

Spatial urban food-print of a Global South city: capturing flows of vegetable supply to Hanoi

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Abstract

Are urban food systems in the Global South following the same trajectory of change as in the North? To answer this question, we need to know how their different components are organized. In this paper, we tackle this issue by means of an in-depth case study of a city in the Global South, focusing on the vegetable supply system of Hanoi, the capital of Vietnam. Using empirical data collected at different nodes in the system, we extrapolate to provide a general picture of Hanoi's vegetable supply. According to our findings, local vegetables make up a significant proportion of the city's supply – 43.6% on average. However, the remaining larger portion of 56.4% travels along extended supply chains: remote producer – collector – wholesaler – retailer – consumer. As it grows and becomes increasingly open to globalization, Hanoi is becoming more dependent on remote sources of food supply. Our study suggests that growing urbanism is tending to make cities in the Global South steadily more disconnected from their local foodshed.

1. Introduction

During the last two decades, urban food has received a lot of attention and became one of the most investigated issues in food research (Morgan, 2015). Demographic projections predict that 67% of world population will be living in urban areas by 2050 (UN, 2015), (OECD/SWAC, 2020). The question of how to feed them sustainably is thus becoming a real challenge, one that is closely bound up with the United Nation's Sustainable Development Goals (SDGs). In the Global North, there is strong momentum to change the conventional agro food system (IPES-Food et al., 2018), (Rastoin and Gherzi, 2010). Political and social efforts have been engaged to transform the system toward a more sustainable one. However, circumstances in Southern cities are rather different from those that pertain in the Global North. Under the pressure of continuous urban growth whose causes could be various ((OECD/SWAC, 2020), urban populations increase, which make city food system bigger and more complex. Some Southern cities have been sharply transformed by globalization over the past 20 years or so, particularly in Asia. Their volume of food demand increases proportionally, facilitated by the fact that household income levels are generally higher in urban than in rural area. It does also require higher efficiency and performance of food chain stakeholders, given the volume of food demand.

The very challenge that the Global South has to face today is to maintain the equilibrium between food security objectives on one side, and sustainable farming on the other.

Until now, food issues in the Global South have often been discussed in terms of access to volume only i.e. calories per capita (FAO, 2012). With the rise of cities, the urban South starts to interest to the full criteria of food security, meaning food availability, quality, access, and stability. In South cities, supermarkets replace progressively open wet markets (Reardon et al., 2019) (Reardon et al., 2009). These supermarkets function in a similar way to those in the Global North. The consumption of processed and fast food is increasing, resulting in a phenomenon known as the "triple burden of malnutrition": the coexistence of overnutrition, undernutrition and micronutrient deficiencies, as well as diseases related to overnutrition (Frenk and Gómez-Dantés, 2011). To perform in a new environment, middle food operators have to invest, and consequently they require stable and competitive supply from farmers. Consequently, farms should improve their productivity, which is generally not a guarantee for ecological farming practices. From a research perspective, it might be asked whether the trend is not toward a convergence between Southern and Northern cities?

Answer to this question is fundamental, because it helps to determine how policy needs to be conducted in the future. If Northern countries reduce the negative impacts of their agro-food systems, but Southern countries move in the opposite way, then the problem is not going to be solved globally. But for a number of reasons, having a clear answer is not easy. The first reason is that there is a lack of knowledge about food systems in the Global South. Today, there is a discrepancy between levels of knowledge about urban food systems in the Global North and South. While urban food systems in Northern cities have been well documented and analyzed, little is known about Southern cities (Olsson, 2018). The second reason is that determining the boundaries of an urban food system is difficult, that for both Northern or Southern cities. The spatial footprint of a food system can be extremely large (Kasper et al., 2017). Some components and sub-

components may be located far from the administrative limits of the urban region in question. Finally, stakeholders in Southern food chains are rather fragmented, and operate informally. Thus, they do not appear in official statistics (Pham and Dinh, 2020), (Giroux et al., 2020). And yet, understanding how the whole system functions is a must when it comes to making an accurate assessment, as such analyses provide a basis for policy recommendations. For example, Zezza and Tasciotti (2010) warned that the role of urban agriculture in developing countries should not be overemphasized, given its weak contribution to the system.

Our paper seeks to address the issue of city food system expansion in the Global South empirically by means of a case study. We have chosen to focus on one food category, in one city: the fresh vegetable supply in Hanoi, the capital of Vietnam. By collecting empirical data on all components of Hanoi's vegetable supply system, we attempt to understand how the city is supplied with vegetables? We go on to discuss how the system is organized, what portion of the total supply is made up of locally-produced vegetables, and more specifically what is the boundary of the system? The choice of Hanoi as case study is supported by the reason that Vietnam is a country in transition, is open to globalization, and has changed extremely rapidly over the last 20 years. Thanks to high economic growth from 2000s, some of Vietnam's cities have seen significant demographic expansion. Among them, Hanoi stands out due to its status as the country's capital. To feed a population of 9 million inhabitants, of which more than 5 million are city dwellers, Hanoi's food supply chains have increased in size and become longer in a relatively short time (Sigrid and al., 2015). We are looking then to seize this phenomena empirically.

2. Background and context of the study

When it comes to assessing an urban food system, the literature usually focuses solely on components located inside the urban perimeter: i.e., urban farmers, urban food processing units or short supply chains based in neighboring areas (Kasper et al., 2017). Meanwhile, the development of the urban metabolism framework (Kennedy et al., 2007), (Barles, 2009) has sharply changed the way we study cities. Many authors have mobilized this methodology to measure in- and out- flows of food in urban areas. This approach involves describing the system as a network of nodes, connected together by material flows. The term "material" does not necessarily refer to a physical entity. Most of the time, it is simply a generic unit of measurement. It could be a flow of nitrogen (Billen et al., 2012), of phosphorus, energy (Papangelou et al., 2020), (Ma et al., 2014), or of virtual water (Akoto-Danso et al., 2019).

The difficulty of such modeling is that it requires large amounts of data. Sometimes, only proxy values are used, such as those provided by the system of national economic accounts. Unfortunately, due to the lack of such a data set in the case of Hanoi, it is impossible to apply this method directly. As a result, we have adapted the urban metabolism framework, combining it with a value chain approach, in order to reconstruct the system of flows within the urban area. The value chain approach has been used by (Cadilhon et al., 2003), (Moustier et al., 2004) in Vietnam. They have constructed food supply chain diagrams for Hanoi and Ho Chi Minh city. These studies being qualitative in approach, the authors were not able to assign values to the flows in question.

In our study, close attention is thus paid to certain well-documented nodes in the Hanoi's vegetable supply system in the value chain approach. Firstly, there is the wholesaler. Moustier et al.,

(2004) focused particularly on wholesale markets, which constitute the entry point for all supply chains. Wholesalers gather merchandise together efficiently and allow it to be distributed to retail and street markets, which in their turn supply end-consumers and other forms of catering outlets.

Secondly, the authors also call attention to the role of Hanoi’s farmers – there are thousands of them – who also supply retail and street markets directly. Vegetables are cultivated in almost all Hanoi’s rural areas, particularly in the Green belt, located 30 km from the city center (Figure 1). Thanks to the proximity of these farmers to the city, their produce can be harvested at the end of the day and delivered to city markets early in the next morning, using rudimentary means of transport such as motorcycles.

Street vendors play a discreet but essential role in providing food to Hanoi’s residents. They are the 3rd important node in the system. Their role has been mentioned in several monographs (Loc and Moustier, 2016), (Turner and Schoenberger, 2012). However, no quantitative study has been realized due to the heterogeneity of this category. Finally, modern channels of food distribution have developed significantly in Vietnam over recent years (Wertheim-Heck et al., 2015), (Moustier et al., 2009) and constitute the 4th node. This development first and foremost reflects government policy, which favors the spread of supermarkets and hypermarkets across the country as a sign of Vietnam’s openness to globalization. The coincidence of this phenomenon with a food safety crisis has transformed these outlets into major figures in the urban food landscape. Supermarkets and food shops are associated primarily with certified and safe food, produced according to standards.

Drawing on these different sources, we have produced a qualitative diagram of Hanoi’s vegetable supply. (Figure 2). In this figure, there are two distinct types of supply flow. “Local flow” refers to supplies sent from rural areas to urban Hanoi, while “other flow” covers all other situations in which products are sent from other provinces to urban Hanoi (including importation from China). Our “definition” of local food is thus based on a geographic boundary. Only flows where both starting and ending points are located inside the boundary are considered as local.

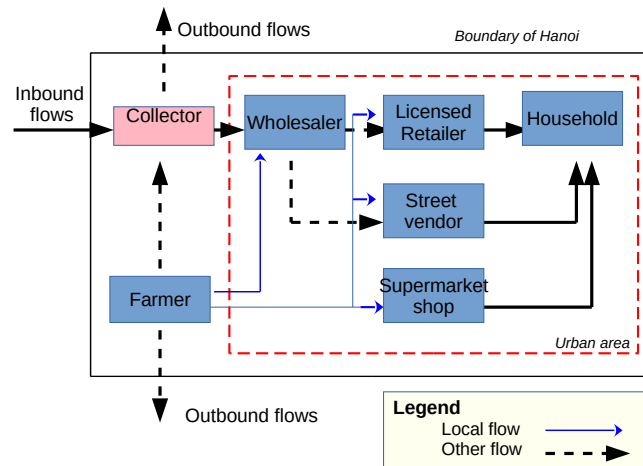


Figure 1: Simplified diagram of Hanoi’s vegetable supply

The two questions that the paper aims to answer are where do fresh vegetables consumed in Hanoi come from ? And whether the urban Hanoi is more reliant on local or remote supply today? The general view is that Hanoi is self-sufficient in vegetables – or to be more precise, self-sufficient

in the winter, its main production season. In annual terms, locally-produced vegetables are believed to represent 60% of the overall supply (DARD, 2015). We are going to check this statement.

3. Methodology

As mentioned above, there are 4 key nodes in the system: (1) wholesaler, (2) retailer, (3) street vendor and (4) supermarket & shop. Consequently, we focused on these nodes when carrying out our surveys, which were conducted using semi-directive interview techniques. In addition to discussion, we used questionnaires to collect information on the types of vegetables traded, the daily volume of trade, the source of supply, as well as customers. Interviewees were asked specific questions about the different categories of supplier and customer (as well as the geographic areas of supply) in order to ascertain the specific volumes involved. This information enabled us to determine values and the source of the various flows. We decided to use tons per day as the unit of measurement. Figures have not been converted into either nitrogen or units of energy since, for while doing so would not alter our overall findings mathematically speaking, they would however obscure the differences between different types of vegetables (see below).

System node	Data	Method of study
(1) Wholesale market	- Interview with the management committee, then with vendors	Survey. Sample: 75 vendors
(2) Planned retail market	- Interview with the management committee, then with vendors	Survey. Sample: 60 vendors
(3) Street (informal) market	- Interviews with vendors	Spatial screening to systematically locate all street markets in the urban area (12 urban districts) Survey. Sample: 80 vendors
(4) Supermarket/shop	- Interviews with regional managers of vegetable stores.	Google Maps API data. Survey. Sample: 4 supermarket chains and 5 food shop chains

Table 1: Summary of the methodology used

In practical terms, we interviewed 75 wholesalers across all 5 wholesale markets in Hanoi, i.e. 15 per market. As for retailers in planned markets – also called popular markets –, we randomly selected 60 of them from 20 markets (out of a total of 106 markets in Hanoi). 80 street vendors, from 4 different urban districts were also selected. Finally, 4 supermarket and 5 vegetable shop chains participated in our survey, accounting for more than 600 points of sale throughout urban Hanoi. Generally, we took a two-step approach. In step 1, we conducted interviews with market or supermarket managers in order to gain an understanding of the overall environment. In step 2, we approached randomly vendors to ask them questions.

After data has been collected, city-level values for vegetable flows between nodes are extrapolated. This extrapolation involves taking the figures reported by the interviewees in each category and projecting overall totals for the urban area of Hanoi based on the estimated total number of retailers in the various categories.

Different methods have been used to come up with these proportions. In the case of wholesalers, we conducted an exhaustive manual count of every vendor in all 5 vegetable wholesale

markets in Hanoi. As for retailers in popular markets, we first counted the total number of vendors in all 20 markets where surveys were carried out. These figures were then extrapolated to all 106 markets controlled by Hanoi city authorities. Since the scope of street vendor activity is unknown, we were obliged to use spatial screening to understand their spatial distribution. Thanks to dashcams mounted on motorbikes, we were able to study all the streets in urban Hanoi where population density is superior to 10,000 inhab/km², which accounts for 102/168 urban communities in the area under study (Delmotte et al., 2020). Coordinates from GPS-tagged videos were used to map the street markets and to establish the number of street vendors in each market, including vegetable vendors. Finally, in the case of supermarkets and specialized stores, we utilized data from Google Maps obtained by automated queries sent to the Google Maps server. The results are given in the Table 2 below:

Types of market	Total	Under study
Wholesale market	5 ^a	5
Popular market	106 ^a	20
Street market	416 ^b	336
Supermarket	79 ^b	61
Safe vegetable shop	727 ^b	644

^a from an official database

^b estimated from data collected by researchers

Table 2: Table of proportion.

The data obtained the methods mentioned above may be skewed by certain factors. Firstly, the number of vendors may vary depending on the day and time of observation. Secondly, Google Maps data may not always be reliable. We thus implemented strategies designed to mitigate these factors. Observation of open markets was carried out at times known to be the busiest in terms of vegetable selling (in the case of wholesale markets, this is between 4 a.m. and 6 a.m.; in that of street markets, from 5:30 a.m. to 8 a.m.; and for popular markets, 9 a.m. to 12 a.m. Concerning data from Google Maps, it is worth bearing in mind that these data are provided by users. We found that food stores in central Hanoi are frequently over-reported – meaning that spatial objects are often geolocated several times by different users – while those at the periphery of the city are frequently under-reported. To deal with the problem of multiple geolocations, we have carefully cleaned this data in order to eliminate instances of double counting. In terms of tackling the issue of under-reporting, we have had no choice but to rely on in-depth interviews with regional managers of the supermarket and food shop chains under study in order to obtain information on the number of their sales outlets. The risk has been further minimized by the fact that we targeted almost all of the well-known big chains in Hanoi.

Finally, to make sure that any potential skewing factors in the table of proportion have been controlled for, we have compared them with production and household consumption data, which come from independent sources – the former from Vietnam GSO, the latter from VHLSS.

4. Findings

4.1 Theoretical ratio of self-sufficiency for vegetables consumed in Hanoi

Firstly, we looked at the level of production of, and demand for vegetables in Hanoi. According to data from GSO, about 700,000 tons of vegetables are produced in Hanoi annually. The region of Red River Delta can produce up to 42 types of vegetable (Pham and al., 2013), but the GSO database only provides information about certain key types: morning glory, mustard, cabbage, cauliflower, cucumber, tomatoes, beans, kohlrabi, carrots and potatoes. These 8 vegetables account for 70% of Hanoi’s production in terms of volume, with morning glory, mustard and cabbage being by far the 3 most important (50% of the total).

VHLSS figures for the consumption of various vegetables (from 2012, 2014, 2016) estimate average individual demand per year for an urban resident at 82 kg (and 72 kg for their rural counterpart). These figures are consistent across all the 3 national surveys, which suggests that they are reliable. We use Hanoi’s population to estimate the overall demand for vegetable of the urban area. According to the 2019 national population census (GSO, 2019), Hanoi’s official population is 8 million, of which 3.9 million live in 12 urban districts and 4.1 million in 17 rural districts. Since the national census counts only official residents, we have added 1.5 million to these figures to account for temporary residents (Parliament Report, 2019), which gives us an estimated food-consuming population in Hanoi of 5.4 million people. Short-term travelers like businessmen or tourists have not been included because of a lack of reliable data sources.

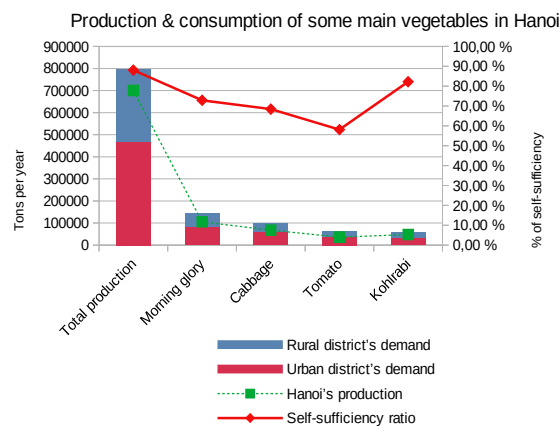


Figure 2: Comparison of vegetable production

Figure 2 shows the gap between vegetable production and consumption in Hanoi based on the comparison of the two aforementioned sources. In general, urban demand is estimated at 465,000 tons per year, while rural demand is 225,000 tons, making for a total demand of 669,300 tons. The self-sufficiency ratio – production/consumption – is thus just over 100%. This means that Hanoi is theoretically self-sufficient in vegetables (if the issue of seasonality is set aside). Meanwhile, there would appear to be shortfalls between production of demand in the case of certain key vegetables. Rates of self-sufficiency are thus lower in such cases: 70% for morning glory, 65% for cabbage, 60% for tomatoes. These percentages are a reminder that vegetables are not mutually interchangeable. Thus, in spite of the theoretically high overall ratio of self-sufficiency, it turns out that the city is dependent on remote sources of supply in many cases. Moreover, post-harvest loss

has not been factored in because of a lack of data. All ratios of self-sufficiency would necessarily be lower if these figures were available.

4.2 Middlemen in the system

Hanoi's vegetable supply system can be divided into a direct channel and an indirect channel. The direct channel connects Hanoi's farmers directly to vendors in wet markets (including popular markets, street markets and street vendors). The indirect channel is comprised of wholesalers – sometimes preceded by collectors – and the supermarket and food shop systems. We shall focus first on the indirect channel, because it is the most important in terms of daily volumes of trade involved.

4.2.1 Wholesalers

A key node in the supply system, Hanoi's vegetable wholesalers collect the merchandise and redistribute it to retailers and other intermediaries, such as collective kitchens, caterers, as well as provincial wholesalers. On the one hand, they obtain their supplies from collectors who provide them with produce from remote producers. On the other hand, they buy directly from farmers who bring vegetables to markets early each morning. Their customers are licensed retailers, street vendors, restaurants, caterers, neighborhood households and provincial wholesalers.

Interviews reveal the existence of 3 kinds of wholesaler: the direct wholesaler, the level 1 wholesaler and the level 2 wholesaler. The most common are direct wholesalers, who account for more than 90% of studied vendors in this category. He/she operates at the interface between the early stage (collector or farmer) and the late stage in the value chain (retailer or street vendor). As for the level 1 wholesaler, he/she receives vegetables from the collector, then redistributes them to level 2 wholesalers. Level 1 corresponds to a degree of product specialization – certain vegetables are traded by a small number of wholesalers (i.e., level 1 wholesalers). On the contrary, level 2 wholesalers operate more like retailers – they sell a broad range of vegetables –, but they deal in greater quantities.

In terms of volume, a direct wholesaler sells about 670 kg of vegetables per day; the figures for a level 1 and a level 2 wholesaler are 870 kg and 380 kg, respectively. These figures correspond to the median value.¹ In total, about 1,300 tons of vegetables pass through Hanoi's wholesale markets every day. This merchandise is then redistributed to wet markets, urban restaurants and collective kitchens throughout the city. They are also sent to rural markets in the greater Hanoi area. This is especially the case of vegetables produced elsewhere – such as potatoes or Chinese cabbage –, which are also in demand among rural consumers.

4.2.2 Retailers

The category of retailer includes both licensed retailers operating in popular markets and street vendors. The main difference between them is their legal status. A retailer in a popular market possesses a business license, which grants him/her a permanent place inside a popular market. A street vendor does not have license and generally operates on public sidewalks. Based on data

¹ In the case of wholesalers, we used different sources of information, including trading volumes provided by the various management committees. The triangulation of these sources suggest that median values are more robust than mean values when it comes to making extrapolations in this category.

acquired by interviews, a licensed retailer sells 108 kg/day on average. Several of them sell as much as 500 kg/day, rivaling level 2 wholesalers. Street vendors average only 54 kg/day.²

The total volume of vegetables sold within official perimeters of popular markets is estimated at 428,22 tons per day, while total volume of street vending is estimated at 318,84 tons per day. These figures confirm the important role played by street vendors in urban Hanoi, since they almost rival licensed vendors in terms of volume. The latter work full time and are authorized by the public authorities.

4.2.3 Supermarkets and food shops

As mentioned above, supermarkets and safe food shops occupy a symbolic place in the country's food system. The largest supermarket chains selling fresh food are: Vincom hypermarkets (including Vinmart + Fivimart), AEON, BigC and Coop mart. Among food shop chains, Vin+ system is the country's largest, with more than 500 shops in urban Hanoi alone. Other food shop chains include Bac Tom, Big Green, Coop food. Based on interviews with these companies, we obtained data about their business segment in Hanoi.

Despite rapid and impressive growth in recent years (Wertheim-Heck and Spaargaren, 2016), the volume of vegetables traded through this channel is still weak. On average, a supermarket sells 550 kg/day, while a shop sells only 31.4 kg/day. Interviews with the regional managers of these chains enable us to estimate an average daily traded volume of 22.6 tons for the supermarkets, and 20.7 tons for the food shops under study. According to managers, these values are more or less consistent throughout the year. These rather modest figures might be explained by the fact that safe certified vegetables are relatively expensive and are purchased only by a high-income segment of Hanoi's population.

4.3 Upstream and downstream stakeholders

Our next step was to determine the patterns of supply and customers for each category of vendor. Obtained by aggregating the responses from all vendors interviewed, the results are presented in figure 4. On the supply side, our findings confirm that farmers figure prominently for all categories of vendor. On average, what is remarkable is the scale of direct supply from farmers: 50% of wholesalers, 35% of retailers in popular markets, and nearly 50% of street vendors purchase their vegetables directly from farmers. Farmers supply almost 100% of vegetables sold in supermarkets and shops through their cooperatives. In terms of consumption, urban households and urban restaurants and hotels are the main consumers in the system. Among the other stakeholders are catering companies and collective kitchens, which service industrial zones located close to Hanoi. Certain collectors and provincial wholesalers also purchase vegetables from Hanoi's wholesale markets. Hanoi's geographic location makes it an advantageous logistics hub for middlemen, one where they can collect, batch, dispatch and trade merchandise.

² Street vendors form an important part of our study. They are by far the most heterogeneous category of vendors in the system. As explained in the section devoted to methodology, we used dashcams to methodically record videos of their activity in urban Hanoi. As a result, we identified 4 profiles of street vendors (1) market-type street vendors, who operate in quite similar conditions to licensed retailers in popular markets; (2) next-door vendors, who exploit their proximity to customers' dwelling places; (3) mobile vendors, who operate using bicycles/motorcycles and (4) storage space vendors, who rent a storage space and use it to sell vegetables. A more detailed description on these 4 sub-categories is provided by (Delmotte et al., 2020).

Within this context, our study identified a special sub-category of supplier: the collector. The literature contains little information about this sub-category. (Cadilhon et al., 2003), for example, describe two kinds of collector in Vietnam: the assembler-collector and the broker-collector. But the authors give no more information and, in general, collectors are largely absent in studies of Vietnam. One reason is that they are not easily accessible due to the fact that they work at night. Another reason is that they are essentially informal vendors and they are thus reluctant to talk about their business, which may be the focus of the authorities' efforts at control.

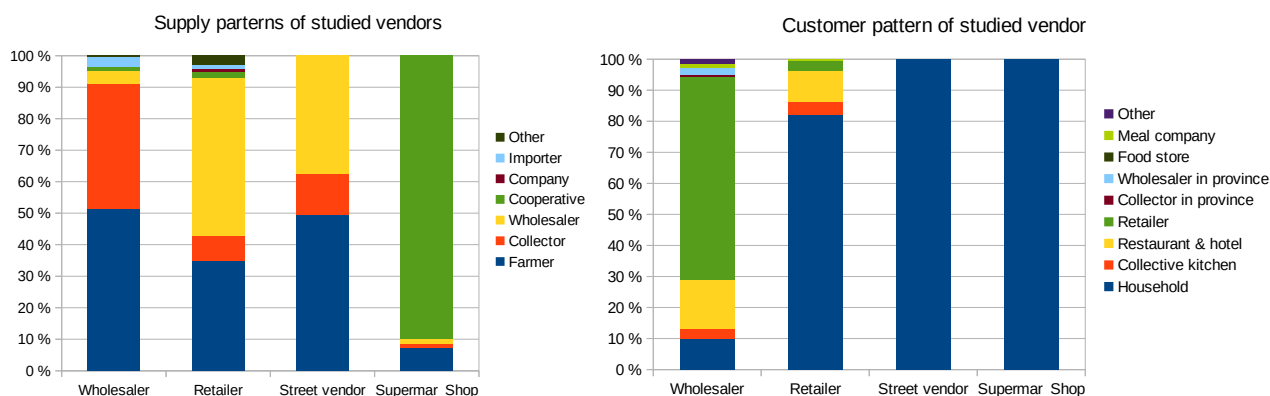


Figure 3 : Supply and customer patterns for studied vendors

We focused on several collectors in order to gain a better understanding of their work. While the number of interviews is insufficient to be statistically significant, they do afford insights: for instance, it would seem that a large proportion of collectors come from farming households. Traditionally, these collectors would collect produce from their farms and those of their neighbors. As demand for vegetables grew, they began to specialize in collecting, covering larger and larger areas – the mountainous areas in the North, or the Central highlands of Vietnam –, thousands of kilometers from Hanoi. Under the market economy, collectors replaced agricultural cooperatives in finding markets for farmers. In terms of the vegetable supply, collectors play a key role in connecting Hanoi's vendors with remote agricultural producers.

4.4 Extrapolation to generate a picture of the system

The last part of our study involves extrapolating in order to obtain overall figures for vegetable flows at the city level. We first estimated the actual number of vegetable vendors in each category in Hanoi. Using table 2 (table of proportion), we estimated the number of vendors (see table 4 below). According to our calculations, there are about 5,300 vegetable retailers working in urban popular markets in Hanoi, and about 5,800 street vendors working in street markets. More than a half of vegetable stalls in Hanoi are run by street vendors. They supplement official markets in the provision of food to households. These two sub-categories together account for about 11,100 retailers (in an urban population of more than 5 million).

As mentioned above, we questioned interviewees about where they sourced their vegetables. This information is sensitive, but we made efforts to ensure our information was as accurate as possible, including questioning the vendor several times to make sure that the answers given were consistent. Our hypothesis is that the more upstream the vendor is, the more accurate information he/she will be able to provide. Generally, retailers tend to overstate supplies from the Hanoi area

and understate supplies obtained directly from farms. We thus prioritize information from vendors at an earlier stage in the value chain, i.e. direct wholesalers or, level 1 and 2 wholesalers, as opposed to retailers.

The results are contained in figure 5 below.

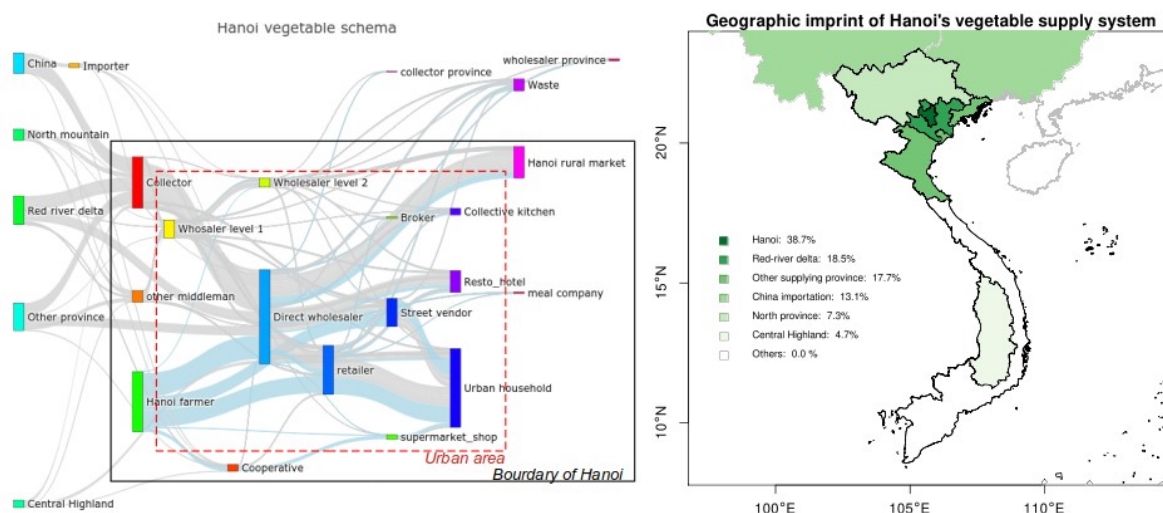


Figure 4 : Vegetables flows feeding Hanoi's urban and its geographical foodsheds

Firstly, the Figure 4 shows that the dominant flow of vegetables is the long supply chain, composed by remote producer – collector – wholesaler – retailer – consumer. We expect that every day, 1837 tons of vegetables - all species included - are sent to the urban Hanoi, of which 712 tons are Hanoi's vegetables and 1125.5 tons are from other provinces or imported. All of them are not consumed in the urban area. The urban demand is estimated at 1287.1 tons per day, the rest are sent to rural markets of Hanoi, or other provinces. Among the regions which supply Hanoi with vegetables, there are the Hanoi region itself (38.7%), provinces in the Red River Delta (18.5%), adjacent provinces to the south of the Red River Delta (17.7%), and China (13.1%). For the most part, Hanoi's main vegetable foodshed is located within a radius of about 500 km.

Vegetables from the Hanoi area make up a non-negligible portion of the supply. Direct supply from farm to popular markets is estimated at 364 tons, i.e. 28% of urban demand. But if we take into account the amount of Hanoi's production that moves through wholesale markets, this proportion is much higher. According to our calculations, it accounts for 43.6% of total urban demand. This percentage of course varies depending on the consumer category: in the case of households it represents 49.6%, while in that of restaurants it is only about 27%. This difference is due to the fact that restaurants buy vegetables mainly from wholesale markets, who in turn are very dependent on remote sources of supply. Consequently, 56.4% of vegetables consumed in urban Hanoi come from remote areas of production.

Category of urban consumer	Estimated demand	Volume of Hanoi's supply	% of Hanoi's supply
Household	933.9	463.2	49.6 %
Restaurant & hotel	259.5	70.0	27.0 %

Catering company	16.7	5.0	29.6 %
Collective kitchen	77.0	23.7	30.7 %
TOTAL URBAN DEMAND	1287.1	561.8	43.6 %

Table 3: Daily urban demand for vegetable and percentage of Hanoi's supply.

Inside the urban perimeter, popular markets, street markets and supermarkets/shops are the three main channels of fresh vegetable distribution when it comes to households. Despite the fact that street vendors are more numerous, their total volume supplied by them is slightly lower than that of popular markets, and accounts for only 34,1% of household demand, compared to 45,9% in the case of popular markets. We estimate that supermarkets and shops supply households with only 5.5% of their vegetables (or 51.6 tons per day).

It is worth mentioning that we also asked a question about the vegetable loss rate. This question is time-consuming, but it allows us to get a general idea about daily loss volumes. Naturally, loss rates depend on the type of vegetable, on the method of conservation, and on individual vendors' strategies. In general, total loss is estimated at 142 tons/day, which represent about 7.8% of the total traded volume.

4. Discussion and policy implications

In spite of the huge databases and powerful statistic tools available, understanding food flows in and out of cities remains a challenge in many countries. In this study, we have collected data using a series of different methods in order to estimate the relative importance of the various components of the vegetable supply system in urban Hanoi. Our work shows that local food – in this case, vegetables produced in the greater Hanoi area – accounts for a large proportion of the city's supply – 46,3% of urban demand, and 49% of urban household consumption. These figures represent a success for Hanoi's food planners, who have focused on protecting vegetable growing land closed to urban areas.

Nevertheless, the evidence shows that Hanoi is far from self-sufficient in vegetables. The high figures for the amounts of local food in the system – 100% in the winter and 60% in the off-season – have undoubtedly been obtained by juxtaposing theoretical total volumes of production with urban demand. But these figures decline when we examine the actual amounts of vegetables handled by intermediary operators. This decrease can be explained the difference in demand for individual vegetables. Since they are not substitutable – i.e., cucumbers cannot replace pumpkins –, the issue is whether local production is capable of supplying a diversified basket of products that matches urban consumers' preferences. Several factors militate against this possibility.

The first factor involves agronomic conditions. Even though Hanoi has a large stock of prime agricultural land at the heart of the Red River Delta, it cannot produce sufficient amounts of all types of vegetables: certain vegetables – such as Chinese cabbage, pumpkins, carrot, tomatoes – are mainly grown in provinces (or China), then imported to Hanoi. The second factor involves economic variables. Depending on harvest and transport conditions, certain vegetables produced in the Hanoi area may enjoy a relative advantage, whereas others may be at a disadvantage. Our interviews reveal that Hanoi's farmers have specialized in certain specific vegetables: i.e., those

most in demand in the city. They tend to grow leafy and aromatic vegetables such as lettuce, morning glory, chives, coriander etc. These vegetables have high added value but require delicate handling. The proximity of the suburbs to urban markets is clearly an advantage in terms of this strategy. In contrast, remotely-grown produce sent on to be sold in Hanoi tends to consist mainly of root vegetables or tubers, which can withstand long-distance transportation by truck. Under the pressure of urbanization, it is not economically viable to grow such crops, given that other provinces can do so at a lower cost. Of course, counterexamples do exist, but they were very much the exception in our interviews.

These results can be fruitfully set side by side with recent research on the evolution of Hanoi's food system. (Le and al., 2020), (Nguyen and al., 2020) show that the vegetable supply has undergone major changes due the economic reforms initiated in Vietnam in 1986. With the country's adoption of a market economy, intermediary food operators emerged naturally, since farmers were unable to both produce and market their output. Our interviews also show that almost 100% of the individuals studied are full time vendors. Very few of them say that they are involved in farming at home. With its increasing openness to globalization, Hanoi's food chains have become longer due to the presence of middlemen. It is thus hardly that the dominant channel of vegetable distribution to urban Hanoi involves a long supply chain, composed of remote producer – collector – wholesaler – retailer/street vendor – consumer. This configuration seems to confirm that feeding a big city inevitably entails the development of mass distribution as part of the food chain.

The case of Hanoi also provides interesting lessons in terms of food policy. Our case study once again confirms the central importance of the rural-urban link to food planning. Based on interviews with Hanoi DARD officials (the Chamber of Plant Production and the Department of Food Quality NAFIQAD), we know that the city has long maintained financial support to farmers. Basically, this involves funding for rural infrastructure (e.g., roads, irrigation). In parallel, the city regulates the conversion of agricultural lands for residential uses. In recent years, Hanoi has seen a lot of residential construction projects (Pulliat, 2015) . But it has also preserved other land for as part of its food planning policy. This explains why the surface area devoted to vegetable growing has not decreased over time, but rather has moved to an area further from the city center. A legacy of the planned economy, agricultural land in Vietnam still belongs to the State. Rights of use are thus allocated by administrative decision, which also facilitates food strategy implementation.

However, no amount of land planning can ultimately help a city experiencing demographic expansion to become “independent” in food. In the case of Hanoi's vegetable supply, recent studies show that the local foodshed has reached its limit. Use of fertilizers and pesticide to boost local productivity has led to several alarming food safety issues (Pham and Marie-Vivien, 2017). A recent decision by the Ministry of Agriculture and Rural Development's (see Decision 5391/QD-BNN-TT) shows that Vietnam is fully aware of the limits of the foodsheds around its big cities. This decision approves the creation of remote areas of safe vegetable production to supply the country's two major cities: Hanoi and Ho Chi Minh City. In the case of Hanoi, between 22,000 and 26,000 ha of provincial land have been set aside, i.e. a total surface area 3 times bigger than the area currently under cultivation. Despite the currently high levels of local direct supply, Hanoi is actually following the trajectory of other globalized world cities, which involves becoming increasingly dependent on remote areas to feed its population.

5. Conclusion

In this study, we have examined the vegetable supply system of Hanoi, in Vietnam, to understand how the city is supplied with vegetables. Our research encompasses all the components of the city's vegetable system, and it estimates the proportion of the overall supply originating from local sources of production. Our finding is that vegetables grown in and around Hanoi account for a high rate comparing to other cities in developed countries. These figures may be ascribable to Hanoi's successful food planning policy. However, it is noteworthy that a large proportion of Hanoi's vegetable supply arrives through a long supply chain (i.e., remote producer – collector – wholesaler – retailer – consumer). This dependence can only be explained by the fact that local production is unable to keep up with the speed of demographic expansion. As long as the urban population continues to increase, the urban food system will inevitably become increasingly dependent on remote areas of agricultural production.

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