

## Assessing Expanding Space Use versus Infill for Economic Activities

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### 1 ABSTRACT

In order to limit additional (net) land take for economic activities, the reality of space use needs to be properly understood since the location of economic activities and the patterns of space use vary in different environments. This was assessed by comparing the spatial patterns obtained from a field inventory with those from existing data for 5 case areas in Flanders (Belgium). Each case area is a transect from a high density urban area to a suburban neighbourhood or even a semi-rural zone, in different (types of) regions: inland-coastline transect, transects in the metropolitan areas of the major cities Antwerp and Ghent (excluding the city centres), in the medium sized city of Hasselt (and its suburbs) and the smaller city of Aalst (and the zone along an important access road), and transects incorporating small towns such as Deinze and Veurne. The observations in the field were made from what is visible from the street, thus representing what is normally perceived as economic activity. The statistics are based on official data, mostly derived from tax returns and social security contributions, and on commercial retail data.

The location of economic activities and the patterns of space use vary in different settlement environments. The analysis then compared similar settlement environments in different regions, and identified typical characteristics for 8 location environments (with some further subcategories). These were presented to experts in workshops and (group) interviews. This revealed that, in some environments, (the combination of) data and statistics give a good understanding of the space use while, in other environments, gaps with realities in the field are obvious. Therefore, suggestions are made for targeted new data collection methods, such as remote sensing, crowd sourcing, and web data extraction.

Keywords: statistics, inventory, urban expansion, land use, spatial economics

### 2 INTRODUCTION

Land recycling allowing inner city development or the re-naturalisation of abandoned artificial areas is a key part of sustainable land management. It is intricately linked with the issue of land take, as in the absence of brownfield redevelopment, areas dedicated to economic use are artificially created at the fringe of cities thus increasing the annual consumption of new land. Simultaneously, new attractive developments at the outskirts of urban areas may attract new residents and firms, leading to the gradual dereliction of the core city areas, and eventually creation of new brownfield sites. In 2014 a comparative study on available data and indicators of available areas for (re)development within the urban fabric concluded that the knowledge base needed to be improved in order to foster analysis of potential future EU land take trends, to set EU-level targets (including control indicators) and to determine appropriate monitoring mechanisms (BIO, 2014).

The European Commission's Roadmap to a Resource Efficient Europe proposed as milestone: "By 2020, EU policies take into account their direct and indirect impact on land use in the EU and globally, and the rate of land take is on track with an aim to achieve no net land take by 2050" (COM(2011) 571 final). In Flanders the concept of 'no net land take' was approved as part of the Spatial Policy Plan Flanders by the regional government in November 2016. This implies an optimisation of space use in developed areas, and

consequently, an understanding of this use within the urban fabric. Considered by international standards, most of Flanders is urban fabric: 11 of the 308 municipalities have more than 50.000 inhabitants, according to the Eurostat degree of urbanisation 7 are considered cities, 228 are towns and suburbs, and 74 are rural areas Eurostat, 2016).

Sarzynski et.al. (2014) identify spatial patterns in metropolitan areas using a combination dimensions, i.e. intensity, compactness, mix and monocentricity, yet ascertain that these areas are still internally complex. They conclude that “anti-sprawl” programs must be carefully constructed based on the particular land use dimensions while generic “anti-sprawl” policies and planning activities are likely to produce disparate metropolitan impacts.

The Flemish departments of Environment and of Innovation and Business set up a series of studies called ‘Segmentation’ to explore the economic land use in this densely populated region. Our paper presents the outcomes of the Segmentation III project, introduced in section 3. Section 4 presents the assessment of actual land-use in 5 case areas in Flanders by comparing the spatial patterns obtained from a field inventory with those from statistics based on existing data. In addition, interviews and workshops were conducted to understand the local context reflected in the spatial organization of parcels, buildings and infrastructure. A comparison of similar sub-zones in the case areas, was used to determine location environments for economic activities. The discrepancy between the field inventory and spatial patterns derived from traditional databases based on e.g. employment and tax returns, show that strengths, weaknesses, gaps and synergies also differ by location. We suggest targeted new data collection methods in different settlement environments. In the final section, we zoom out, and conclude that assessing expanding space use versus infill for economic activities is scale dependent.

### 3 THE ‘SEGMENTATION III’ PROJECT

The study (called Segmentation III) was conducted in a collaborative learning setting involving two departments (Environment and Innovation and business) of the Flemish Region, Buck Consultants International, and researchers from the University of Leuven. The study had two main goals:

- (1) increase the knowledge of the factual land use for economic activities as an input for a future observatory on economic space;
- (2) analyse the relevant concepts in the Spatial Policy Plan Flanders (BRV) by applying them in an economic context.

It succeed two previous studies (Segmentation I and II) that gradually try to unravel the complexities behind the mix and interweaving of economic activities with other functions using space such as housing. While segmentation I (van Dinteren, Muskens, Geudens, & Haskoning DHV, 2015; van Dinteren, Muskens, Geudens, Zaman, & Pennincx, 2015) focused on a segmentation and classification of economic locations (environments or milieus), Segmentation II (Pennincx, De Mulder, & Zaman, 2016) analysed the transformation of economic estates, while Segmentation III aims at gaining insights in the ways and reasons why economic space embedded in settlements tends to degrade or to be underused.

The search for detailed factual land use explains why a series of applied methods (GIS layering, hot spot analysis etc.) and statistical analysis techniques serve a highly empirical approach with a focus on the degrees of and opportunities for interweaving of residential and economic functions. Field survey and in-depth interviews complement the approach in creating a new database of field observations and enrich the interpretation of the resulting spatial patterns. The current paper addresses the understanding of space use for economic activities within the urban fabric. The consultations with economic stakeholders and with civil servants to translate these in potential starting points for spatial economic policy are beyond the scope of this paper since this is still work in progress (A new Segmentation IV project was launched to further elaborate these issues.

In the previous section we mentioned the issue of underused space and degraded land. One of the key concepts the Segmentation Projects are focussing on, in search for an effective answer, is ‘interweaving’.

Interweaving implies that several activities share the same space. The nature of these activities is flexible: work with work, work with housing, work with nature and leisure etc. under the condition that the activities are not hindering each other while the main function or activity is always guaranteed. Shared use of space,

rooms or infrastructure is a particular format of interweaving (VR - Witboek BRV, 2016). Therefore, each spatial environment has a particular interweaving profile. The possibilities for interweaving of a firm with its surrounding milieu depend on the interaction between the different actors: firm and stakeholders living or working in the vicinity. In other words the interweaving profile of the firm and the interweaving profile of the area surrounding the firm, have to be in balance (Leinfelder & Pisman, 2008).

This concept is related to what is called ‘spatial productivity’. This concept indicates the degree to which an economic location is efficient and effective in creating employment, in producing goods and/or in delivering services, and thus in delivering economic output. A high spatial productivity is aimed for but not at the expense of the good functioning of the firm. Therefore, the challenge is to determine a minimal use of space that benefits society and firms in a particular context. Therefore researchers and policy makers look for economic locations that optimise the space productivity which implies an efficiency (productivity per space unit) of the firm and fuel the efficiency of the production factor ‘land’ (e.g. reflected by the creation of added value) without hampering the functioning of firm. Such a vision allows e.g. for buffers between activities if this is appropriate in view of the nature of activities.

## 4 ASSESSMENT OF ACTUAL LAND-USE FOR ECONOMIC ACTIVITIES

### 4.1 Overall approach

We mentioned in the introduction that the inventory in the field was one of the specific aims of the project. This meticulous work delivered data on the economic reality in terms of use of land and spatial patterns for economic purposes in order to make a comparison with existing major statistical databases. This confrontation was aimed for since the hypothesis formulated, questioned the ability of the statistical data to grasp all the (important) characteristics of the (f)actual economic land use. In fact, the hypothesis supposed important gaps that can hinder efficient policy making and planning

Researchers started with an inventory of all visual economic activities, walking or cycling through the streets in particular case study areas, indicated by the project awarding authorities. The method used for inventarisation is an extended version of the one developed for and used in the Brussels Northern Area (Giaretta & Zaman, 2017). For each parcel (based on the digital reference map of Flanders –GRB- indicating buildings, parcels, routes and other geographical and infrastructural features) showing economic use, a number of features were recorded, according to a strict protocol, which was developed in cooperation with policy and planning officials. Elements taken into account, were structured into two categories: the firm/activity (dominant activity, activities on the ground floor, activities on the other floors, for rent/sale, physical condition or state of the used space) and characteristics of the parcel or plot (green/blue infrastructure, temporary constructions, temporary use, ramps, number of parking lots, fence, quality of the surfacing, multiple buildings), enriched with pictures in complicated or special situations. This inventory was thematically mapped in different ways, using GIS, respecting the parcel as a unit.

The identification of the different location environments was developed through action research. Therefore a number of stakeholders from practice and policy officials collaborated with the researchers to delimit and label sub-zones within the case study areas. These sub-zones were identified based on particular characteristics in terms of patterns and relationship between different kinds of economic land use and housing. No prior categorisation from literature or former research was taken into account during this phase. The identification of the environments was based on a process of ‘out-of-the box’ thinking and interpretation based on the patterns emerging through the mapping out of the field inventarisations. Although the aim was to think out of the box, spatial practitioners involved divided the space in more or less ‘known’ master-categories we recognise from the previous labelling (citycentre, main access road, economic estate, residential area, scattered build up area) and made a subdivision starting from that point.

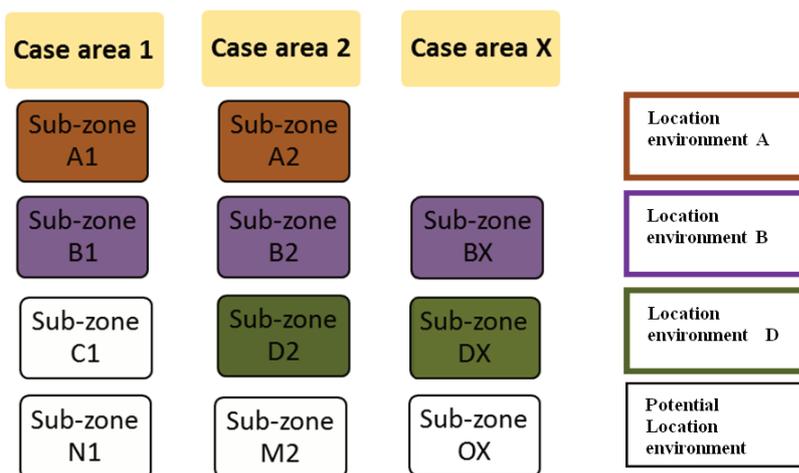


Figure 1: The identification of location environments

#### 4.2 Selection and demarcation of case study areas

Five case areas in Flanders (Belgium) were selected by the project awarding authorities (Figure 2). Each case area is a transect from a high density urban area to a suburban neighbourhood or even a semi-rural zone, in different (types of) regions: coastline (Koksijde)-inland (Veurne) transect, transects in the metropolitan area of the major cities of Antwerp and Ghent, in the medium sized city of Hasselt (and its suburbs), and the smaller city of Aalst (including the area along one arterial or access road) and small towns such as Deinze or Veurne. These choices emerge from experience with a very diverse urban and semi-urban to semi-rural fabric with a very complicated, partly historically built-up tissue in which mixed land use and interweaving is a general phenomenon. The selection is broad enough to cover a diverse range of particular environments that contribute to the differentiated landscape of economic land use and physical as well as functional relationships. Table 1 gives an overview of the particular cases and numbers related to the in-field inventory. From the numbers, one can see that the inventory is very detailed and the information very substantial. Therefore, one can detect several layers of environments with differences between the case study areas but particularly also within case study areas. For sure the cases studies, ‘Wijnegem-Malle’ (transect through the metropolitan area of Antwerp) is partly comparable, partly different from the ‘Deinze-Gent’ case (transect through the metropolitan area of Ghent or the Hasselt case which focusses on the densely populated and economically used city centre with a transect through its suburbs. This again is different from the ‘Aalst-Herzele’ case, studying on old industrial tissue and city centre up to developments along access roads through an urbanized country side while the Koksijde-Veurne case focusses on specific economic uses in areas with a high impact of agriculture (inland) or tourism and services (coastline). By examining the detailed patterns (on a plot level) it becomes clear that differences within the cases are not only prominent but that the previous labelling (centre, main access road, economic estate, residential area) is too vague and general in terms of location milieus for economic activities.

To illustrate this point, we present two exemplary maps. The first one (Figure 4) shows the first identification of rough sub-zones, based on the resulting pattern showing all parcels with an economic use (without distinguish any sub category). The second one (Figure 5) illustrates that clusters of economic activities in one and the same suburban milieu might be very different in terms of economic nature and dedication.

Case	Number of activities	Number of firms	Number of parcels with
Koksijde- Veurne	1235	1054	945
Aalst- Herzele	2194	1714	1519
Hasselt	2680	2187	1686
Deinze- Gent	1118	889	788
Wijnegem- Malle	1263	1149	983
Total for all cases	8490	6993	5921

Table 1: Number of activities, firms and parcels per case area from the inventory

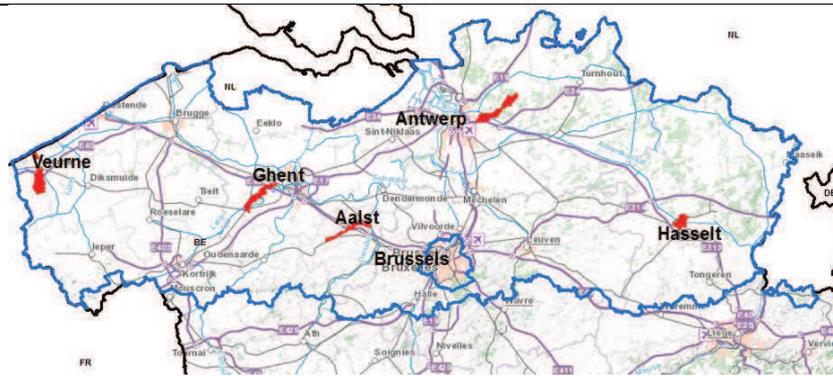


Figure 2: Situation of the five case study areas within Flanders

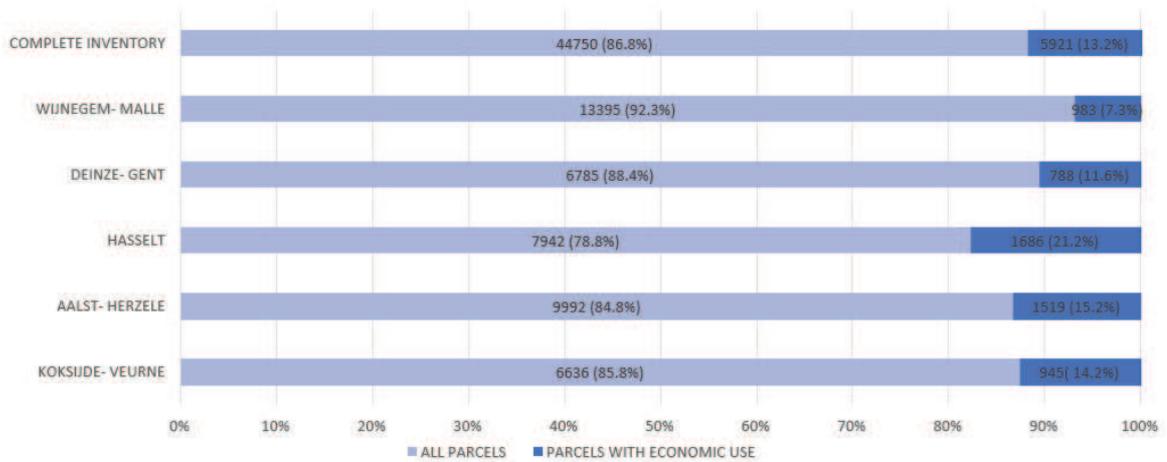


Figure 3: Share of parcels giving proof of economic land use during the inventory

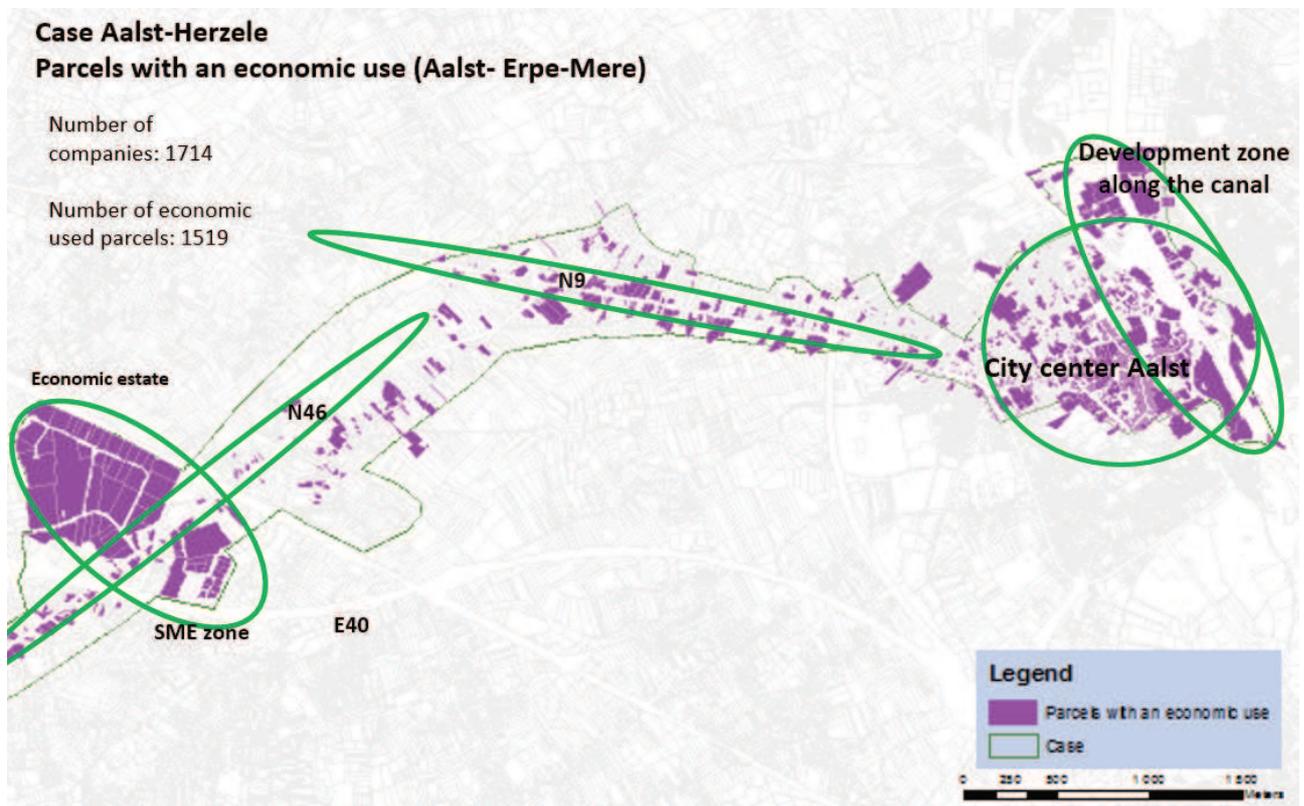


Figure 4: Factual economic use of plots in the Aalst-Herzele case study area

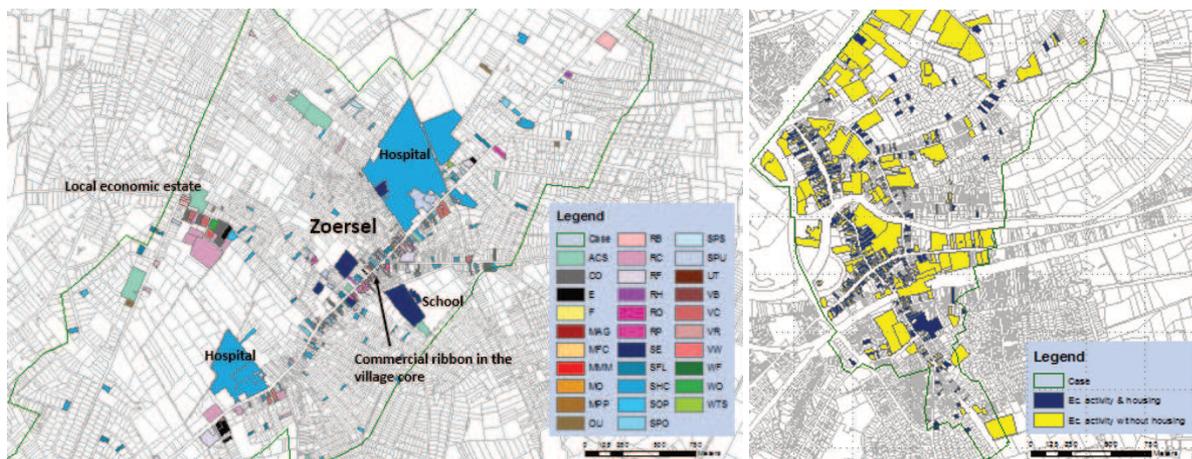


Figure 5: Factual economic use of plots in Zoersel, Figure 6: Economic use combined with housing (Deinze)

The activity codes in the legend are: ACS - Arts, culture and sports; CO - Construction; E - Vacant; F - Faith; MAG - Manufacture/agriculture; MFC - Manufacture/food, drinks and catering; MMM - Manufacture/metals and machinery; MO - Other manufacturing; MPP - Printing and publishing; OU - Unknown; RB - Restaurants and bars; PC - Retail/construction; RF - Retail/food; RH - Hotels and lodging; RO - Other retail; RP - Retail/personal; SE - Services/education; SFL - Services/financial, insurance, legal and consultancy; SHC - Services/healthcare; SOP - Other personal services; SPO - Other professional services; SPS - Public services; UT - Utilities; VB - Vehicle/bicycle; VC - Vehicle/car and truck; VR - Vehicle/rail; VW - Vehicle/water; WF - Wholesale/food; WO - Other wholesale; WTS - Transport and storage.

Of course, other, more sophisticated analyses and combinations with other indicators help the researcher to describe the characteristics of these environments even more in depth. One of those indicators is the combination with housing since it makes a huge difference in terms of density of land use. Figure 5 illustrates such a pattern. This allows, among others, to distinguish more traditional and/or historical and organically grown economic tissues such as shopping streets in cities centres from more artificial and dedicated zoning for economic use in which, housing might be forbidden or tied by strict regulations. The same goes for a combination with the presence of vacant buildings for economic use (production, offices, shops). Another interesting GIS procedure is dissolving adjacent parcels with a similar economic use into 1 feature. This allows for insights in the degree of fragmentation versus concentration.

### 4.3 Identification of location environments

In line with the analytical logic presented in the previous section and following an action research method with the concepts of interweaving and spatial productivity in mind, eight location milieus could be identified of which two were subdivided. The delineation of the location milieus had to be determined in order to analyse the milieus, but the research team considers this as an open delineation. We tried to summarize the results in the following table (table 2).

We try to illustrate how the summary above is elaborated in detail for the different case by taking some location environments from the Aalst-Herzele case (see also figure 4). In this case, we take Aalst as an exemplary case.

A first location environment is the city or urban centre which, in line with the expectations, is characterized by a high concentration of mixed retail, (ho)reca and services. Aalst responds to that profile with 57% of the economic plots used by retail and horeca and 26% by services. Vacant buildings in the centre are quite common as well (13%). A combination of economic activities and a residential function was recorded in 53% of the economically used plots in this location environment. Even then, detailed patterns can be found, among others that a residential function combined with an economic function, tends to be limited in the real core and characteristic for the 'edges'.

Location environments	Most common econ. activities – broad categorisation	Combined with housing	Vacancy rate	Agglomeration effects <sup>1</sup>	Size of parcels
Urban centres	Approx. 50% of all main economic activities in retail and catering	Approx. 50% of all parcels with an economic function. Big differences between cities	+/- 10%	Concentration of similar economic activities	Small parcels but a large range. Median of approx. 200 m <sup>2</sup>
High street retail area (urban commercial centres)	Approx. 50-80% of all main economic activities of activities in retail and catering	Approx. 50% of all parcels with an economic use	+/- 10%	Large concentr. of similar economic activities, more specifically retail and catering	Smaller parcels. Median of approx. 180m <sup>2</sup>
Services along the city belt	>50% of all main economic activities in services	Approx. two third of all parcels with an economic use is combined with housing. Exceptions: bigger parcels with schools, hospitals...	+/- 10%	Mainly adjacent activities in services	In general larger compared to the urban centres. Median of ca. 250 m <sup>2</sup> . Large range and big differences across areas
Residential areas characterized by scattered services	Approx. 2/3 of all main economic activities in services	Approx. 75% of all parcels with an economic function	Close to zero	No concentration; adjacent functions	Large parcels and range. Median of approx. 680 m <sup>2</sup> .
Arterial roads					
Arterial roads characterized by retail and car related business	Economic activities mainly in retail & catering and car related businesses	Approx. one third of all parcels with an economic function	Limited	Limited	Large parcels and range. Median of approx. 1315m <sup>2</sup>
Arterial roads characterized by services, retail & cat.	Economic activities mainly in retail & catering and services	Approx. 50 percent of all parcels with an economic function.	< 10 %.	Limited	Smaller compared to 'main access roads in general. Median of approx. 380m <sup>2</sup>
Smaller centres					
(Village) centre characterized by retail and services	Economic activities mainly in retail & catering and services	Approx. 80% of all parcels with an economic function.	Approx. 6%.	Concentration of similar economic activities	Medium sized parcels. Median of approx. 430 m <sup>2</sup>
(Village) centre characterized by scattered services	Approx. 50 % of economic activities in services and 25% in retail & catering	Approx. two thirds of all parcels with an economic function	Limited.	Limited	Larger parcels and a large range. Median of approx. 830 m <sup>2</sup>
Open areas <sup>2</sup>	Mainly agriculture	Approx. 75% of all parcels with an economic function	Limited.	n.a.	Very large parcels and a large range. Median of ca.4600 m <sup>2</sup>
Business parks	Wholesale and logistics (ca. 25%), services, production, retail & construction	Approx. 100% of all parcels with an economic function	Approx. 8 %.	Large, especially for activities in production/manufacturing.	Very large parcels. Median of approx. 3260 m <sup>2</sup> .

Table 2 Eight location environments delimited (based on field inventory in 5 case study areas)

As can be expected, comparable activities are often situated on adjacent plots, especially retail and reca; therefore if one merge plots from the same 'economic use' category, less than half (49%) of the parcels are left which indicates a low(er) fragmentation/ high(er) concentration of similar economic activities. It is not surprising that this figure drops to 29% if one take the core shopping area only (see Table 2). Nevertheless, it is interesting to notice that this fragmentation is quite different from city to city with, in our research, a range from 41% of parcels left for Hasselt (30% for the core shopping area) and 65% of plots left for Deinze (60% for the core shopping area). The median plot size in Aalst is nearly 170 m<sup>2</sup> which is fairly small compared to other cities in our research. What is clear from our results is, that a city centre, as a location milieu, has many

<sup>1</sup> Measured in terms of adjacent parcels with the same economic use

<sup>2</sup> Only built-up parcels are inventoried

different appearances. Of course, the urban centre of Aalst shows similarities with other cities such as Hasselt, but important differences can be detected when comparing with Veurne or Deinze. In smaller cities, the mix in the city or town centre seems to be larger. This reveals, at least, that size of the city or town is important, not only in terms of quantity of economic activities but also in qualitative terms, being differences in their locational patterns inside the centre and dominance or weakness of subcategories within the major activity categories such as ‘personal services’. But even within the same city size category, the centres may differ quite extensively as was the case between Veurne and Deinze. This can be influenced by the population densities and other characteristics of the catchment area around the city or its functional role on a regional level.

Around a number of inner ring roads, railway stations or particular squares (called a milieu of services along the city belt or in the urban fringe), one can detect a concentration of services, while retail and reca are less dominant (compared to the city centres) or even relatively absent. While, for Aalst, retail and reca drop to 32%, services gain in share, up to 52%. The fragmentation is quite high since merging plots characterised by similar activities, leaves us with 64% of the former number of plots after the procedure was carried out, although the interweaving with other functions and activities is low and just in case we detect interweaving, it might be with vacant economic buildings. On a plot level we notice interweaving among services and between services and vacant economic buildings. Slightly more than 65% of all plots with economic use (in this milieu) are combined with housing, which is in line with the other cities. The median plot size of all economic used plots is 214 m<sup>2</sup>. One can conclude that this milieu is fairly consistent across the different cities and towns in our inventory but differences can be detected between cities of approximately the same size and between bigger and smaller cities. For example, the share of professional services is considerably higher in Hasselt than in Aalst while vacant buildings are more common in Aalst. Further, the diversity of economic activities in this milieu is higher in bigger cities and less in smaller cities while, for the city centre the contrary could be found.

The study revealed a type of location environment labelled ‘residential areas with scattered services’. This type of ‘milieu’ which could be detected in all case study areas, is particularly interesting because of the discrepancy between what could be observed in the field and figures from databases such as VKBO (Flemish database of registered economic activities and firms). This kind of environment can be found near city centres, in residential neighbourhoods along access roads as well as near the centre of urbanised and densely populated villages. From the parcels with economic use, 20% host a medical service function and 16%, a personal service function; all kinds of services constitute a share of 62% while retail and horeca constitute a share of only 19%. The distribution of economic activities is scattered, indicated by a figure of 88% of the plots remaining after merging adjacent parcels that belong to the same activity category. Further, it is not surprising that 73% of the economically used plots are combined with housing, while on very few plots, a combination of several activities could be detected. The median plot size goes up again and attains 677 m<sup>2</sup>.

Main access roads revealed to be a very specific location environment although many differences can be found within this category from a density, activity and plot size perspective. Some particular characteristics in terms of activities can be summarized as follows: i) large mix (no dominant activity), ii) relative absence of personal services; iii) remarkable presence of car related companies (10% of the economically used plots). A percentage of 80% remaining plots after a join of adjacent ‘same-activity’ plots, indicates rather diversity than fragmentation while only about half (52%) of the plots combine economic activities with a residential function. The importance of this kind of location environment in Flanders on the one hand and its diversity on the other hand, urged the researchers to distinguish two sub-categories: access roads with retail (e.g. furniture and sanitary equipment and other products related to homebuilding, 18%) and car related businesses (16%) on the one hand and access roads with a more mixed profile in which services are more important on the other hand. The former combines economic activities far less (34%) with housing compared to (62%) while the median plot size is much bigger (1315 m<sup>2</sup> versus 380 m<sup>2</sup>).

Finally, we would like to give some details about village centres. This type of location environment is abundant in all case study areas and occur repeatedly in different shapes and formats. Not one activity is very dominant but, of course, services (43% of the economically used plots) and retail/horeca (38%) are very important. Within the category of services, personal services are the most important (13%) while within retail, groceries are on top of the list (9%). With personal products’ retail (8%) almost as important, one should realize that this location environment is going beyond the provision for every day needs. The

percentage of plots kept over a join is 75% which does not indicate a high concentration but not a high fragmentation either. Diversification of activities might explain this figure. Again the researchers opted for a sub-categorisation into village centres with a prominent presence and concentration of retail and reca (often in combination with the location along an important road) and others with spread services.

In this overview, we presented only 5 location milieus in detail. It seems that the remaining (core shopping centres, open area with ca. 50% of the economically used plots being dedicated to agriculture and finally economic estates) milieus are more straightforward and in general less surprising. They have a more specific dedication and focus on certain economic activities. Nevertheless, in next stages, it can be interesting to analyse exactly those activities in these areas that are deviating from the (clear) pattern.

It is worth mentioning that a comparable inventory was done in the fringe of Brussels (commissioned by the same Department of the Flemish government) which explores the actual use of space in a metropolitan area (Giaretta, Penninx, De Mulder, & Zaman, 2018 (forthcoming). Although comparable location environments can be found, Brussels constitutes another reality in terms of degree of urbanisation and functionalities of the urban tissue.

#### 4.4 The combination of field observations with different data and statistics: gaps and synergies

All too often, one supposes that the existing data(bases) will reveal the complexity (in terms of type) and the location (in terms of milieu) of economic activities and that these data will be able to underpinn policies related to space for economy and the needs of economic actors in space. On a daily basis, policy makers and officials experience that the reality is far more complex than data from databases reveal. Detecting and especially understanding the processes that foster or hinder the interweaving of economic and other activities and understanding location strategies and decisions by economic actors in relation to attitudes and opinions of other stakeholders sharing the same space, is a concern. Nevertheless it is very difficult to ‚proof‘ that there is a gap between the data and the reality in the field. This project allowed for the first time to confront a very detailed field inventory (and resulting spatial pattern) with the pattern emerging from data, and subsequently, answering three questions: i) to what extend are both patterns confirming each other or not, ii) how can existing data enrich the field inventory (e.g. in order to calculate the space productivity) and iii) do policy makers need targeted new data and data collection methods?

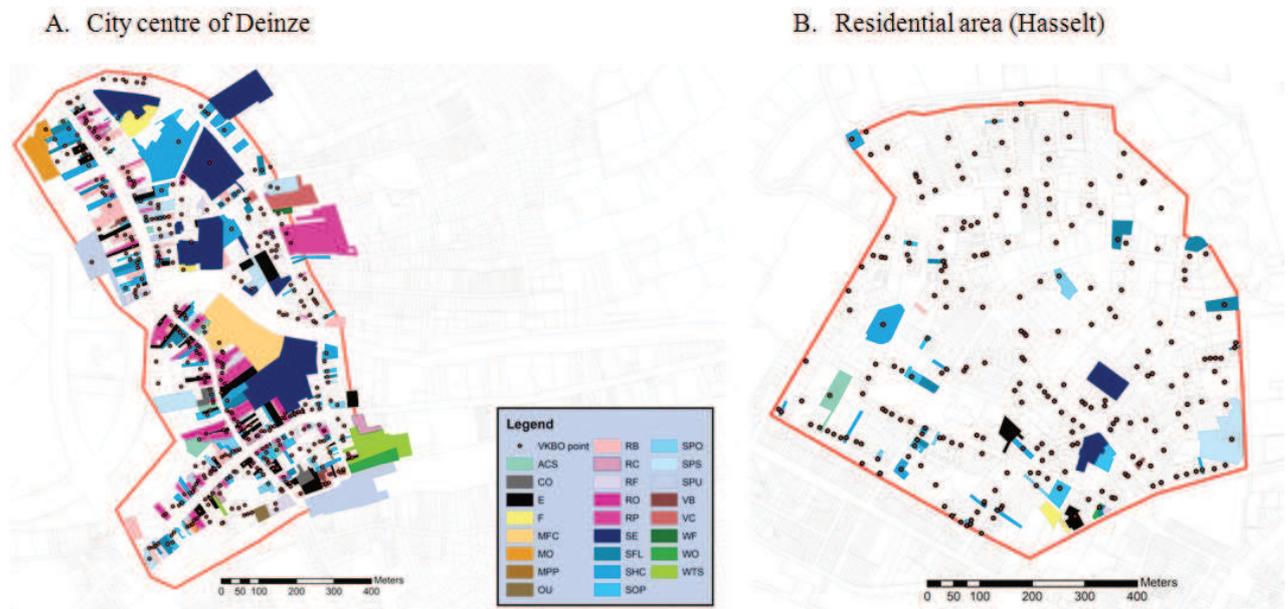


Figure 7: Database address points versus Inventory mapping of visual economic activities

The first question was researched by creating a GIS overlay between registered companies (address points – XY coordinates) in the enriched database of registered economic activities and firms (from VKBO) and the cartographic representation of the inventory of economic activities that could be detected in the field (parcels). The outcome can be threefold: address from the database and plot with economic activity are in line (4206 plots on 8957 address point of firms), we registered a kind of economic activity during the fieldwork but it does not show from the database (1702 plot on 8957) or we have a mapped firm from the

database without visual appearance in the field (4751 plots on 8957). These differences between case study areas and location environments are considerable but the bottom line is that only 47% of the registered firms matches with the inventory from the field. The main question therefore is: why?

Before reflecting a explanations, we present two illustrative maps, one from a city centre and one from a residential area, illustrating the discrepancy described above (Figure 6).

Some explanations are simple and straight forward. It is possible that an economic activity takes place without leaving a visual indication in the field. This could be the case for small, independent businesses and activities of self-employed. Especially people with the double status of employee and self-employed as a secondary occupation might be registered without a material witness of their (limited) activity. This explains why we have a large amount of mismatches in residential areas (Figure 7). There is also the frequent situation that the registered office is not corresponding with the place where the activity actually takes place. It is common practice that owners of a company register their company at their home address while the activity takes place somewhere else. In the latter –well known- case, the mapping of the database becomes a doubtful source for the real spread of economic activities.

When looking into the situation for the location environment ,city centres‘ one can conclude that the inventory identified more plots with an economic, compared to the amount of plots one could identify from the database (almost 103% vs. 66% in the inventory as a whole). Consequently, there is a greater convergence between the VKBO and inventory in terms of plots (76,7%) and companies (61,4%), while the discrepancy between these two numbers indicated that the presence of multiple companies on a parcel (e.g. high rise building) are not visible. For ,core shopping centres‘, the convergence is even stronger, both in terms of plots (93%) and companies (71%). On the other hand (in both environments), around 25% of the activities, seen in the field, could not be found on a corresponding plot in the database. Spatial productivity in city centres is therefore higher than can be detected from the database and one can state that a combination of both is useful to quantify the space productivity in city centres. This is also in line with the situation in the location environment ,service area at the urban fringe/ along the urban belt‘.

The situation is totally different in the location environment ,residential areas‘. Only 17% of the parcels identified in the database could be detected during the inventory (and 21% in terms of the amount of companies). But it is surprisingly, that we identified more companies (in numbers) on all detected plots in the inventory than could be expected from the database (102% vs. 76% for the inventory as a whole). Nevertheless, the important mismatch in which it is not even clear if it is about registered offices (with a use of space elsewhere or even nowhere, e.g. in the case of transportation) or a ,hidden‘ activity, makes the VKBO database less suitable to calculate the space productivity without additional analysis (field research aiming at detecting if an activity is taking place as well as characteristics of the company).

As for the location environment ,access roads‘, the convergence between the VKBO and inventory in terms of plots (55%) and companies (50.3%) is only slightly higher compared to the inventory as a whole. At the same time it should be stressed that the share of identified plots which were not found in the database is relatively high (29%), while on parcels where the researchers registered economic activities, there is still a discrepancy in the amount of companies. The usefulness of the VKBO database combined with the inventory is therefore rather limited and not clear-cut. One could suppose that the situation might be less complex in ,village centres‘ where activities can be seen due to minor densities. However, the convergence between the VKBO and field inventory is only slightly higher, both in terms of plots (58%) and in terms of companies (56%). Besides, it is striking that in a sub-type with spread services, the mismatch in terms of plots with economic activities without a corresponding firm in the database is much higher than in the sub-type with a high concentration of retail and horeca (resp. 34% and 18%).

Ultimately, in the ,open area‘, we notice an average convergence between the VKBO and inventory, both in terms of plots (47.9%) and in terms of companies (in numbers) (55%). If we just consider the amount of parcels which should indicate a economic activity (according to the VKBO), we detected 82 percent of the plots. This is indicating a high number of plots which were detected on the field but are not identified in the database (41.8%), while at the same time there are plots showing an economic activity which we did not notice on the field. The former is partly a consequence of farms using more than one plot, while this is logically not identified from the VKBO (XY coordinates based on adress). The same is true for the ,economic estates‘. Merely looking at the numbers, more than 120% of the number of plots (based on the

VKBO) were identified. At the same time, the convergence between the VKBO and the inventory in terms of plots is 77% and 65% in terms of companies. Almost 37% of all plots detected in the inventory could be identified from the VKBO. In practice many of the larger companies use several plots, especially if they carry out more than 1 activity (e.g. production, office & warehouse).

In short, especially a high match between a parcel in economic use being on the inventory and being reflected in the VKBO data, makes the database an instrument to reflect economic space productivity. We summarize this match in table 3.

Location environment/milieu	% parcels in the inventory + in VKBO
City centres	77%
Core shopping centres	93%
Service areas urban fringe	68%
Residential areas	17%
Access roads	55%
Village centres	58%
Open areas	48%
Economic estates	77%

Table 3. Share of the 'Inventory in the field' firms with VKBO match in the total number of firms in VKBO

From Table 3, it is clear that the VKBO database, although very important and one of the main sources on the Flemish companies, its significance for mapping the location patterns of the companies and to detect location environments as well as its value to calculate space productivity is very variable according to the location environment at stake.

## 5 SOME REFLECTIONS

Let's start with the contribution of the research outcome to the following policy objective: better and more intensive design of the existing land use which contribute to lowering the pressure on open space. At present in Flanders, an additional 6 hectares a day are taken for the development of housing, economic activities and employment, facilities and infrastructure. The aim is to lower this additional consumption of open space to 3 hectares in 2025 and to stop additional net land take by 2040. Since, in reality, 80% of the Flemish firms is already located outside economic estates but rather in interwoven conditions, the broad policy lines opt for a concentration of functions in urban areas and a general interweaving of functions and activities steered by a coherent vision on space. This implies that the policy makers need instruments to put such a policy in place that go beyond policy for economic development or space for economy. The new instruments should foster the growing tendency to channel new developments towards transformed and revitalized brown fields.

For sure, the outcome of our research presents an multitude of location environments. One of the dividing characteristics is the presence of a residential function. In some areas, the residential function is very important or even dominant, in other environments, housing is relatively rare or absent. The traditional (rigid) instruments cope with the monofunctional situations but proves not to be sufficient in cases of intensive interweaving and fragmentation, the latter urging for more flexible instruments. This goes in pair with the need for a more context related reflection since not only the instruments are lacking to stimulate interweaving but also insights in the contexts where interweaving can (not) be stimulated. Further one should take into account that interweaving is not limited to a particular scale. One can distinguish at least five levels from a multifunctional use on the regional level, cities and their catchment area, specific location environments, parcels with several activities or a combination of living and working and the individual firm (building).

The study reveals patterns linked to 2D parcel information. Including the third dimension could add additional insights, especially in urban environments where the interweaving of activities may reflect interactions between activities at different floors, or in different parts of the buildings. The field inventory did not allow observations inside buildings. The potential of innovative approaches, such as crowd sourcing and participative mapping could be further explored, to fill up this gap.

Our results present the existence of location environments that, in many cases, are dominated by particular economic activities. The hypothesis therefore is, that these particular location environments are suitable for these activities. In other words, location milieus seem to provide the necessary or preferred location factors of specific economic activities. When narrowing the number of location environments to four (city centre, access road, residential area and economic estate), qualitative research added to understanding the location behavior and preference of the firms as prime stakeholders for that matter. From literature and a research on location factors (e.g. Vanneste et al., 2003a, 2003b), we know that accessibility, an affordable plot and/or building, no hinderence by other functions, a pleasant environment (for work and living) accessibility of permits and welcoming authorities are important but also depending on the nature of the economic activity. In most cases, this information is obtained via a survey; in our case interviews with the firms in the case study areas and workshops with field experts allowed to go much more in detail and understand the economic logic behind the location, the relationship between adjacent firms and the relation (bond) of the firm with the stakeholders in the surrounding area (such as the residents) (Table 4).

As we mentioned in the introduction, the translation of our results into potential starting points for spatial economic policy is beyond the scope of this paper. They do contribute to the understanding of space use for economic activities and the tremendous complexities policy makers are confronted with. It certainly underlines the need to develop new or adapted instruments to measure fragmentation and interweaving in relation to dominant versus mixed economic land use and combinations of economic versus residential use. This research proof very clearly that one of the main statistical resource, the VKBO database, is only useful in particular situations (location environments) while in other, remote sensing, crowd sourcing, and web data extraction might be appropriate levers to create additional policy-supporting data.

	City centre	Main access road	Economic estate	Residential area
Production	<ul style="list-style-type: none"> <li>• Mostly small scale activities</li> <li>• Larger activities:historically grown situation</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable, especially for smaller scale companies</li> <li>• Frequently noticed</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred location for most production activities (larger parcels, specific regulation, accessibility)</li> </ul>	<ul style="list-style-type: none"> <li>• Historically grown</li> <li>• Not a preferred location for production and vice versa</li> </ul>
Wholesale activities	<ul style="list-style-type: none"> <li>• Suitable, although not too large</li> <li>• Frequently noticed</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred location for most companies due to accessibility and visibility</li> </ul>	<ul style="list-style-type: none"> <li>• Attractive location for wholesale companies if combined with a good accessibility)</li> </ul>	<ul style="list-style-type: none"> <li>• Not a preferred location</li> <li>• Historically grown or small-scale activities</li> </ul>
Logistics	<ul style="list-style-type: none"> <li>• In general not a preferred location due to limited accessibility</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable, especially for smaller scale companies</li> <li>• Frequently noticed</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred location for companies in logistics(size of parcels, accessibility)</li> </ul>	<ul style="list-style-type: none"> <li>• Not a preferred location and vice versa (traffic generation)</li> </ul>
Retail/horeca	<ul style="list-style-type: none"> <li>• Preferred location for many activities in retail and horeca</li> </ul>	<ul style="list-style-type: none"> <li>• Attractive environment for larger activities (accessibility and visibility)</li> </ul>	<ul style="list-style-type: none"> <li>• Potentially attractive</li> <li>• Reversed: quality of economic estate can be enhanced by adding retail/horeca facilities</li> </ul>	<ul style="list-style-type: none"> <li>• Potentially attractive (small scale activities)</li> <li>• Can improve liveability in certain residential areas</li> </ul>
Services (offices)	<ul style="list-style-type: none"> <li>• Preferred location for offices with a public function</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred location environment for offices (accessibility and visibility)</li> </ul>	<ul style="list-style-type: none"> <li>• In some cases a preferred location for offices (near highways)</li> </ul>	<ul style="list-style-type: none"> <li>• Offices at home (small-scale &amp; self-employed) and other small-scale activities</li> </ul>
Services (health, education et cetera.)	<ul style="list-style-type: none"> <li>• Small scale services (often combined with other services or retail)</li> </ul>	<ul style="list-style-type: none"> <li>• Medium and larged sized services</li> </ul>	<ul style="list-style-type: none"> <li>• Not a preferred location</li> <li>• Large functions (e.g. hospitals) as separate economic estate?</li> </ul>	<ul style="list-style-type: none"> <li>• Small-scale services as medical practices.</li> </ul>

Table 4: Relationship location environment – locations factors for six activity categories (KU Leuven, BCI, 2017, based on interviews and expert workshops)

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