale for deploying diverse methods was to explore their distinct applicability and complementarity in mapping food flows on the one hand, and to assess the availability of data required for the different methods on the other. The approach in two of the cases is described below.

4.1. The Amsterdam case: Wholesaler - Food Service flows

In Amsterdam, an attempt was made to quantify the food flows from wholesale to food service establishments. These flows are of particular interest for the city as they constitute 25-40% of all cargo flows in the city and put a disproportionately large pressure on the city's logistics space (Rademakers 2018). With over 5000 food service establishments in the city, these flows are highly fragmented. Therefore, collecting data from each individually is not feasible (Rademakers et al. 2018). Instead, we opted to develop a model that would enable us to predict the food flows (in terms of number and type of food deliveries) to these food service establishments based on the (publicly available) characteristics of those establishments. This model requires two types of data:

- Data on characteristics of food service establishments: These data were taken from the Food actor dataset described in section 3, enriched with data obtained from the municipality and on-line resources like Google and dinner sites. These data sources provide information on type of cuisine, quality, price segment, public rating (as proxy for occupancy rate), opening hours, type of enterprise and type of horeca-permit.
- Data on deliveries. these data were obtained from four wholesalers (one year of deliveries to all customers in Amsterdam) and 30 food service enterprises, ranging from hotels, coffee bars and lunchrooms to star restaurants.

Using machine learning (Random Forest method), correlations between characteristics of food service enterprises, and the number and type of deliveries made to these establishments are identified and applied to a test set, to determine their accuracy. The model is still under development. If successful, it will offer insight into the food logistics flows per area of the city, depending on the profile of food service establishments located there. Not surprisingly, obtaining data from wholesalers and food service enterprises proved difficult. In the former case, data are commercially sensitive, and smaller wholesalers do not always have data available. Most food service establishments do not see the benefit of providing data. This difficulty reinforced the usefulness of a model that does not require recurrent collection of such data.

To provide context to these data, and to identify opportunities for change, the collection of quantitative data was supplemented by qualitative research into the practices, motivations and interests of both the wholesalers and food service establishments that determine deliveries. This was done through focus group interviews with wholesalers as well as interviews with a sample of food service establishments. Findings from that research

indicate that besides the characteristics of the food service establishments available in the open data, the number of deliveries and suppliers highly depends on the type of entrepreneur, company mission, and professionalism in the ordering process (Rademakers et al. 2018). That part of the research is beyond the scope of this article.

4.2. The Almere case: Retail – consumer flows

Within the AMA, the municipality of Almere has perhaps the most explicit urban food policy, made concrete in its target to meet 20% of Almere's food consumption with regional production by 2022 (Jansma et al. 2016). The Almere case study (ten Brug et al., 2018) was conceived to develop a methodology to measure progress towards this target. For reasons of feasibility several choices were made to limit the scope of the research. Firstly, the geographical scope of 'regional production' was limited to the province of Flevoland. Secondly, the case limited itself to flows reaching consumers via retail outlets, which is the most common route from farm to fork, thus excluding out-of-home consumption. The scope was further narrowed by focusing on fresh fruit and vegetables. In measuring and mapping the food flows three perspectives were used (1) regional primary producers (to get a sense of regional production and where it is destined), (2) urban food retailers (to uncover where which products are sourced from), and (3) consumers (to uncover what is where being purchased).

To get to grips with the complexity of the food system a two-phased mixed method approach was applied, informed by a study in Vietnam (Wertheim-Heck et al., 2018). In the first phase, we collected publicly available datasets and triangulated and combined these secondary data. Data were obtained through literature review, consulting (semi)open datasets, and by web scraping. Datasets included academic food consumption surveys (University of Groningen) and open-access data on local, regional and national land use and production (FoodCube). Food demand in Almere was determined by transposing national consumption survey data (Netherlands National Institute for Public Health and the Environment-RIVM) to the Almere municipality, correcting for gender and age distribution. Web research yielded data on retail chains and the location of their producers. The analysis of the secondary data uncovered important data-gaps and informed directions for further primary data collection.

In the second phase field research was conducted to complement the secondary data-set with primary data collection in Almere, including both quantitative and qualitative data collection methods. Phase two kicked off with observation and count of products in Almere retail. In all supermarkets, organic shops, ethnic stores, and open-air markets the following information was recorded: the indicative percentage of food versus non-food; the indicative percentage of ultra-processed versus whole and minimally processed food within the food category; the (country of) origin, the price and if applicable the organic certification of all fruits and vegetables offered in store. This was complemented with information on the reasons behind the decisions of producers, retailers and consumers that shape the food flows. Semi-structured interviews (n=13), were conducted with major retailers and producers, as well as local experts on food policy development and interventions. A survey was deployed to collect data on the every-day food shopping and consumption practices, attitudes and preferences among consumers (n=96) in two socio-cultural distinct Almere neighbourhoods.

The data collected show that there are 1784 agricultural producers in Flevoland, 64% of which grow vegetables. For the major crops - like onion, potato, carrot - the yields per acre in Flevoland are among the highest in the world. Onion (37%) and table potato (36%) take-up the major part (73%) of the agricultural arable land in

Flevoland, followed by carrot (12%) and chicory (7%). Most of the production is designated for export and for these major products the Netherlands belongs to the world's largest exporters; 3.2% of the consumption potatoes grown in Flevoland in a year, could already feed Almere for a year. Besides the high quality of the products, that allow for a long shelf life, storage and logistic capacity have enhanced this export position. Also, of high importance is the favorable export routes through the ports of Enkhuizen, Rotterdam and Vlissingen. For instance, 90% of the onions produced in Flevoland are exported internationally through the harbor of Rotterdam and Vlissingen. Most producers have limited insight in where their products end-up in the world market. The remainder 10% of the arable agricultural land in Flevoland is allocated to the production of other vegetable crops like spinach, turnip and kale. Although potentially allowing for diversification in the locally sourced menu, the regional production is currently insufficient to meet the consumption demand of Almere.

With production being largely export oriented the question remained, what foods are being offered and consumed within the city of Almere. Preliminary research on food shopping practices of consumers in Almere uncovered that over 70% of the foods are purchased at conventional supermarkets. Supermarkets are characterized by central sourcing and distribution systems and none of these central distribution hubs are within the regional, Flevoland, area. These centralized practices inhibit a more direct connection between regional production and local consumption. To assess the actual availability of regional produce across a variety of food retail channels, census counts of fruits and vegetables based on origin were conducted across the following retail channels: supermarkets, organic shops, ethnic stores, and open-air week markets.

Although the study was limited and was not crosschecked for seasonal influences, the counts confirmed the unavailability or unrecognizability of regional products in supermarkets. Over 80% of the fruits and nearly 60% of the vegetables were internationally sourced. With 50%, the largest portion of national products was found in the organic sections of the supermarket. For the crops that are typically grown in Flevoland, like the aforementioned onion, potato, carrot and chicory, the counts demonstrated that these products more than other vegetables, originated from within the Netherlands.

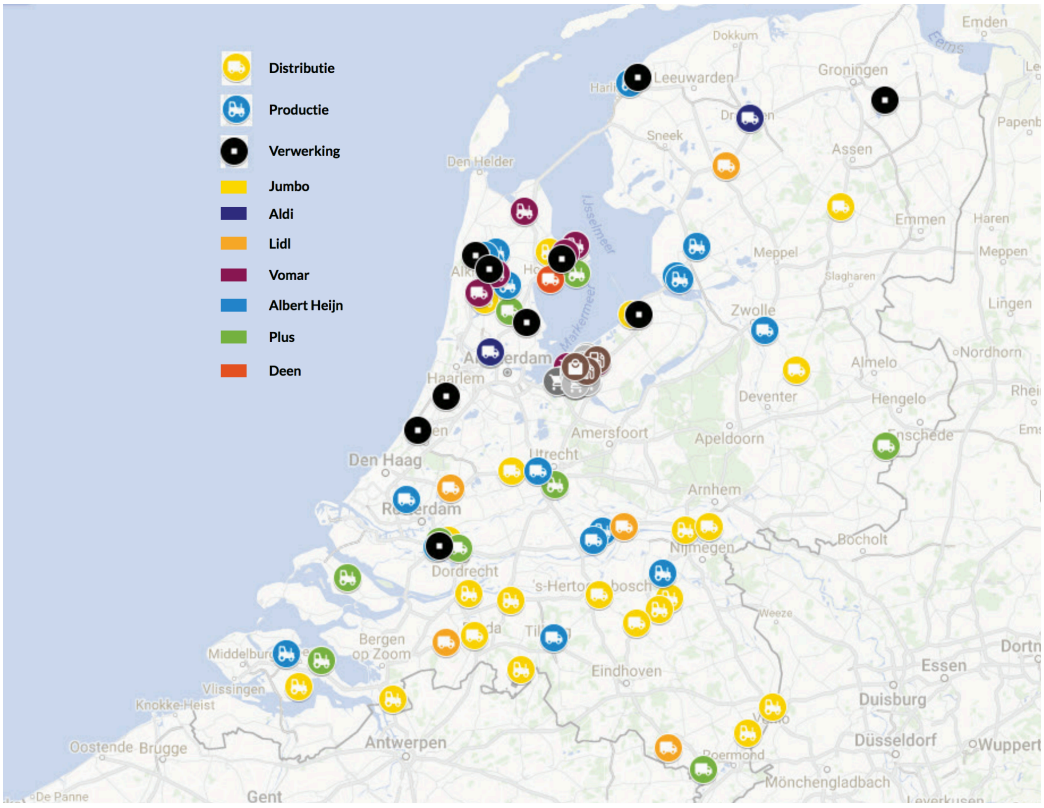

Figure 2: Screenshot of vegetable producers, distribution centers and processing companies supplying supermarkets in Almere. Interactive map available: https://www.google.com/maps/d/edit?mid=1mTv0PVcL0Fscr6QxSareF3pxmViTNSiV&ll=52.36879507250639%2C5.240883054914548&z=12

Counts in organic shops provided similar results as those encountered in the organic section of conventional supermarkets: 100% of the potatoes and 50% of the fruits and vegetables originated from within The Netherlands. Also here, more detailed information on origin was absent.

When realizing a local food system, the citizen consumers are crucial players. The population of Almere includes 183 distinct ethnic backgrounds, characterized by clustered distribution across the different urban areas. To preliminary grasp how back ground plays in with neighborhood food environment, the study included a limited and initial comparative analysis on local between two Almere districts: Parkwijk and Stedenwijk. Geographically mapping retail outlets and assessing the food healthiness within the food retail outlets provided insights on the accessing opportunities of healthy and local foods at the district level. Many consumers indeed appeared to do their groceries within their own district. In both districts consumers largely relied on shopping at supermarkets with little to no regional food products on offer. Also, the awareness about or interest in regional food products was low in both districts. However, the study also uncovered differences. A more diverse retail environment appeared to result in more diverse shopping practices in terms of shopping location. In Parkwijk, the diversity of food retail outlets was slightly higher and consumer shopping practices also showed a slightly more diverse pattern in shopping for food. The research was too limited to make conclusive statements but provides avenues for further study.

5. Applying methodology to gain insights for urban food policy: Diving further into the Almere case

What does a state-of-the-art evidence-based analysis tell us about the opportunities and limitations of a regionally oriented food system for the city of Almere? The Almere case study described in the previous section

yields insights into the extent to which food produced in Flevoland is offered and consumed in the city of Almere (the baseline situation). It also identified potential hurdles in achieving the 20% policy target, and questions to be further addressed to track progress towards this target.

Let us first consider the municipality's food context. The city of Almere was only recently established, in 1975, but has rapidly developed into the seventh largest municipality of the Netherlands, with over 200.000 inhabitants. It is the largest municipality in the province of Flevoland: an area of land reclaimed from the sea in the 1960's and designated for agricultural production (van Dijk et al. 2017). Due to the favorable agro-ecological conditions and advanced farming practices, Flevoland developed into a highly productive and export oriented agricultural area. Within this agricultural setting the New-Town Almere was designed as a poly-nuclear garden city, with the idea to anchor the relation between its residents, nature and food production (Jansma et al 2016). While urban agriculture never took off as envisioned, food supply is an important pillar in the sustainability policy of the municipality of Almere, and indeed its overall vision for the future. With the world Horticultural Exhibition coming up in 2022, it is Almere's ambition to show that cities themselves can produce healthy food for their residents in a sustainable way, by sourcing 20% of its food supply from regional producers by 2022. While re-localization of food supply is not unique to Almere; other cities are also increasingly focusing on regional food supply. The location of Almere in the agricultural province of Flevoland, however, seems ideal for the transition to a more regionally oriented urban food system.

So, what do the findings signify for Almere's food re-localization ambitions? Firstly, the food actor and flow analysis provides a rough baseline of the current situation; indicating that in spite of the city's agricultural roots, the citizens of Almere are disconnected from the producers in the agricultural hinterland, both in terms of food flows and in terms of awareness and affinity. Consumers mainly purchase fresh foods in supermarkets, that largely lack a regional offer. On the producer side, a link to the urban market is missing. Bulk production is oriented towards export markets, mediated by middlemen. By correlating data from these different parts of the food supply chain, our study uncovered the local-global disconnect in the urban food system of Almere. Onions are an illustrative example. Where onions produced in Flevoland are being exported to Latin American, African and Asian countries, supermarkets in Almere offer consumers onions from New Zealand, Egypt and Spain.

Secondly, although the study did not address the 'how' question, a number of observations can be made from the data. In order to reach the policy goal of 20% local food, part of the bulk produce now destined for global markets would need to be sold through retailers in the city. Fresh fruit and vegetables are the obvious choice as they benefit from a short supply chain and could stay within the region. To realise this shift will require collaboration in the supply chain. In the first place, retailers, who hold much of the power in the supply chain, must be brought on board and be motivated to explore local sourcing opportunities, starting with the bulk non-perishable produce so abundant in Flevoland: Onions, potatoes and carrots. Also, retailers play a key role in raising awareness of consumers, by communicating the origin and story behind their purchases. Also, retailers hold invaluable data tracing consumption to producers which is invaluable in more accurately monitoring progress towards re-localization goals.

The study points at opportunities for growing different kinds of vegetables, to cater to the many different cultural kitchens in Almere which now rely on import. Producers will have to be made aware of these opportunities and feel secure that their investment in shifting production will pay off (through, for instance, guaranteed demand and agreements on price). There are already a number of small-scale initiatives to link to

urban consumers, through farmers' markets and through websites indicating where regional produce can be procured. These channels target niche markets at a premium, to cover the much higher logistics costs of these small flows. To make a real shift, part of the bulk flows will need to be diverted to the local market. This is only possible if a cost-efficient supply chain can be set up. More research is needed into the requirements of such a supply chain.

Based on the case study, no answers can be given regarding the positive and negative societal impacts of food re-localization on different population groups in economic, environmental, nutritional, social and cultural terms. Based on the data collected, these issues can now be further researched. It is clear, however, that a debate around Almere's food re-localization ambitions should be held across different policy areas.

6. Conclusion

Our study addressed two related questions: (1) How to develop holistic food actors and flows mappings that are replicable overtime and transferrable to other contexts? (2) How can these mappings be put to use for urban food policy development? Starting with the first question, our experiments in developing methodology to map food actors has revealed great opportunities in combining existing open datasets and web-scraping to create a refreshable, up-to-date dataset of food actors at little cost. The quality of this dataset is sufficient for use as a basis for further extension and analysis. By using data with standard NACE codes and international web resources, it should be possible to replicate this mapping in other EU countries and compare results between metropolitan areas. Thus, our research contributes to building an international body of evidence on food systems. However, methodological experiments to map food flows proved more challenging. Different parts of the food supply chain require different approaches and data sources. Logistics research provides an avenue for mapping the supply chain; consumer research provides more fine-grained data that have yet to be linked to supply chain data. A third angle, not tested here, could be to use data on market shares of the various food actors as input for a type of input-output analysis. This angle will be explored in future research.

Mapping food systems requires managing the trade-off between giving fine-grained insights into the food flows of a given metropolitan area, and the labour-intensity of data collection. In the absence of accurate baseline data regarding the current consumption of regional produce, methods deployed for uncovering these data are labour intensive and rely on employing students to collect primary data. Invaluable data are held by private sector operators (wholesalers, retail chains, logistics companies) and are currently unavailable. Unlocking these data will require building win-win propositions (such as unlocking data for contributors that will help them develop beneficial collaborations across the supply chain) and neutral, secure data sharing platforms and protocols.

Regarding the second question about the extent to which the resulting data offer useful input for urban food policy, as investigated for the case of Almere, we encountered limitations in the evidence base created. Firstly, the food actors mapped are not the only actors influencing the food system. A host of other actors, from policy and legislation at different levels, financial institutions, global markets etc. provide the context, prerequisites, drivers and inhibitors of transformation in the regional food system. These were not taken into account. Secondly, our research focused on the quantitative availability of local foods. The goal in conventional resilience research seems to be to get the facts right so they can be modelled into a system. However, transformation in the end is about citizens and their food consumption. Transformation processes cannot be captured through quantitative data only. We argue the importance of including the human dimensions of food systems transformations. Cultural diversity in food behaviour results in a need for in-depth insights. Furthermore, cities worldwide are facing the

challenge of making sustainable, healthy and safe food available to all citizens. Having local, fresh food available, does not necessarily imply it also will be accessible to everyone: issues of social justice and equity and social-economic stratification exists, resulting in a distance between the 'healthy' world and networks and the 'unhealthy' one.

Moreover, it has proven challenging to make data available to those working on food policy. While data providers were prepared to share data for the research, concerns around privacy and ownership, whether justified or not, caused great reticence around openly sharing the resulting dataset on food actors. Achieving the intended results of the project (to provide an evidence base for urban food policy) therefore not only depends on whether we succeeded in producing relevant datasets, but also on institutional and regulatory factors in making those data available for the purpose for which they were created.

7. Discussion

Around the globe, policymakers are stimulating initiatives that aim to re-establish the regional food production-consumption connection. However, an evidence base to inform policy makers in their decisions is largely absent, which prompts question on the effectiveness of policy directions and interventions. In the food systems literature the value of data and tools in supporting decision making practices and the development of a coherent vision on the future of food in the metropolitan region is being acknowledged (Marsden, 2017), but yet, there is no tool that produces accurate and up-to-date (location) data on actors and the food flows between. Our research set out to develop methodologies for unlocking data on food actors and flows on a regular basis, so as to monitor and inform urban food system policy.

Although the development of our open-source data-set to depict the urban food system (actors and flows) based on actual food actor establishments and a model to predict food flows to and from these actors is ongoing, it offers a promising approach for other parts of the supply chain where flows are fragmented, and data are hard to come by. Evidence on the urban food system is important, but needs to be continuous (not one-off), build on different kinds of data, and include different methodologies for different parts of the food chain. However, a quantitative approach to understand the food system will not be enough as an evidence-base for making changes in the food system. As the Almere case has shown, qualitative insights are important to provide context and explanation for quantitative findings – crucial for designing policy interventions (or indeed, any other interventions)

Evidence points at correlations between the structure of the food system (i.e. presence or absence of actors in the food chain) and food consumption choices and demographic and socio-economic factors. However, there still is a need to link data on the food system (food consumption, presence of actors in different parts of the food chain, etc.) to demographic and socio-economic data, in order to draw useful inferences in a number of policy areas relevant to urban resilience, including employment, social equity, cultural diversity, health and nutrition. It is important here to make this link in such a way that policy makers who might not be familiar or realise the relevance of food for their policy area, can draw new insights from these data and raise questions for debate (interactive dashboard).

In our research we spend ample time and effort to ensure the data can be made available for – and are accessible to – those who plan or execute interventions in the regional food system. This has shown to be a major challenge. However, we believe, getting this further on track will also be of value to similar data on other flows that impact the resilience of cities, such as medical supply and consumption flows?

A regional food system as a switching point for cities between local initiatives and daily practices of citizens on the one hand, and abstract global food systems on the other, offers an informative platform. The future food security and resilience of metropolitan areas is largely depending on the restructuration of food flows. Our research

provides an evidence base for policymakers striving to strengthen the sustainability and security of urban food provision. Although food production and food retail are not in the hands of local and regional policy-makers, their decisions on issues such as accessibility of the city for food deliveries, permissions for different types of food retail to open a business, and funding possibilities for food start-ups do have an impact on the security and sustainability of the regional and local food system. To assess the effects of the policy options available at the local and regional level, we have started to develop a methodology that demands less resources (time, money) than previously has been done. This could be of interest to any city interested in creating an evidence-base for policies to improve its resilience.

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Conflict of Interest

The authors declare no conflict of interest

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