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THE SPANISH CADASTRE: OFFICE LOCATION, MORPHOLOGIES AND DYNAMICS IN METROPOLITAN MADRID

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ABSTRACT

As service activities have been gaining ground in the urban space and economy, the service sector has become an extremely attractive area of study, offices in particular, as they are the natural location for such activities. This paper firstly discusses and classifies the various sources of information used in the existing literature to study the metropolitan and urban identification and location of offices. Secondly, the paper adds the Spanish Cadastre as an alternative source of information because of its recent conversion to digital format, and applies it to the offices of the Madrilenian Urban Region.

Key words: Cadastre, land registry, office buildings, location, morphology, dynamics.

RESUMEN

Conforme las actividades terciarias han ido ganando terreno en la economía y el espacio urbano, el sector servicios se ha convertido en un objeto de estudio extremadamente atractivo, especialmente las oficinas, ya que son la localización natural para dichas actividades. Este artículo discute y clasifica las diferentes fuentes de información utilizadas en la literatura para estudiar la identificación y localización urbana y metropolitana de oficinas. El artículo

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añade el Catastro Español como una fuente alternativa debido a su reciente conversión a formato digital, y lo aplica al caso de las oficinas de la Región Urbana Madrileña.

Palabras clave: Catastro, registro de la propiedad, edificios de oficinas, localización, morfología, dinámicas.

I. INTRODUCTION

Urban structures change with time, although this change has occurred at a faster rate in recent decades. Population, activities, employment, or buildings appear, increase or decrease, divide or merge, and change spatial locations according to different factors at varying interrelated scales. Recent metropolitan processes are characterized by the volatility of capital, thus, cities and broader urban areas have become interchangeable entities that are forced to compete with each other (Gospodini, 2002; Halbert and Pain, 2010). This is due because of an extension to farther distances in terms of the intense interspatial relations specific to metropolitan areas (Sassen, 2001), because of the change from monocentric to polycentric metropolitan urban regions (Hall and Pain, 2006; Solís and Troitiño, 2012), and because of the increasing importance and the restructuring of service activities (Castells, 1996; De Magalhães, 1999).

As a result, present urban economies are extremely tertiary in developed countries, since industry and manufacturing have been given way to services since the second half of the 20th century, especially since the 1980s. Studying tertiary activities in the form of offices reveals a crucial source of information for understanding the economic and spatial transformation of cities. In some sense, these activities may also highlight and reveal real metropolitan structures that exist above official ones (i.e. functional urban areas; Garmendia et al., 2012).

As the service sector has been gaining ground both in the urban economy and in the urban space, its study has become attractive. Although the majority of studies have focused on the office service activities themselves, this paper focuses on the locations, morphologies, and dynamics of office spaces and articulates the problem of how to locate them. This paper proposes the use of an ancient but still underused source of information for the analysis of large, medium and small offices throughout the urban milieu: the cadastre and/or land registry.

The aim of this paper is twofold. The first objective is to collocate the existing literature on metropolitan and urban offices location and dynamics analysis procedures. The second objective is to demonstrate how these analyses can be conducted using digitalized data from the cadastre, which has been (re)discovered as a tool for obtaining the urban location of the different land uses. The Spanish cadastre data, «freely» accessible on the Internet, can be downloaded and implemented using a GIS program, resulting in a more efficient manner of conducting (office) land use analysis. In doing so, an image of metropolitan office real estate is constructed depicting the distribution of these buildings in relation to other city buildings (residential, commercial, industrial, etc.).

II. THE OFFICE BUILDING IN A METROPOLITAN CONTEXT

The office sector, once considered a uniform sector, has been progressively subdivided into sub-sectors, each typified by different activity characteristics, location requirements,

and building preferences. Unlike manufacturing or agricultural activities, advanced producer or high-order services, especially the Head Offices (HOs) for these service firms, are characterized by the use and generation of immaterial information and/or (tacit or codified) knowledge, which is the «raw material» used to conduct business, either internally (from the HO to the final step in the production line) or externally (generally, from HOs to other firms' HOs). Thus, office activities may be designated as those using the most and the highest quality of immaterial activity[1]. The most advanced offices are called primary offices (Sui and Wheeler, 1993), front offices (Coffey and Shearmur, 2002; Shearmur and Alvergne, 2002), head offices (Jakobsen and Onsager, 2005; Aeslen and Jakobsen, 2007) or headquarters (Rocco, 2008; Ozus, 2009). The more trivial offices are called nonprimary (Sui and Wheeler, 1993) or back offices (Coffey and Shearmur, 2002; Shearmur and Alvergne, 2002).

The office building, conceived in London in the 18th century as exchange houses, has remained concentrated in the downtown because of its needs of centrality. However, from the 1980s, because of IT and communications generalization, there has been a view that holds that because of technology urban functions can be located independently of space in an endless, uniform spatial diffusion (Hall, 2003), a process which some have called of «deterritorialization» (Marc Augé's *non-places* theory, 1995). The displacement of firms from the centre has established the current labour organization, the firm model of recent decades, the structuring of present urban spaces, and the organization of general economic processes.

Nevertheless, experience has demonstrated that metropolitan office location does not occur with this uniform, diffused pattern. Conversely, different parts of the office sector are located in different precise metropolitan areas, thus producing new socio-economic spatial segregation. In this sense, «the cluster of office buildings creates real management centres that act as poles of attraction of the remainder office real estate market, which attempts to be as close as possible to this cluster» (Gamir, 1986: 456), while in parallel, high densities and congestion may trigger outward business (re)location (Lang et al., 2006).

Present real estate market distribution may be explained in terms of either different *spatial locations* or different *structural locations* (Stevenson, 2007). Spatial fragmentation is related to the concept of «zoning» or the horizontal distribution of land uses. In this sense, there are firms that prefer or are able to locate centrally, in or near the Central Business District (CBD), whereas others prefer or may find it appropriate to locate on the periphery or at high accessibility places. Structural fragmentation is connected with vertical or hierarchical distribution: some firms prefer to locate their HOs in the CBD or in special urban areas, whereas their manufacturing or more trivial services and activities are located in the periphery. This practice produces an extremely complex metropolitan distribution of economic activities.

Many scholars have attempted to explain how and where urban activities locate. Von Thünen, Weber, Christaller, and Alonso focused on similarities regarding the distribution of land uses to cement their theories. Spatial proximity, accessibility, or land price influence the distribution of activities throughout the territory. Office location behaviour is conditioned

1 Marmolejo and Roca (2008) explain that «immaterial activities» could be classified into three categories: (1) those related to strategy, management and guidance of the process; they are the most qualified and require a very high proportion of tacit knowledge; (2) those related to planning, co-ordination and development; (3) and those related to supervising, direct execution and policy.

by four groups of factors: (1) the general *accessibility* of different spatial scales: urban, metropolitan and interurban (Rocco and van Nes, 2005); (2) inter and intra-office contacts requiring communication and hence *agglomeration* (Sui and Wheler, 1993; Jakobsen and Onsager, 2005; Simmie, 2002; Aeslen and Jakobsen, 2007); (3) building surface availability and *land price*; and (4) the *social perception* of each urban area (quality of life; community services; and the natural, cultural and entrepreneurial milieu), as offices attempt to locate in urban areas considered to be of high quality, image, and visibility (Marmolejo and Roca, 2008; Rocco and van Nes, 2005). It is also important to consider (5) *policies or legislation* (i.e. zoning) enacted by governments to redirect office growth (Bailly and Fernie, 1980). As Rocco (2008) affirms, «the State continues to play a central role in the promotion of projects conceived to house the top managerial activities or command functions» (i.e. La Défense in Paris or the London Docklands). In the same sense, *municipal attitude* «affects willingness to engage in development» (Charney, 2007: 1188).

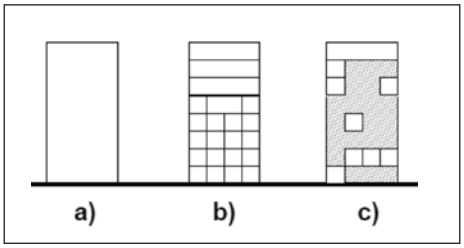
Different office activities tend to have different metropolitan or urban locations. The lower the activity's leadership degree, the more routine tasks an office requires, and the more decentralized and/or the farther from the traditional city centre are located. Jakobsen and Onsager (2005) refer to HOs as being primarily inherent (but not exclusive) to large companies and to the top management level of organizations, which generally tend to locate in urban or metropolitan areas where they can easily find contacts with other HOs or firms of a similar organizational level and with a specialized labour force. Therefore, more office space can be found in metropolitan areas than in other intermediate or small cities. In the US, the greatest quantities of HOs and/or primary offices space are concentrated in the largest metropolitan areas (Sui and Wheeler, 1993: 35) and are generally found in well-established downtowns or inner-city locations, whereas back offices are more likely to be located on the city fringe or in suburban locations (Charney, 2007: 1180-81).

Primary metropolitan locations of producer services could be reduced to three types of areas (Bailly and Fernie, 1980; Sassen, 2001; Garmendia et al., 2012): (1) the metropolitan centre, through a process of renewal and rehabilitation of (historic/traditional) sites already constructed[2] because the central city is still paramount for some companies as a tertiary and commercial centrality (Mignot, 1999; Coffey and Shearmur, 2002); (2) districts specifically developed to house tertiary activities strategically located next to existing activities but not in a city's historical centre, thus allowing for benefits from proximity to similar companies or a specialized labour force, and extending the existing CBD centrality (i.e. Canary Wharf in London, La Défense in Paris, Postdamer Platz in Berlin, or AZCA in Madrid); and finally, (3) peripheral areas that are not exceedingly far from the city centre, sometimes for very large companies or HOs that attract other related companies or vice versa, and other times, special metropolitan sub-centres or office parks because of their attractive business premises, which other towns closer to a metropolitan area do not possess. This paper contributes to a fourth type of producer services location, consisting of (4) routine offices which, to a greater or a lesser extent, locate in every residential or industrial space.

2 In the near future, «due to the age distribution of the building stock and resulting refurbishment needs», downtown habitat demand will rest primarily upon «maintenance, refurbishment and adaptation of the building stock» (Kohler and Hassler, 2002: 234).

Concerning the urban morphology, offices may locate in buildings designed specifically for a particular activity, which is characterized by relevant recognition as the firm symbol or as the city icon and is relatively easy to distinguish. Large firms normally use this type of building, produced for office purposes (Santander Bank HO in Madrid, HSBC or BP HO in London, or SNCF HO in Paris; *Fig. 1.a*). Thus, studying the location of large office firms and buildings is relatively easy. In the same sense, several small firms may use a single building specifically designed for office purposes, which one may believe is the location of only one large office firm (i.e. office buildings in business parks; *Fig. 1.b*).

Figure 1
OFFICES URBAN MORPHOLOGIES WITHIN BUILDINGS



Source: Own elaboration.

Conversely, many small and medium firms may locate in buildings with mixed uses and are thus more difficult to locate because their buildings are not easily distinguishable. From an urban point of view, these small offices may not have high relevance; this is the case when a few offices are scattered within residential, commercial, or industrial areas (*Fig. 1.c*). In the case of dense cities, such as traditional southern European cities, it is very common for parts of pre-21th century urban areas to host a mix of residential and office activities. In these cases, the ability to recognize the percentage of mixed use is very relevant. Although an area may be «officially» recognized as residential, it may actually be an office area containing many small offices within apartment buildings. Other intermediate cases include the location of large office firms in several close and mixed-use buildings (i.e. firms that were small at their origin and progressively located in different close buildings when expanding) or their location in parts of buildings not necessarily designed for them (i.e. the small office of an industrial storage or distribution firm, or offices in shopping centres), which may indicate that they are difficult to recognize.

This paper contributes to this third type of urban morphology and enhances the methodologies and the analysis of metropolitan office buildings, allowing for a new analysis of offices in mixed-use buildings (*Fig. 1.c*) in consolidated urban areas, which has attracted very little attention so far.

III. OFFICE LOCATION, MORPHOLOGIES AND DYNAMICS: SOURCES OF INFORMATION AND METHODOLOGIES OF ANALYSIS

As previously mentioned, the metropolitan distribution of office activity should consider three groups of aspects: first, the urban characteristics of offices, including general

accessibility, land price, building availability, the location of each population stratum and community services, and social perception; second, the complexity of the office sector, considering each of its subsectors, their size, and structure; and third, the characteristics of the office areas, including location (agglomeration vs. diffusion), surfaces, and office morphology. The first and second groups of aspects are common to most urban studies so this paper will not address them. This section focuses on the latter, that is, the different sources of information and methods recorded in the literature for studying the metropolitan and urban identification and location of office activity.

The methodologies used to identify and locate office activity in cities can be classified into two groups (*Table 1*): those that place emphasis on activity type and size (sector, employment, production, etc.) and those that place it on building characteristics (surface, price, etc.). The first group comprises three sources of information: locating the office's labour force or employment, locating the HO of the largest companies or firms, and using sources that address local taxes on office activities. Two methods comprise the second group: locating service firms registered on lists or guides to office space for rent/sale or with real estate companies, and identifying property developers' location patterns. Once located, some scholars have also conducted postal or telephone surveys of (head) offices.

Table 1
METHODOLOGIES AND SOURCES FOR OFFICE ACTIVITY/BUILDING LOCATION

FOCUS	***METHOD***	***SOURCE***
Activity type and size	1. Office labour force	Censuses
	2. HO of the largest companies	Chambers of Commerce
	3. Local activity taxes	Governments
Building characteristics	4. Office rents/prices inquiries	Lists or guides on office space
	5. Preferences of property developers	Office property developers
	6. Postal or telephone surveys to HOs	*Researcher surveys*

Source: Own elaboration.

The most used methodology in the literature is **locating offices' employees**, which can be accomplished in two ways: either by locating where they live or by locating where they work. The former is almost always accomplished through the use of census data, which are normally fully accessible and are useful for studying the specialization of population in particular cities or municipalities. The latter is primarily accomplished through the use of firms' employment data, which are normally not accessible, but governments provide it to scholars upon request. Both are catalogued using internationally accepted business classifications, such as the Statistical Classification of Economic Activities in the European Community (NACE) or the North American Industry Classification System (NAICS) (Sassen, 2001; Muller and Doloreux, 2009).

Employment data from different years are commonly compared so that spatial dynamics of office activity can be analysed (Coffey and Shearmur, 2002; Marmolejo and Roca, 2008).

Nevertheless, employment data may be assigned to one office location (usually the HO) if firms have several offices, or may not be assigned precisely to each employee's location, thus introducing inaccuracies to the analysis. Another shortcoming of these data may originate from the inadequate assignment of certain employees to particular working categories; e.g., a manufacturing activity that employs a small percentage of persons for office activities may assign all individuals to manufacturing. Employment data, both in terms of where employees live and where they work, are normally provided up to the municipal level (or, at most, by district/ward); thus, these two sources of information can be used for regional analysis, whereas detailed intra-urban analysis is rarely possible with their use.

A second method commonly used to obtain the urban distribution of offices is the **location of firms' HOs or large offices**[3]. Lists of firms and their addresses do exist, but this information is not freely accessible. Business associations, such as chambers of commerce and entrepreneurs associations, do own this type of information and normally provide it to scholars on demand. These registers are a very useful indirect source of information to use in locating and analysing the urban or metropolitan distribution and dynamics of service activities and HOs, especially those most advanced in IT, management or innovation. Nevertheless, classifications of firms are often conducted according to the specific criteria of each association and, thus, these classifications may differ. Often, these listings include only larger office businesses. Chambers of commerce also possess precise information on firms' size (employees, production, etc.).

A third type of data used to locate firms, which also offers a sense of firms' size, can be obtained using the **business activity tax**, which is paid annually in each city or municipality by each economic activity. This tax exists in most countries (Fouquet, 2004:34): Impuesto de Actividades Económicas in Spain, Taxe Professionnelle in France, Gewerbesteuer in Germany, Imposta Regionale sulle Attività Produttive in Italy, Enterprise Tax in Japan, or Corporate Tax in the U.S. This source of information is not public, but researchers are normally able to obtain it by request, and it is quite accurate because it is elaborated for taxing purposes. However, in each case data have to be analysed thoroughly because of possible different nature (i.e. local or regional), composition, and degrees of accessibility. Data are classified under similar NACE/NAICS activity types and usually generate a census of municipal economic activities. The tax is calculated in accordance with the number of employees, the use of energy, the building surface, and location (i.e. more or less important streets). In the Spanish case, its interest is limited for two reasons: first, many individual activities (a factory, a shop, a workshop, or an office) are registered under several classes to cover the variety of products or services they provide (i.e. selling different types of goods) and, thus, it is difficult to determine if one complex activity or several activities are conducted at each location; second, since 2003, economic activities established on a personal basis

3 Some (thematic) listing examples that allow the location of firms are the telephone directory for Business service firms in Moscow (Gritsai, 1997); a ranking of the largest firms or HOs in the city/country, such as *Kapital and Norges største bedrifter [The Largest Firms in Norway]* (Jakobsen and Onsager, 2005; Aslesen and Jakobsen, 2007); a list of firms studied in a particular study, such as the *GaWC, the Globalisation and World Cities Study Group and Network* (Loughborough University, UK) (Rocco and van Nes, 2005); or even a list of firms that have won an innovation award, such as the *Department of Trade and Industry's SMART/SPUR* and the *Design Council's Millennium Product awards* in the UK (Simmie, 2002).

without a legal company, and companies with under €1 million annual cash flow do not pay this tax and, since that time, most small activities have not been covered by this source of information (Alonso, 2001).

The second group of sources of information on office building characteristics (size, price, etc.) depends primarily on the availability of lists of (office) firms within the area of study. The first methodology is used to locate companies already registered on **lists or guides of existing office space**, such as *Black's Guide to Office Leasing*, a directory of office space published by a company based in Gaithersburg, Maryland (Lang, 2000; 2003; 2006), or in *office sales and rental companies* because they possess indirect information on the distribution of this type of urban economic space. By locating the postal addresses of general office spaces for rent or for sale, their location and distribution in the urban space can be obtained. This method is also profusely utilized to study rental or sale prices of office spaces, which are used in a different manner but easier to obtain than transaction office rents. In this manner, some have used rent or sale prices to distinguish the most expensive or the cheapest neighbourhoods (Colwell et al., 1998), or even to analyse the factors that influence prices (Ozus, 2009)[4]. Whatever the source employed, the aim is to identify and to locate the areas where office space in rent/sale is located and, hence where, in general, offices are located in the territory. The inconvenience of using this method is that it provides only a sample of existing office space. Furthermore, the method allows for discussion not of the types of activities housed in these office spaces (HO, advanced, trivial, innovation, etc.) but simply of the office price, surface area, and location availability.

The second method relies on the urban development process. Charney (2007) **identifies office property developers** in Greater Toronto to ascertain where they decide to build and hence, where office real estate is or will be located. In his research, Charney employed newspaper articles and corporate annual reports from 1969 to 2003 to identify developers and their specific office buildings. This method relies on the massive searching of newspapers for news of new office buildings in the city, which entails not finding each and every office building. However, it is a very innovative method of searching for specific office buildings, not including small office buildings or small offices inside residential buildings.

Finally, most of the five above-mentioned methods allow **surveys** (by mail, by telephone, interview, etc.) to be undertaken with a particular group of firms from those sources. Apart from locating the firm and understanding the firm's location patterns, it is also interesting to be aware of the firm's location factors, some other detailed information, or the firm's economic relations with both its clients and suppliers, that is, to be aware of the quantity and the quality of information exchanges and their extent (urban, metropolitan, national, or international). Some examples are Simmie (2002), Jakobsen and Onsager (2005), or Aeslen and Jakobsen (2007), which deepen their companies' registers by conducting «intensive case studies» or qualitative interviews.

4 In Spain, Gamir (1986) resorted to a survey of private offices in 1982, a modern office building census conducted by a real estate private company in 1982, two economic magazines' list of the HOs of large companies in the country from 1984, and building license requests from Madrid City Hall between 1975 and 1981.

IV. OTHER ALTERNATIVE SOURCES FOR STUDYING OFFICES IN SPAIN. THE CADASTRE

As observed in the previous section, every location method has some type of shortcoming, primarily because they are not major sources developed specifically for the location of offices, so one must resort to secondary sources of information and choose the one that best fulfils the study's primary objectives. In fact, when locating office firms or office employments there is a risk of not locating every one because of their high degree of spatial change, creation or disappearance. However, when locating the premises devoted to office use, the exact location of office activity within the region or the city is known, independently of the type of office activity (management, administration, insurance, etc.), the office firm, and the amount of employment it offers.

This paper aims to find a source to locate not only HOs or office buildings but also offices in mixed-use buildings, that is, the totality of office space in large metropolitan regions (i.e. Madrid and some neighbouring functional metropolitan municipalities). Therefore, other possible sources of information were resorted to map or to locate urban areas with specific land uses (i.e. offices).

4.1. Alternative sources of information

The ***Spanish Premises Census*** was conducted in 2001 in parallel with the Population Census. The Spanish Premises Census offers only a snapshot for the corresponding year of all of the premises (active or inactive), according to their use[5] and at the municipal, district or section levels. However, this source is especially biased toward housing premises and is thus very useful for residential analysis (size, ownership, equipment, etc.) but not for mapping office areas or dynamics.

The potential of ***cartography, aerial photographs, and land use maps***, such as the European Corine Land Cover (CLC), is to retrieve numerical and geographical data at a particular scale, from which land use maps can be obtained. From a scale point of view, this source may be useful for regional analysis but inadequate for more detailed urban analysis. From a land-use point of view, the CLC does not allow for the identification of office areas because it only separates «Industrial or Commercial» use. Likewise, official 1:50.000 and 1:25.000 maps do not separate office land use. Font et al. (2005) have used 1:60.000-scale aerial photographs to measure transformations in metropolitan Barcelona regarding land occupation, land use zonings, land uses, dispersed occupation and urban facilities.

Municipal building permits have been used profusely to produce land use maps for certain small urban areas. For instance, Lopez de Lucio (1999) has used them to map major office buildings in particular areas of the Madrid municipality (*Fig. 5.b*), and Garmendia et al. (2008) used them to determine the residential building rhythm in neighbourhoods surrounding a high-speed rail station. This source of information is reliable only for major office use buildings and is not reliable for offices located in mixed-use buildings because the entire building is often processed as residential. This source of information is not public,

5 *Use of premises*: Health, Educational, Social welfare, Cultural or sports facilities, Commercial, Office, Industrial, and Agrarian premises.

but researchers may able to obtain it by request to the municipal department of urban planning. Using this type of information is also very time-consuming because municipal information on building permits is not organized for this purpose and requires important manual manipulation for the re-organization of data.

A similar source of information is the ***building technical certificate***, recorded by regional architects' associations, which have the information at the level of the municipality. Again, the information is not public and has to be requested. It has been used by the authors of this paper to record the office surface developed in the Madrid metropolitan region municipalities. Nevertheless, the inconsistencies of this source of information (i.e. some of the major office buildings were not included, some of the records were badly registered, and others did not correspond with reality) led to a search for a more reliable source of information.

Finally, the ***cadastre*** has been used to understand the evolution of urban land properties and ownership, and their influence on urban morphology; and even to analyse the property concentration and the complexity of the urban land registry (Pillet, 2012). The traditional urban cadastral maps and alphanumeric information have been major sources for detailed studies of urban transformations (Capel, 1975; Sobral, 1994; Más, 2005; Temes, 2008). This is the source considered to fit the best our target of locating every single office space.

4.2. The Spanish Cadastre

In most European countries, the cadastre collects every real estate property, either urban or rural, including horizontal properties (several property owners in one building), and differentiates the current use of each property for tax purposes. In general, this information is accessed by request to the corresponding agency or ministry but sometimes data can be accessed online.

The most recent evolution of European cadastres has occurred not in relation to the information they contain but rather to their use and purpose. Actually, there is a clear relation between the Land Registry (for legal purposes) and the Cadastre (for tax purposes) and, in some European countries, such as France, Italy and the Netherlands, they constitute one sole institution (Pillet, 2008). In the first case, the cadastral map and general information can be directly consulted online (www.cadastre.gouv.fr), whereas in the second case, only personal data can be retrieved online (www.agenziaterritorio.it). In the Netherlands, the cadastre was transferred from the Ministry of Finance to an independent agency supervised by the Ministry of Housing, Spatial Planning and Environment (MEH, 1990; www.kadaster.nl). In the UK, there is no cadastre but the land registry records the ownership of land and property, and is only open to the property owner (www.landregistry.gov.uk). In other cases, both institutions are independent, either sharing the same database (e.g., Austria, Finland and Switzerland) or being formally connected (i.e. Germany, Denmark and Spain) (Pillet, 2012). In fact, although there is no unique European cadastre, the European Union has created a Permanent Committee on Cadastre (www.eurocadastre.org) to coordinate the individual national cadastres and their use.

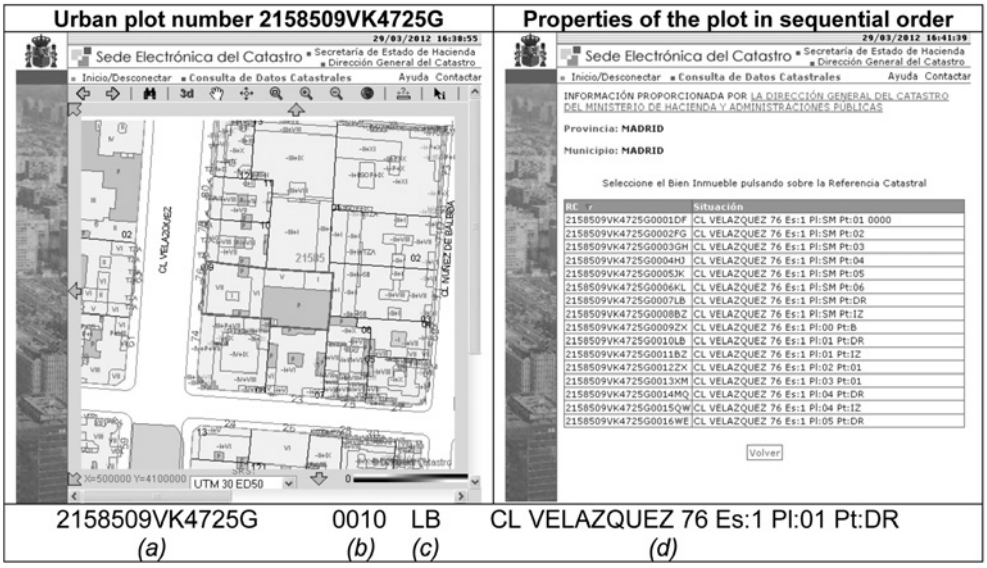
In addition to its tax purpose, Spanish Cadastral law 48/2002 stated that «cadastral information will be available to public policies and citizens who require information about the territory». Therefore, in 2004 the Spanish Ministry of Finances and Public Administration

introduced the **Spanish Cadastral Electronic Site** (www.sedecatastro.gob.es), a spatial information infrastructure which offers the possibility of consulting and downloading the cadastral data from each municipality[6]. This source of information allows for not only the location of offices by municipality but also the achievement of this location at the most detailed level: the urban plot. In addition, properties can be located (at the municipal or the urban level) and divided into periods of construction, surface, and use. Because the purpose of the cadastre is to tax land and building properties (normally being part of the Treasury Ministry) based on their location, surface, value and use, these items are normally updated. However, the property value is excluded from public information, preventing us from demarcating expensive or cheap urban areas, for instance.

The Spanish Cadastral Electronic Site offers the following information:

- **For each plot** of urban land (*Fig. 2*) it indicates the plot number (*a*), the sequential number of each of the properties on the plot (*b*), and two control characters (*c*). The site also indicates the plot's precise location in terms of province/municipality, street and number, thus facilitating the automatic production of thematic maps. When a plot contains a building with several properties, the site lists each of them and indicates their precise location on the building (*d*): stair (Es), floor (Pl) and door (Pt).

Figure 2
PROPERTIES ON ONE PLOT WITH HORIZONTAL PROPERTIES (GRAPHIC AND DATA)



Source: Cadastral Electronic Site 2010.

6 It does not include the owner and tax information, which are kept secret.

- **For each property** in each plot/building (*Fig. 3*), three groups of data are indicated: (1) the *property data* show the cadastral reference number, the location (including the location in the building), the type (urban or rural), the surface, its percentage of the entire building, the use, and the year the property was built; (2) the *plot data* (where the property integrates) show the location, the total developed area, the total land surface, and the type of plot[7]; (3) the *built elements of the property data* show the use and the location in the building and surface.

Figure 3
CHARACTERISTICS OF ONE PROPERTY (OFFICE) ON THE PLOT

1)

Datos del Bien Inmueble	
Referencia catastral	2158509VK4725G0010LB Obtener etiqueta Copiar referencia al portapapeles
Localización	CL VELAZQUEZ 76 Es:1 Pl:01 Pt:DR 28001 MADRID (MADRID)
Clase	Urbano
Superficie (**)	313 m^2
Coeficiente de participación	8,490000 %
Uso	Oficinas
Año construcción local principal	1920

2)

Datos de la Finca en la que se integra el Bien Inmueble	
Localización	CL VELAZQUEZ 76 MADRID (MADRID)
Superficie construida	3.601 m^2
Superficie suelo	1.104 m^2
Tipo Finca	Parcela con varios inmuebles (division horizontal)

3)

Elementos Construidos del Bien Inmueble					
	Uso	Escalera	Planta	Puerta	Superficie catastral (m^2)
	OFICINA	1	01	DR	285
	ELEMENTOS COMUNES				28

Source: Cadastral Electronic Site 2010.

What renders this source of information especially interesting for research purposes is the possibility of freely[8] downloading alphanumeric data and vector cartography from the online website, which can be processed and implemented using a GIS program. After proper identification in the website, the alphanumeric data can be downloaded in a spreadsheet format, through which the property register can be modified. Firstly, the property use «office» can be pre-selected among all the possible uses[9], as well as the fields of interest (year of construction, property surface, and plot surface, in our particular case). Then, the alphanumeric data can be connected to the cartography using the common cadastral reference number[10], either to the local level, by summing up data for each municipality, or to the plot or block level, by joining the plot and property numbers in both the database and the cartography. In this manner, plenty of cadastral information can be easily accessed and transformed into maps, using and combining all these different variables (*Table 2*).

7 Plots can sometimes be subdivided horizontally, with different properties on the plot, which constitutes «horizontal property».

8 It is first necessary to obtain an «Identity Certificate of a Natural Person» at the Directorate General for Cadastre.

9 The different uses are as follows: Storage/Parking; Residential; Industrial; Offices; Commercial; Sports; Entertainment; Leisure and Hotel; Health and Welfare; Cultural; Religious; Urbanization works, Landscaping and Undeveloped land; Singular building; Agricultural storage, Agricultural activities.

10 A Geographic Information System (ArcGIS) has been used to accomplish this task.

Table 2
VARIABLES AND ANALYSES RELATED TO LOCATION, MORPHOLOGY AND DYNAMICS

	VARIABLES	***ANALYSES***
Location	SURFACE (m^2): Total built space & Total office space	Total built up area in a municipality, a street, or a block Average office space by inhabitant and by year, or by employees working in a particular sector Plots with buildings dedicated exclusively to office use Distribution of offices in comparison with the price of land or the price of offices by district
Morphology	PROPERTIES: Total number of properties & Number of properties dedicated to offices	Total property area committed to a certain land use (i.e. office), number of office properties and average office space Small, medium, or large offices Single-firm or multi-firm office buildings Municipalities or areas with the largest/smallest quantities of larger/smaller offices Plots with office buildings with more than a certain amount of surface
Dynamics	YEAR the property was built	Year/period when the current office properties were built Periods of time in which more/less offices were built

Source: Own elaboration.

However, some shortcomings are derived from the use of this source of information. The most important shortcoming is that it only provides the present situation; it provides information on properties that are now offices and when they were built, but the length of time for which they have been used as offices is unknown. The building could be a historical one that was transformed at the end of the 20th century into the HO of an important bank, for instance. Moreover, for detailed historical studies of a plot or a block, it might be more useful to rely on municipal building permits or on the Land Registry (García, 2005). Additionally, the cadastral land and building tax values (price) differ from real market values and does not appear alongside public information.

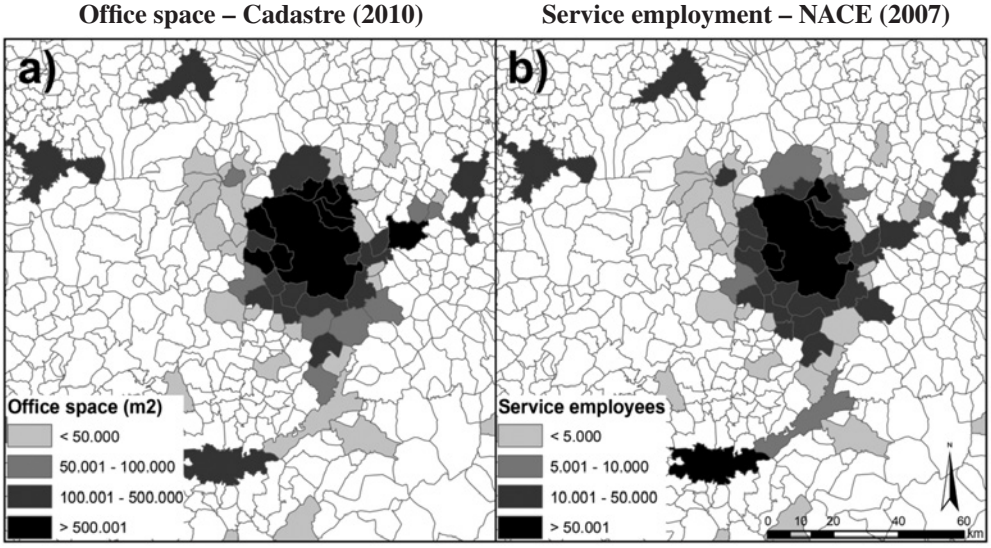
V. USING THE CADASTRE: LOCATION, MORPHOLOGIES AND DYNAMICS OF OFFICES IN MADRID

This section aims to answer the questions posed throughout the paper and to demonstrate the potential of the Spanish Cadastre as a source for analysing real estate uses. To accomplish this, a bi-scalar (regional and local) and tri-thematic approaches (location, morphology and dynamics) were developed.

As mentioned before, a **regional analysis** is achieved by grouping the office property records and variables by municipality. This method reveals a concentration of office space in Madrid, its adjacent municipalities, and the remote provincial capital cities (*Fig. 4.a*). When comparing this cadastral data to the total municipal service employment data derived from the Social Security affiliation (*Fig. 4.b*), one uncovers general coincidences and a few differences.

In general, the municipalities with higher service employment coincide with those with higher office surface. Nevertheless, certain municipalities surrounding Madrid present slightly different groupings. It appears as if service employment remains concentrated in Madrid, whereas office surface is more extensive in neighbouring municipalities. This result also indicates that the average office surface per service employee is lower in Madrid than in neighbouring municipalities.

Figure 4
MUNICIPAL OFFICE SPACE AND SERVICE EMPLOYEE DATA ON THE MADRID REGIONAL SCALE



*Only municipalities with more than 10,000 inhabitants in 2010 and located within a radius of 100 km from the municipality of Madrid.
Source: Cadastral Electronic Site 2010 and Social Security 2007; own elaboration

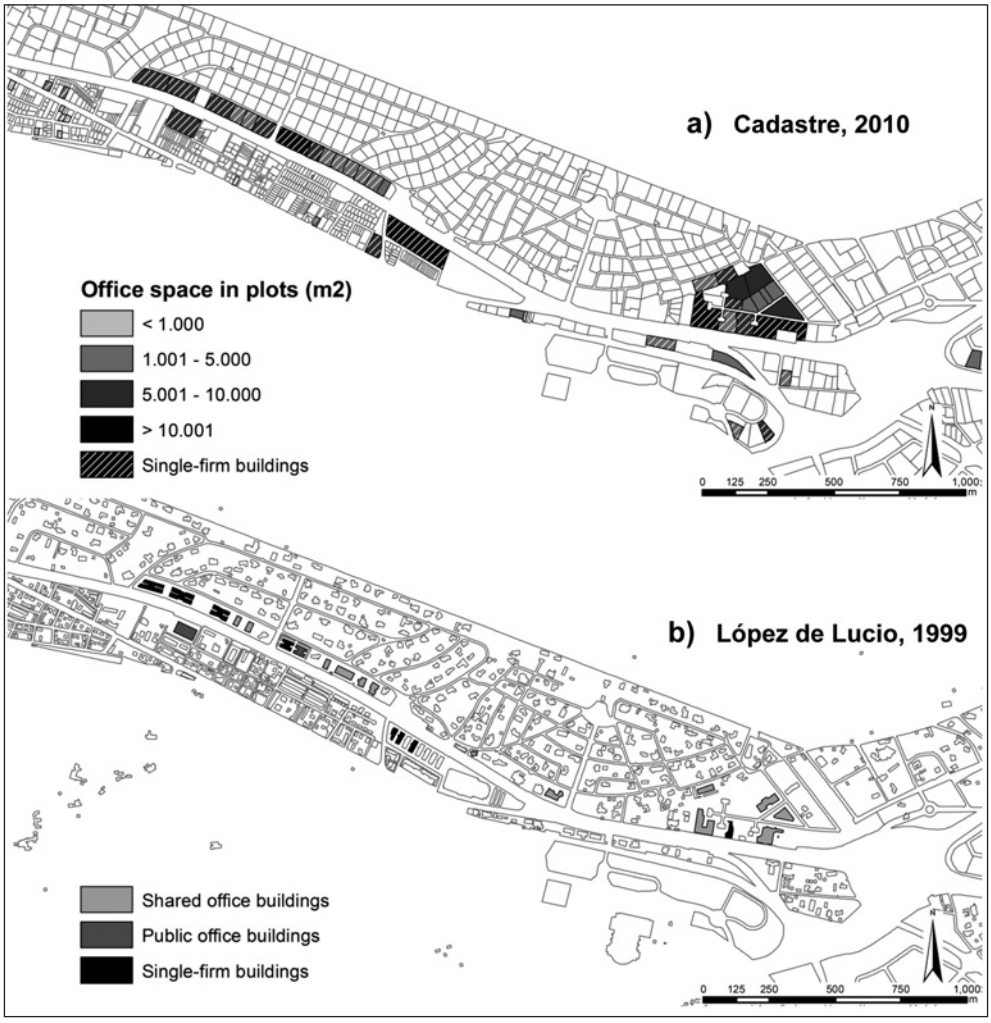
Secondly, a **local analysis** is conducted using office space data by plot. When comparing the total office surface by plot obtained from the cadastre (2010; *Fig. 5.a*) with the information obtained by López de Lucio (1999; *Fig. 5.b*) from the Madrid building permits information, one can also observe general coincidences and a few differences.

Most plots with office space covered in the cadastre information are also covered in building permit information. However, several plots that have small office spaces in mixed-use buildings (*Fig. 5.a*) are not covered in the building permit information (*Fig. 5.b*). Therefore, when mapping land uses intensities, the cadastre is of paramount importance.

The second issue that can be obtained from the cadastral data is the **office morphology**, which can be achieved dealing with two variables: the number of properties a plot with office use has and the total office surface in the building. Primarily, when adding up the number of properties that each plot with office use possess, we are able to discern if a plot/building hosts a single firm or multiple firms. If the plot with office use has one property, we have a single office or a single firm located in that plot/building (*Fig. 5.a*). If the plot with office use

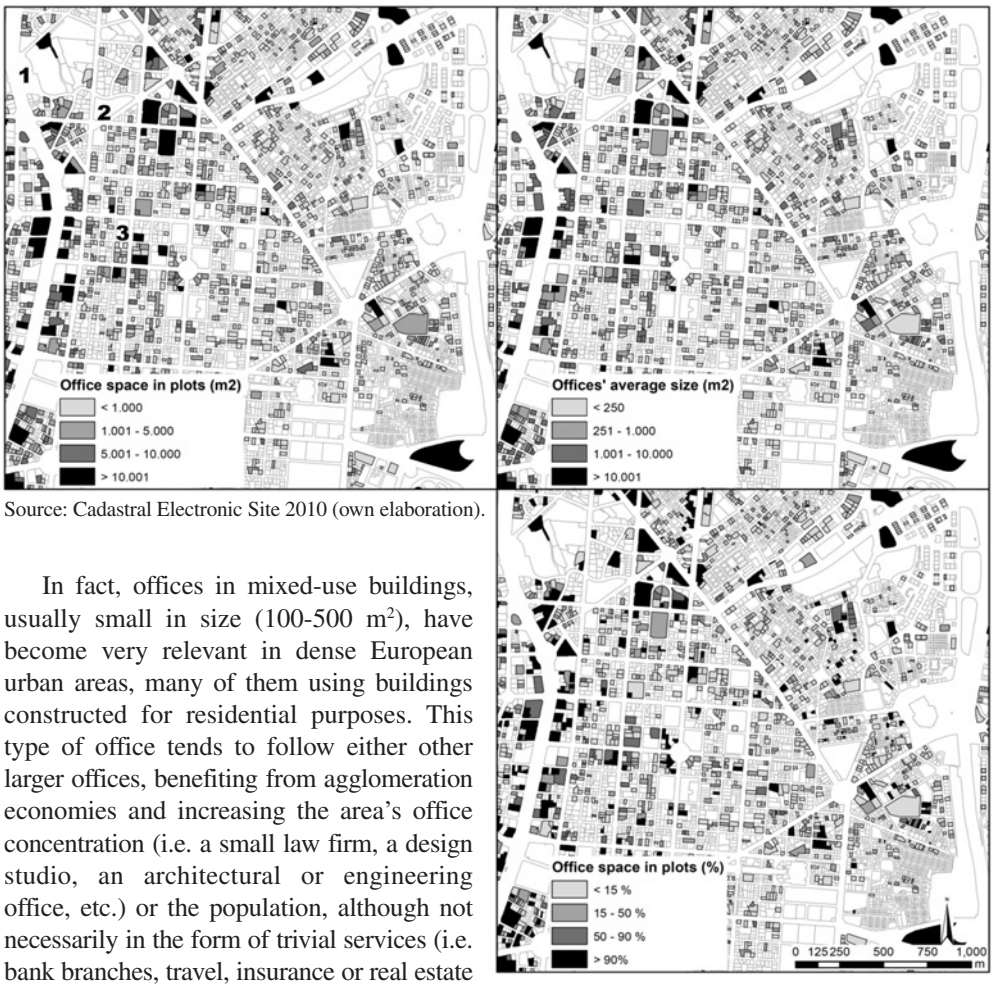
has more than one property, we have two situations: a multiple-office building or a mixed-use building (i.e. office and residential). In order to discern between these two possibilities, we subtract the total office surface area in the building to the total constructed surface. When the outcome is zero or close to it, we might deduce we have a multiple-office building. If not, we might consider having a mixed-use building. However, we should also be aware of other offices' compatible uses. Generally, single-firm or multiple-office buildings have a considerable amount of parking surface. In this case, we might consider office and parking use as a compatible and single use when developing our research.

Figure 5
OFFICE SPACE BY PLOT ON AN URBAN SCALE (NW HIGHWAY CORRIDOR, MADRID)



Source: Cadastral Electronic Site 2010 and López de Lucio (1999); own elaboration.

Figure 6
OFFICE SPACES IN THE SALAMANCA DISTRICT (MADRID)

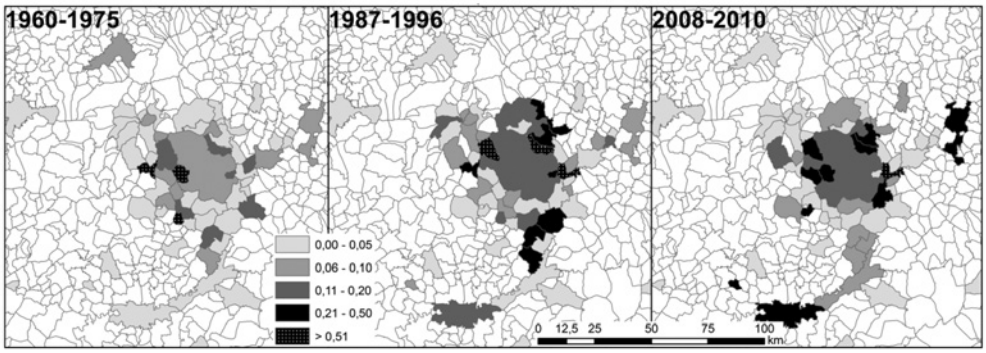


Source: Cadastral Electronic Site 2010 (own elaboration).

In fact, offices in mixed-use buildings, usually small in size (100-500 m^2), have become very relevant in dense European urban areas, many of them using buildings constructed for residential purposes. This type of office tends to follow either other larger offices, benefiting from agglomeration economies and increasing the area's office concentration (i.e. a small law firm, a design studio, an architectural or engineering office, etc.) or the population, although not necessarily in the form of trivial services (i.e. bank branches, travel, insurance or real estate agencies, etc.). These areas of *gradual tertiarization* are very difficult to highlight using building permits or other types of sources, and thus were not detected in López de Lucio's study (1999).

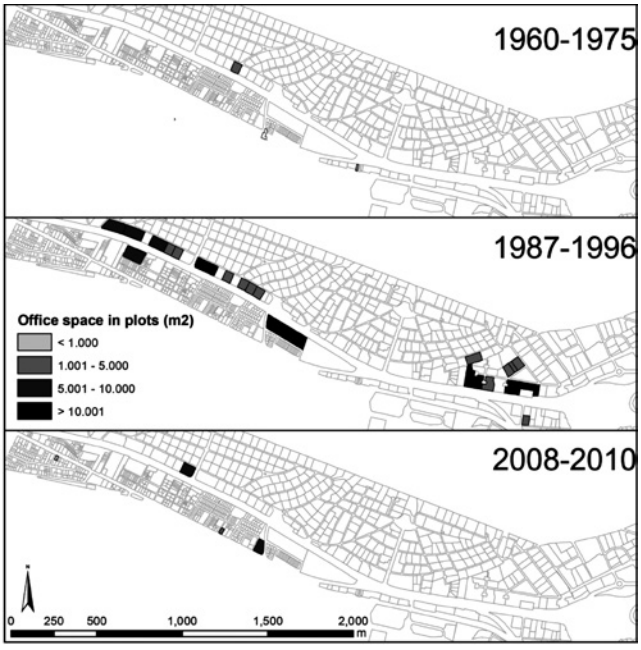
One of these areas in Madrid is the Salamanca district, part of the 19th century city extension or «Ensanche» (*Fig. 6*). The larger numbers of office space are observed along the most important streets: Castellana Avenue (west, #1), María de Molina Street (north, #2), and the Velázquez and José Ortega y Gasset intersection (#3). However, when dividing total office space by the number of offices, that is, when determining the offices' average size, it is clear that just some of the plots have a high amount of office space because of the accumulation of many small offices. It can also be observed that many plots contain mixed-use buildings (with different degrees of prevalence of non-office uses). Therefore, the cadastre is very useful when locating mixed-use areas containing many small offices.

Figure 7
DYNAMICS OF REAL ESTATE WITH REGARD TO PRESENT OFFICE USE IN THE VICINITY OF MADRID (M²/POP/YEARS)



*Only municipalities with more than 10,000 inhabitants in 2010 and located within a radius of 100 km from the municipality of Madrid.
Source: Cadastral Electronic Site 2010 and Population Censuses (1970, 1991, 2010); own elaboration.

Figure 8
DYNAMICS OF OFFICE REAL ESTATE ALONG NORTH-WESTERN CORRIDOR IN MADRID



Source: Cadastral Electronic Site 2010 (own elaboration).

The third important analytical aspect of cadastral data is the analysis of **land use dynamics**. As mentioned, there are essentially two questions to consider with this type of

analysis: when were the current office spaces established and when the previous use became office use within the mixed-use areas. The cadastre provides the construction year of each property currently used for office purposes (*Figs. 7 and 8*). This information mixes properties that currently house offices but were built for other purposes (i.e. residential) with surfaces originally built for office use.

Regarding the regional scale (*Fig. 7*), the annual office space per inhabitant in Madrid has increased since the 1960s. During the first period, office space was stronger and concentrated in municipalities adjacent to Madrid, especially in the western section. During the second period (after accessing the European Union in 1986) office space spread to a greater degree throughout the neighbouring municipalities. During the last period, office space has been more important in suburban municipalities, as well as in two remote provincial capital cities that are beginning to participate functionally in the Madrilenian Urban Region.

Finally, on a local scale (*Fig. 8*), the rhythm and intensity of building construction for office use in the north-western highway corridor of Madrid was greater from 1987 to 1996, whereas, during the previous and subsequent periods, the activity was much more reduced.

VI. CONCLUDING REMARKS

The recent literature confirms the complexity of the advanced producer services sector and its activities, which primarily occur within offices and which, in turn, adopt different urban locations and morphologies, depending on the nature of the office activity. Office activities, once considered a homogeneous urban function, are open today as a system composed of different sub-functions with relatively different location, morphologies and dynamics patterns; trends which this paper addresses. Because of the paramount importance of the service sector in the current global economy, both services and offices have become extremely attractive concepts to scholars in many fields. In this sense, as urban and metropolitan structures change, the location, morphologies, and dynamics of offices have become a key aspect for understanding them.

Consequently, having reliable sources of information as accurate foundations for the spatial analysis of offices is becoming increasingly relevant. Historically, the cadastre has been an underused source of information for urban studies; this may be changing because of the cadastre's greater accessibility after being transformed into digital format in most countries. With respect to the spatial study of the office sector, the cadastre allows for the identification of every urban office space (block, plot, parts of buildings, etc.), as it allows for the identification of not only buildings constructed for office purposes but also embedded office space in residential buildings (or other types of uses), which can sometimes be very important with regard to land use patterns.

In fact, employment and building surface area location are two of the traditional variables for the study of offices because information on economic revenue is almost never available. Office information on building surface area (1) has traditionally been partial, because only large and purposely office-oriented buildings were considered; (2) required great quantities of time, because building-by-building information was used (such as building permits or building technical certificates); (3) or was inaccurate, because it relied on the investigation of known office spaces (but not likely future spaces).

This paper demonstrates how the electronically-based information assembled on the Spanish Cadastral Electronic Site and, in due time, by most other national cadastral systems, can be downloaded and implemented using a GIS program, thus providing useful, reliable, and easy-to-understand maps on scales ranging from regional (by municipality) to local (by plot). This source can also provide maps on total office surface, office size, percentage devoted to office use of a building, and so on. This provision allows for the extension of information on office spaces' morphology. It is also possible to add other variables to better understand office locations, morphologies, and dynamics, such as population and employees' economic activity, among others. The greatest shortcoming of this source is that although it provides an accurate representation of the present situation, it only provides indirect historical information.

Lastly, this paper compares the cadastral results on a regional or an urban scale with those obtained through other sources of information. In fact, the primary advantage of the cadastre is that it allows one to work using different scales, depending on the needs of the research, and is more accurate and more reliable than any other source of information. Once located, the cadastre also allows for the study of intensities and the location of 100% of office areas and offices scattered throughout or «hidden» within residential, commercial or industrial areas.

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