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Assessing Discrepancies between Official Economic Statistics and Land Use through a Field Inventory System

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Abstract: To limit additional (net) land take for economic activities, the reality of space use needs to be properly understood. This was assessed by comparing the spatial patterns obtained from a field inventory with those from existing data for five case areas in Flanders (Belgium). Each case area is a transect from a high-density urban area to a suburban neighborhood or even a semi-rural zone. The statistics on these areas, based on official data, mostly derived from tax returns, social security contributions, and on commercial retail data, were checked with field observations. The location of economic activities and the patterns of space use vary in different settlement environments, resulting in the identification of typical characteristics for eight location environment types. While in, for example, core shopping centers a strong convergence can be noticed between existing statistics and the field inventory (71% of companies and 93% of parcels are detected on the field), in residential areas (21% of companies and 17% of parcels are detected on the field) the convergence is very limited. In other words, 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, a field inventory system can enrich the picture and present another reality to complement both existing statistics and other land-use data methods such as remote sensing and web data extraction.

Keywords: urban expansion; land use; land take; urban sprawl; spatial economics; inventory; locational determinants; government; urban policy; location environments

1. Introduction

Land recycling allowing inner-city development or the re-naturalization of abandoned land 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. In turn, 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 [1].

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" [2]. 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 optimization of space use in developed areas, and consequently, an understanding of this use within the urban fabric. Considered by international standards, most of Flanders can be considered as urban fabric. According to the Eurostat definition of urbanization, 7 out of the 308 Flemish municipalities are considered as "cities", 228 get the classification "towns and suburbs", and 74 (only) are rural; 11 of the 308 municipalities have more than 50.000 inhabitants while the average density is 485 inhabitants/km^2 [3].

Sarzynski et al. [4] identify spatial patterns in metropolitan areas using a combination of indicators and metrics, i.e., intensity, compactness, mix and mono-centricity, yet ascertain that delimited 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 Entrepreneurship set up a series of studies called "Segmentation" to explore the economic land use in Flanders. Our paper presents the outcomes of the Segmentation III project, introduced in Section 3 together with the methodology and overall approach. Section 4 presents the assessment of actual land use in five case areas in Flanders by comparing the spatial patterns obtained from a field inventory with those from statistics based on existing data. 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 which field observation play a more prominent role. In the final section, we zoom out, and conclude that assessing expanding space use versus infill for economic activities is scale dependent.

2. Efficient Land Use and Consumption, Spatial Productivity and Urban Sprawl: A Literature Review

As mentioned before, Flanders is aiming towards no additional land take in 2040, while nowadays we can speak about an additional daily land take of 6 hectares [5]. In other words, changes in policy planning considerations and habits are required to realize the aforementioned goals. These policy goals are partly related to the fact that land in itself is nowadays being considered as a non-renewable resource, which points to the need to increase the spatial efficiency of land use. Louw et al. [6] and Hubacek & Van den Bergh [7] point for example towards the changed meanings of land in (spatial) economics. From a neoclassical viewpoint less attention has been paid to land as a production factor, whereby capital and labor inputs are generally considered more important. It is only recently that land is reintroduced in economic theories and more attention is paid to the efficiency of land use in planning policies, partly the result of the focus on sustainable development. In addition, several dynamics as population growth, urbanization (China), limited supply of land (Hong Kong, Singapore) and urban sprawl (Belgium, The Netherlands) contribute to the renewed discussion on efficient land use. Van der Krabben et al. [8] show for example that there is a relation between urbanization and spatial productivity on the one hand, and the combination of activities/sectors and spatial productivity on the other hand. Nevertheless, there is very little knowledge about the measurement and analysis of efficient land use, with an exception of agricultural land use and productivity. Besides, it is often unclear how much land is used in practice by different activities, including the distinction between economic and non-economic land use.

The newly proposed policy plan in Flanders [9] is pointing to concepts as "intermixing of functions" (multifunctional land use), intensification of land use, land re-use (brownfield development and infill activities) and temporary land use. These concepts find ground in theories and movements as New Urbanism and Smart Growth in the USA and Compact Cities in Europe as an answer to limit further urban sprawl and related costs e.g., [10–12]. This is highly relevant as Belgium has the second highest degree of urban sprawl in Europe (after the Netherlands) according to the EEA WUP-indicator (The metric (weighted urban proliferation) is used to quantify urban sprawl. It is the product of the dispersion, a weighting of dispersion, the percentage of built-up area and a weighting of the land uptake per person. It is measures in urban permeation units per square meter of landscape). Notwithstanding these high levels, a further increase in both countries could be noticed during the last decade [13,14]. The oversupply of building plots will further steer suburbanization and sprawling in Flanders in the coming years, which can not only be tackled by the new planning policy [15]. This "tradition" in urban sprawl is accompanied by lock-in effects, which only get bigger and harder to reverse [13], as also identified by De Decker [16] and Bervoets et al. [17] in Flanders.

Intensifying the use of space and strengthening the multifunctional use of space are different concepts. Nevertheless, these are often related as was illustrated for the Flemish business parks (in an earlier study commissioned by the Flemish Environmental department; [18]). Multifunctional land use is focusing on the creation of synergies by combining different land-use functions [19]. In turn, this is partly related to the urban quality which must be safeguarded when intensifying space. In other words, the challenge is to focus on a higher (living) quality while using less space [20]. Of course, not all economic (and non-economic) activities can be intermixed and a specific framework for the spatial differentiation of economic activities is needed for policy goals and planning. Such a framework is difficult to establish and mainly lacking at the moment. Besides, there is often a gap between theory and reality. To give an example, the Association of Dutch Municipalities developed different categories of economic activities which could be mixed with residential activities, based on environmental hindrance/impact. According to this categorization 86 percent of all economic activities (companies) in the Netherlands can be combined with residential activities. In reality, 40 percent of companies that can be mixed are in business parks, while approximately the same amount of companies, which cannot be mixed, are in residential or mixed areas [21]. In addition, it can be stressed that there is (still) a lack of knowledge of locational decisions of many companies/sectors (regarding logistics) [22]. Rodenburg & Nijkamp [23] for example stress that little is known about the combination of land-use functions that result in positive (or negative) synergies. In any case, it is important to consider both the susceptibility of activities and areas in terms of intermixing and multifunctional use [24]. The possibilities for interweaving of a firm with its surrounding milieu depend on the interaction between the different actors: firms 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, must be in balance [25].

Sarzynski & Levy [26] distinguish several approaches to measure spatial efficiency. The first approach is oriented towards assessing overall land-use patterns and urban sprawl, whereby metrics as density, proximity, centrality and concentration are used. They are useful to analyze agglomeration effects but limited in terms of spatial efficiency as it neglects how people behave in different environments. Alternative approaches are therefore more focused on measuring average commuting times, congestion and road usage, etc., or on measuring all kinds of accessibility (e.g., access to jobs/skilled labor, access to markets/services). This is partly related to three factors (identified by Sarzynski & Levy [26]) that influence the spatial arrangement of economic activities: business location decisions, residential decisions, provision of physical infrastructure.

Based on these factors two overarching (partly interconnected) strategies to improve the spatial efficiency are identified, namely the strengthening of co-location and the improvement of connectivity. Of course, one should consider possible externalities (e.g., congestion), which result in the need to foster a certain level of de-concentration in certain areas, rather than concentration. In other words, the authors point to the need of a long-term view and more research into the consequences of (urban

and spatial) patterns for economic development. It should be clear that insight in existing patterns is therefore a crucial factor.

In addition, and related to spatial efficiency, several ways to measure urban sprawl and land use can be mentioned, the earlier mentioned "weighted urban proliferation" being one of them. However, as shown by Vermeiren et al. [27] the WUP-scores are too complex to understand and to use by a broader public, partly because open green areas and dense city centers can have the same score. Besides, one underestimates urban sprawl in Flanders by not completely considering the ribbon development. Although several authors [28,29] are also indicating or using spatial metrics to analyze urban sprawl, they often prove difficult to interpret, due to a lack of consensus on thresholds [30]. In other words, it seems that more qualitative research is needed to assess on the field howland is really used and which combination of activities are present. For sure, satellite imagery and remote sensing are advancing fast and can be important tools to analyze and model urban growth and land cover [31–33], but they (still) have limited value for urban policy making that needs *detailed* information regarding land use and combinations of activities and uses.

3. Context and Methodology

3.1. Context

The study (called Segmentation III) was conducted in a collaborative learning setting involving two departments (Environment and Innovation and Entrepreneurship) of the Flemish Government, Buck Consultants International, and researchers from the University of Leuven (KU 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. Analyze the relevant concepts in the Spatial Policy Plan Flanders (BRV) by applying them in common economic contexts.

It succeeded two previous studies (Segmentation I and II) in view of gradually trying to unravel the complexities behind the mix and intermixing of economic activities with other functions using space such as housing. While segmentation I [34,35] focused on a segmentation and classification of economic locations (environments or milieus), Segmentation II [36] analyzed the transformation of economic estates. Segmentation III aims at gaining insights in the ways and reasons why economic space embedded in settlements tends to degrade or to be underused.

All too often, one supposes that the existing data(bases) can 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 underpin policies related to space for economy and the needs of economic actors in space in a satisfactory way. Daily, 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, understanding location strategies and decisions by economic actors, relations to attitudes and opinions of other stakeholders sharing the same space, are the main concerns. Nevertheless, it is very difficult to prove that a gap exists between the data and the reality in the field. The Segmentation III 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?

Therefore, and on request of the policy makers, the inventory came first and did not build on statistical data. The team rather worked the other way around, organizing a quantitative inventory of the field on an array of different contexts, while exploring—afterwards—the way this inventory could (or should) be enriched by exiting statistical data. 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.

In-depth interviews complement the approach in creating an additional database for interpretation of the resulting spatial patterns. The current paper addresses the understanding of space use for economic activities within the urban fabric resulting from this inventory with reference to existing databases when possible and useful. The in-depth interviews, and consultations with economic stakeholders and with civil servants to translate the resulting patterns in potential starting points for spatial economic policy are beyond the scope of this paper since this is still work in progress.

3.2. Approach and Methodology

Five case areas in Flanders (Belgium) were selected by the project awarding authorities (Figure 1). Each case area is a transect from a high-density urban area to a suburban neighborhood or even a semi-rural zone, in different (types of) regions: coastline (Koksijde)-inland (Veurne) transect, transects in the metropolitan area (but outside the city centers) 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).

Figure 1. Situation of the five case study areas within Flanders.

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 (urban) environments that contribute to the differentiated landscape of economic land use and physical as well as functional relationships. To complement existing studies in bigger metropolitan areas such as Brussels, Ghent and Antwerp, it was a deliberate choice not to include the bigger city centers and focus on smaller regional cities or the outskirts of bigger cities. For example, the Koksijde-Veurne case study consists of a touristic seaside town, a small regional city with approximately 12.000 inhabitants, and a hinterland mainly focused on agriculture. The transect in the metropolitan area of Antwerp starts at the city fringe and is mainly focused on a (partly upscale) suburban area in the direct vicinity of a primary arterial road. The transect in the metropolitan region of Ghent includes a secondary arterial road towards the smaller city of Deinze (approx. 30.000 inhabitants) throughout residential areas and some business parks. The city of Aalst, a former industrial city (with approx. 85.000 inhabitants) is largely covered, as well the main access road towards the highway surrounded by several industrial estates and business parks. In Hasselt (approx. 78.000 inhabitants) the city center is covered as well as some suburbs, more traditional business parks and a modern business park on a former redeveloped industrial site.

Researchers started with an inventory of all visual economic activities (Economic activities are all locations with an economic function or meant to have an economic function. This means that also vacant buildings which are meant to have an economic activity (e.g., by a "for rent" sign) were part of the inventoried activities.), walking or cycling through the streets in the selected case study areas. The method used for inventarization is an extended version of the one developed for and used in a former project situated in the northern edge of the Brussels Area [37]. 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, several features were recorded, according to a protocol, which was developed in cooperation with policy and planning officials. Elements considered 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). This inventory was thematically mapped in different ways, using GIS, respecting the parcel as a unit. The actual field inventory was carried out by 5 researchers (one of them being the supervisor) by making use of a strict protocol, which was tested first in a different complex environment with students in Leuven. Besides, to improve the consistency, the researchers inventoried the same streets in the beginning to discuss potential difficulties, and met regularly during field work days to discuss difficulties experienced. Besides, activities were described as specific as possible during the fieldwork and afterwards classified by only two researchers to improve the consistency regarding the classifications and final database. The classification scheme used is the same as in the earlier mentioned study focused on Brussels [10], although some additional subdivisions were made. This classification scheme (32 categories) differs from existing NACE scheme (Statistical Classification of Economic Activities in the European Community) by taking related activities together (e.g., car-related activities includes for example both car dealers, fuel stations, car wash companies etc.). In addition to the 32 (sub) categories, 10 overarching categories were used (Arts, Culture and Sport, Construction, Vacant, Production/Manufacturing, Retail and Horeca, Services, Utilities, Vehicle-related activities, Wholesale and Logistics).

The next step was focused on the identification of the different location environments (which was developed through action research). Therefore several stakeholders from practice and policy officials collaborated with the researchers to identify and label sub-zones within the case study areas. These sub-zones were identified based on particular visual characteristics in terms of patterns and relationship and combinations between different kinds of economic land use and housing, in combination with local knowledge about the areas. No prior categorization from literature or former research was considered during this phase. The identification of the environments was therefore based on a process of "out-of-the-box" thinking and interpretation based on the patterns emerging through the mapping out of the field inventory. This resulted in a first set of potential settlement/location environments. As a next step these first potential location environments were compared across the cases to identify and name comparable location environments, which were used for further analysis. This resulted in several master-categories, using the kind of labelling (city center, main access road, economic estate, residential area, scattered build up area) that is familiar to practitioners. Consequently, several GIS procedures were carried out to get insight in the particularity of the location environments. These more sophisticated analyses and combinations with other indicators helped the researchers to describe the characteristics of these environments even more in depth. This allows, among others, to distinguish more traditional and/or historical and organically grown economic tissues such as shopping streets in cities centers from more artificial and dedicated zoning for economic use. One of those indicators is the combination with housing since it can make a huge difference in terms of density of land use. This is even the case across areas classified in the same location environment and thus based on the presence of similar economic activities (e.g., a residential location environment identified based on housing in combination with dispersed services (doctors, lawyers, et cetera) can be both a suburban area with large parcels or a 19th century inner-city residential neighborhood). This makes it difficult to further generalize

for each identified location environment by using in-depth statistics. Another interesting GIS procedure carried out is dissolving adjacent parcels with a similar economic use into 1 feature. This allows for insights in the degree of fragmentation versus concentration between and across location environments.

Simultaneously with the GIS procedures, and as mentioned in Section 3.1. the patterns in the location environments where compared to patterns resulting from existing statistics. Here we will focus on the two most important sources, the VKBO (Verrijkte Kruispuntbank Ondernemingen—Enriched database of registered economic activities and firms) [38] and Locatus [39]. The first one is the authentic (federal) source of data on companies enriched with addresses and some other information (dataset of March 2017). Locatus is a commercial company collecting data (e.g., addresses, activities according to NACE, retail floor space) about stores, shopping areas and footfall in the Benelux, Spain and several cities across Europe (dataset of February 2017).

4. Results

4.1. Inventory and Identification of Location Environments

As mentioned before, we used a gradual approach to identify location environments. Before explicating the 8 identified location environments or milieus, Table 1 gives an overview of the scope of the study. For each case study, the number of detected parcels with at least one economic activity, the number of firms and number of activities are mentioned. When calculating the share of the total number of parcels, one can see that this varies from 7% up to 20% (The total number of parcels was calculated with GIS, from the cadastral documents in the areas where field work took place). Of course, this is just a start since the whole objective is to distinguish location milieus within (and across) the case study areas. Differences in these numbers are mainly arisen from the density and characteristics of the area. As indicated Hasselt was mainly a complex urban tissue, while Wijnegem-Malle is a suburban residential area. Once again, identified location environments still show a considerable amount of differentiation on this kind of characteristics although the patterns of activities are approximately the same. This confirms some internal complexity which cannot be fully grasped with statistics, which was also mentioned by Sarzynski et al. [4].

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

Case	Number of Activities	Number of Firms	Number of Parcels with an Economic Land Use (Percentage of Total Parcels in Study Area)
Koksijde-Veurne	1235	1054	945 (14.2%)
Aalst-Herzele	2194	1714	1519 (15.2%)
Hasselt	2680	2187	1686 (21.2%)
Deinze-Gent	1118	889	788 (11.6%)
Wijnegem-Malle	1263	1149	983 (7.3%)
Total for all	8490	6993	5921 (13.2%)

One of the first steps after the inventarization was the first identification of rough sub-zones, based on the resulting pattern showing all parcels with an economic use (without distinguishing any sub-category) (see Figure 2). It shows how different the situation can be in different part of a case study area in terms of density and structure. The following two figures show more qualitative characteristics. Figure 3 shows economic activities distinguished by category, while Figure 4 shows the combination with housing. The latter for example enable to distinguish between more historical shopping streets and more recent developments at the outskirts characterized by a zoning in which housing is less common or not allowed. In line with the analytical logic presented in the previous section and following the gradual approach of identifying the location environments or milieus through action research, eight location environments could be identified, of which two were further subdivided. The delineation of the location environments had to be determined to do some analysis, but the research team considers this as an open delineation. This also means that not every parcel is appointed

to a location environment (see Table 2 for some numbers), while at the same time, some parcels are appointed to two location environments. We tried to summarize the main results in Table 3. Furthermore, it should be stressed that certain patterns are not identified as they fall partly outside the case study areas. The list with identified location environments is therefore not exhaustive.

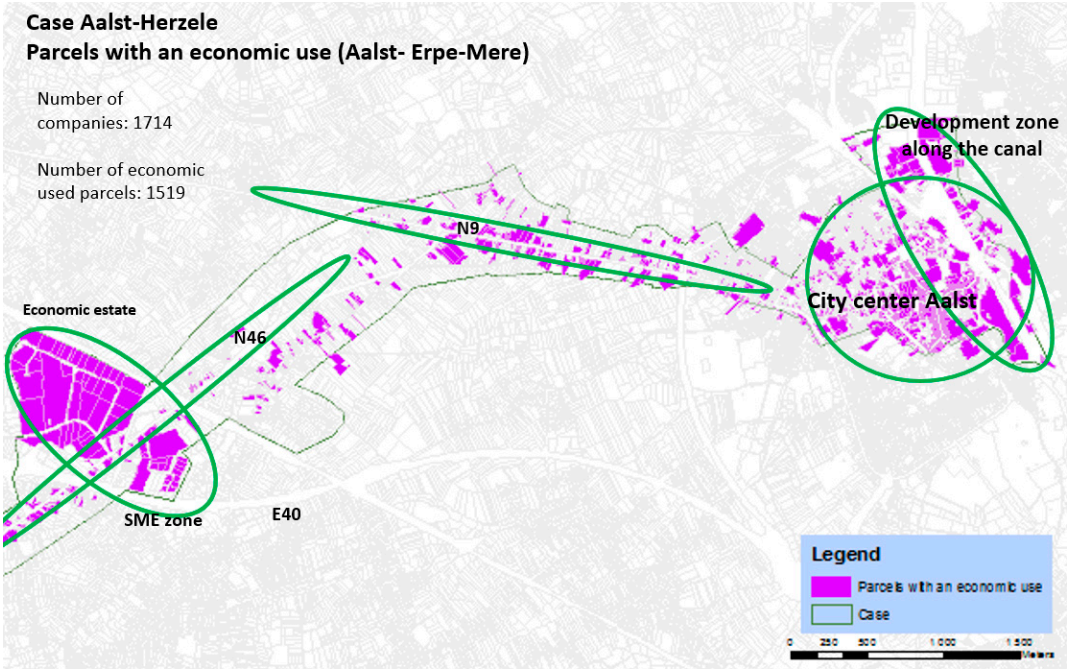

Figure 2. Factual economic use of plots in the Aalst-Herzele case study area.

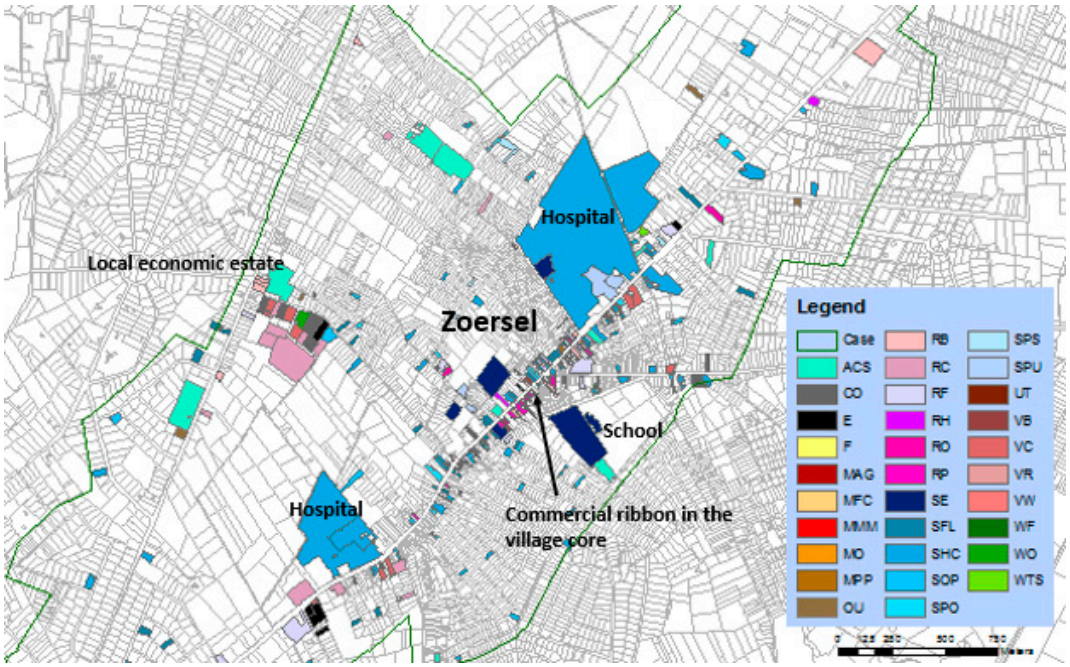

Figure 3. Factual economic use of plots in Zoersel. The activity codes in the legend are: ACS—Arts, culture and sports; CO—Construction; E—Vacant; F—Faith; MAG—Manufacture/agriculture; MFC—Manufacture/food, drinks and catering; MMM—Manufacture/metals and machinery; MO—Other manufacturing; MPP—Printing 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 trick; VR—Vehicle/rail; VW—Vehicle/water; WF—Wholesale/food; WO—Other wholesale; WTS—Transport and storage.

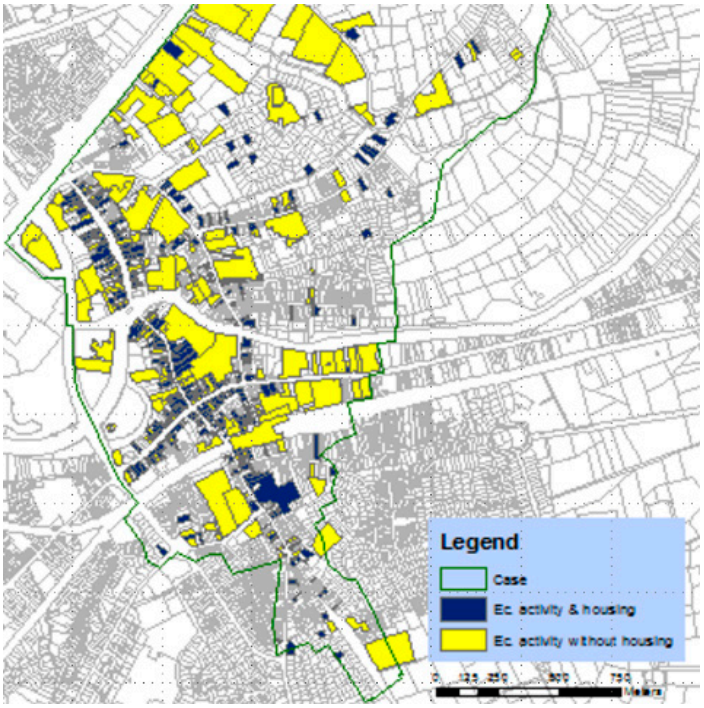

Figure 4. Combination of economic activities with housing (Deinze).

Table 2. Detected parcels with an economic function per location environment.

Location Environments	Number of Parcels with an Economic Function	Average Size (m^2)	Median (m^2)	Standard Deviation
City/urban center	2432	578	196	1707
High street retail/core shopping area	1341	330	181	743
Services along the city belt	680	809	253	2235
Residential areas characterized by scattered services	590	1579	677	3349
Access roads characterized by retail and car-related business	209	2136	1315	2595
Access roads characterized by services, retail and catering	444	1269	380	3246
Village center characterized by retail and services	401	1327	433	12,007
Village center characterized by scattered services	220	1770	836	3223
Open areas	172	7467	4598	8788
Business parks	453	6518	3328	10,220

Table 3. Eight location environments identified (based on field inventory in 5 case study areas).

Location Environments	Most Common Econ. Activities [1]	Combined with Housing	Vacancy Rate	Agglomeration Effects [2]	Size of Parcels
Urban centers	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 (50% of remaining parcels after adjacency)	Small parcels but a large range. Median of approx. 200 m^2
High street retail area (urban commercial centers)	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 (38% remaining parcels)	Smaller parcels. Median of approx. 180 m^2
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 (60% remaining parcels)	In general, larger compared to the urban centers. Median of ca. 250 m^2. 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	±4%	No concentration; adjacent functions (88% remaining parcels)	Large parcels and range. Median of approx. 680 m^2
Access roads [4]					
Access roads characterized by retail and car-related business	Economic activities mainly in retail and catering and car-related businesses	Approx. one third of all parcels with an economic function	±7.5%	Limited (73% remaining parcels)	Large parcels and range. Median of approx. 1315 m^2
Access roads characterized by services, retail and catering	Economic activities mainly in retail and catering and services	Approx. 50% of all parcels with an economic function	±10%	Limited (82% remaining parcels)	Smaller compared to main arterial roads in general. Median of approx. 380 m^2
Smaller centers [5]					
(Village) center characterized by retail and services	Economic activities mainly in retail and catering and services	Approx. 80% of all parcels with an economic function	±6%	Limited concentration of similar economic activities (69% remaining parcels)	Medium sized parcels. Median of approx. 430 m^2
(Village) center characterized by scattered services	Approx. 50% of economic activities in services and 25% in retail and catering	Approx. two thirds of all parcels with an economic function	±4%	Limited (78% of remaining parcels)	Larger parcels and a large range. Median of approx. 830 m^2
Open areas [3]	Mainly agriculture	Approx. 75% of all parcels with an economic function	<1%	n.a.	Very large parcels and a large range. Median of ca. 4600 m^2
Business Parks/economic estates	Wholesale and logistics (ca. 25%), services, production, retail and construction	Approx. 100% of all parcels with an economic function	±8%	Large (but not uniform across milieu, especially for activities in production/manufacturing (75% of remaining parcels)	Very large parcels. Median of approx. 3260 m^2

[1] Broad categorization. [2] Measured in terms of adjacent parcels with the same economic use. [3] Only built-up parcels are inventoried. [4] Not all parcels (874) of the access roads belong to the subdivisions (209 and 444) (see Table 2). [5] Not all parcels (675) of the smaller centers (villages) belong to the subdivisions (401 and 220) (see Table 2).

We try to illustrate how the summary above is elaborated in detail for the different cases by taking at first instance some location environments from the Aalst-Herzele case (see also Figure 2).

A first location environment is the city or urban center which, in line with the expectations, is characterized by a high concentration of mixed retail, (ho) reca (hotel/restaurant/café) and services. Aalst responds to that profile with 57% of the economic parcels used by retail and horeca and 26% by services. Vacant buildings (with former economic use) in the center are quite common as well (13%). A combination of economic activities and a residential function was recorded in 53% of the economically used parcels in this location environment. Even then, specific patterns can be found, such as a combination of a residential function and an economic function, being especially characteristic for the *edges* of the core.

As can be expected, comparable activities are often situated on adjacent parcels, especially retail and reca. Therefore, if one merge parcels from the same broad "economic use" category, less than half (49%) of the parcels are left which indicates a low fragmentation/high concentration of similar economic activities. It is not surprising that this figure drops even more (to 29%) if one takes the core shopping area only (see Table 2). Nevertheless, it is interesting to notice that this concentration is quite different from city to city with, in our research, a range from 41% of parcels left for the larger city of Hasselt (30% for the core shopping area) and 65% of parcels left for the smaller city of Deinze (60% for the core shopping area). The median plot size in Aalst is nearly 170 m^2 which is fairly small compared to other cities in our research. What is clear from our results is, that a city center, as a location milieu, has many different appearances. Of course, the urban center of Aalst shows similarities with other cities such as Hasselt, but important differences can be detected when comparing with Veurne or Deinze which are smaller. In smaller cities, the mix in the city or town center 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. One can detect important differences in locational patterns inside the center and dominance or weakness of particular subcategories within the major activity categories such as "personal services". Patterns are influenced by the population densities and other characteristics of the catchment area around the city or its functional role on a regional level as well.

Around several 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 centers) 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 parcels characterized by similar activities, leaves us with 64% of the former number of parcels 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. Slightly more than 65% of all parcels 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 parcels is 214 m^2. One can conclude that this milieu is fairly consistent across the different cities and towns in our inventory, but differences can be detected. For example, the share of professional services is considerably higher in Hasselt than 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 center the contrary could be found.

The study revealed a type of location environment labelled "residential areas with scattered services" (For this and the following location environments the numbers are calculated on all areas labelled with the specific location environment type regardless the case). 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 centers, in residential neighborhoods along access roads as well as near the center of urbanized and densely populated villages. Among the parcels with economic use, 20% hosts a medical service function and 16% a personal service function; all kinds of services constitute a share of 62% (combined) 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 parcels remaining after adjacent parcels that belong to the same activity category are merged. Further, it is not surprising that 73% of the economically used parcels are combined with housing, while on very few parcels, a combination of several activities could be detected. The median plot size goes up again and attains 677 m^2.

Main access roads (all combined, in general) revealed to be a very specific location environment or milieu 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 compared to other location environments (10% of the economically used parcels). A percentage of 80% remaining parcels after a join of adjacent "same-activity" parcels, is an indicator of diversity while only about half (52%) of the parcels combine economic activities with a residential function. The importance of this kind of location environment (at least in Flanders) on the one hand and its diversity on the other hand, urges the researchers to distinguish two subcategories to which some of the access roads belong to: 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. When comparing the share of economic activities combined with housing, the figure is considerably lower for the former type than for the latter (34% versus 62%) while the median plot size is much bigger (1315 m^2 versus 380 m^2).

Finally, we would like to give some details about village centers. This type of location environment occurs repeatedly in different shapes and formats. Not one activity is very dominant but, of course, services (43% of the economically used parcels) 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 parcels left after 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-categorization into village centers with a prominent presence and concentration of retail and reca (often in combination with the location along an important road) and others with dispersed services.

In this overview, we presented only 5 location milieus in detail. It seems that the remaining (shopping centers, open area with ca. 50% of the economically used parcels 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.

4.2. The Combination of Field Observations with Different Data and Statistics: Gaps and Analysis

As mentioned in the former section, an important goal is to compare the resulting patterns from the field observation with existing statistics. This is done for both the complete inventory as for the different location environments. A GIS overlay was created 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 parcel with economic activity are in line (4206 parcels on 8957 parcels with an address point of firms), we registered a kind of economic activity during the fieldwork but it does not show from the database (1702 parcel from 5908 detected parcels in total) or we have a mapped firm from the database without visual appearance in the field (4751 parcels on 8957 parcels with an address point of firms). 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 (in terms of a detected economic activity). The main question therefore is: why?

Before reflecting at explanations, we present two illustrative maps, one from a city center and one from a residential area, illustrating the discrepancy described above (Figure 5).

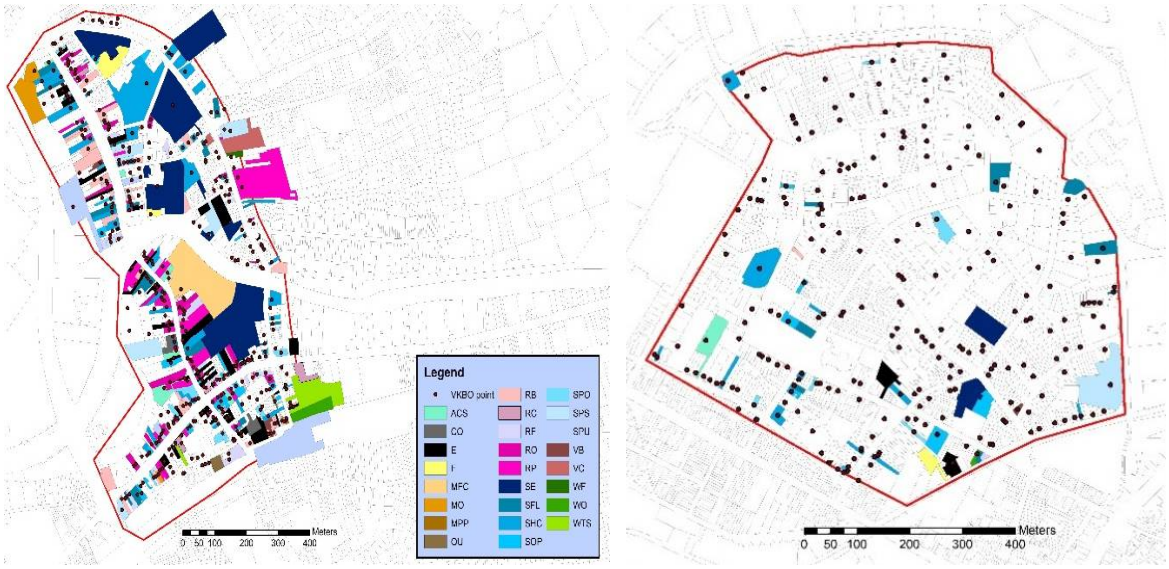

Figure 5. Database address points versus inventory mapping of visual economic activities. (**a**) City center of Deinze; (**b**) Residential area (Hasselt).

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 number of mismatches in residential areas (Figure 5). 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.

We illustrated a poor match between our field observations and the data from existing databases (e.g., VKBO) but this (mis) match is different for the economic environments or milieus distinguished before (see Table 4). When looking into the situation for the location environment "*city centers*" one can conclude that the inventory identified more parcels in economic use, compared to the number of economic parcels one could identify from the database (almost 103%). Consequently, there is a greater convergence between the VKBO and the inventory in terms of parcels (76, 7%) and companies (61, 4%), while the discrepancy between these parcels and companies indicates that the presence of multiple companies on the same parcel is often not visible (In this respect it can be mentioned that the discrepancy between the amount of companies (thus not parcels) in the VKBO and detected on the field is larger in the bigger and more dense cities of Hasselt and Aalst. This indicates that additional companies (e.g., in multistory buildings) are not visible). For "*core shopping centers*", the convergence is even stronger, both in terms of parcels (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. The Locatus database also shows a strong convergence, whereby 91% percent of the economic parcels could be found on the field (based on numbers) (The Locatus database encompass (only) retail activities, horeca activities, vacant s(retail) space and some (personal) services, such as hairdressers, banks, etc. Some of these activities are in different categories in our database. The numbers mentioned are based on a comparison of retail and horeca activities and vacant buildings from our field database to the database of Locatus. As a consequence, the correspondence between Locatus and the field inventory is slightly underestimated). Spatial productivity in city centers 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 centers. This is also in line with the situation in the location environment "*service area at the urban fringe/along the urban belt*".

Table 4. Field inventory and VKBO.

Location Environment/Milieu	% Companies Detected (Numbers)	% Parcels Detected (Numbers)	% Parcels in the Inventory and in VKBO	% Parcel Detected but Not in VKBO
City centers	61%	103%	77%	25%
Core shopping centers	71%	125%	93%	26%
Services along the city belt	61%	94%	68%	28%
Residential areas	21%	26%	17%	35%
Access roads (combined)	50%	78%	55%	29%
Village centers (combined)	56%	81%	58%	28%
Open areas	56%	82%	48%	42%
Economic estates (business parks)	67%	121%	77%	36%
Total	45%	66%	47%	29%

The situation is 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). However, it is surprising that we identified more companies (in numbers) on detected parcels in the inventory than could be expected from the database (102%). The important mismatch is indicating the existence of registered offices with a use of economic space elsewhere or even nowhere (e.g., in the case of transportation) or a "hidden" activity. In any case, this 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 investigating on the characteristics of these companies).

As for the location environment "*access roads*", the convergence between the VKBO and inventory in terms of parcels (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 economic parcels during the field observation and which were not found in the database, is relatively high (29%). Furthermore, on parcels with economic activities registered in the database, a discrepancy in the amount of companies could be noticed. The usefulness of the VKBO database for this milieu, is therefore rather limited or at least not clear-cut. One could suppose that the situation might be less complex in "*village centers*" 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 parcels (58%) and in terms of companies (56%). Besides, it is striking that in the sub-type with spread services, the mismatch in terms of parcels 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%).

Regarding the "*open area*", the convergence between the VKBO and inventory, both in terms of parcels (47.9%) and in terms of companies (55%) is rather weak as well. If we just consider the number of parcels which should indicate an economic activity (according to the VKBO), 82% were detected in the field. In reverse a high number of parcels in economic use detected on the field could not be identified in the database (41.8%). This is partly due to the difference between use parcels and cadastral parcels meaning that entrepreneurs (e.g., farmers) develop several activities (at apparently different parcels) that cannot be identified from the VKBO (XY coordinates based on address). Ultimately, for the location environment "*economic estates*", the detected parcels with an economic use represent 120% (in numbers) compared to the number of parcels in the VKBO. Nevertheless, only 47% of the parcels in the VKBO are matched with an observed activity on the field. In reality, many of the larger companies use several parcels, especially if they carry out more than 1 activity (e.g., production, office and warehouse) (36% of parcels inventoried have no economic activity according to the VKBO).

In short, especially a high match between a plot 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 4.

From Table 4, it is clear that the VKBO database, although very important and one of the main sources for data on Flemish companies, is very variable according to the location environment at stake and therefore one should be very careful using it for mapping the location patterns of the companies, for detecting location environments as well as for calculating space productivity.

5. Discussion and Conclusions

Let us 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 Flemish firms are 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 that go beyond policy for economic development or space for economy only. 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 a 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 prove 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 consider that interweaving is not limited to a particular scale. One can distinguish at least five levels from a multifunctional use on a 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. This research proves very clearly that one of the main statistical resources, the VKBO database, is not always suitable to identify location patterns/environments on their own. This does not mean that data from administrative databases are useless, on the contrary. They enrich field inventories within a system of mutual linking, bringing together different realities. It is important to have an insight in the specific logic of databases, knowing that a discrepancy with the field is possible and even plausible in some economic milieus. One should also take into mind that a field inventory system is not always possible on a large scale due to for example time constraints. Therefore, their ability to detect different economic environments for policy reasons or to enrich field data, is highly variable.

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. In some particular situations (location environments) remote sensing, crowd sourcing, and web data extraction might be appropriate levers to create additional policy-supporting data.

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 complementary understanding of use of space for economic activities and the tremendous complexities policy

makers are confronted with, while creating awareness and a critical attitude towards traditional (data) instruments. 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 functions, in which field observation gains a more prominent role.

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