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# Recent Evolution of Logistic Spatial Patterns in Metropolitan Contexts: The Case of Madrilenian Urban Region

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## 1. INTRODUCCIÓN

In the context of the capitalist economy, progressively more and more open and connected under the paradigm of the industry 4.0, the logistic activity has been increasing relevance to meet the demands of the commerce (Browne, 1993; Dizian, Ripert and Dablant, 2012). Logistics have become a function of boosting economic activity, with a great influence in the competitiveness at all levels (Ministerio de Fomento, 2013). It is an opportunity factor in terms of wealth, competitiveness and efficiency, but not only, it is also in terms of labour (EC, 2008; JII, 2016) and spatial impact because of its effects in the reorganization of both urban and rural areas. Despite its relevance and interest, the logistic sector lacks a fully and clear definition as economic sector (EC, 2008).

This work approaches the logistics from a geographic perspective. Specifically, it pays attention to an unexplored topic which is the expansion of the logistic economy and its impact in the metropolitan reconfiguration (Heitz and Dablanc, 2015; Dablanc et al. 2017). Our hypothesis set that progressively the area for logistics are located in more remote places from core cities and inner metropolitan areas where the investment has been focused on traditionally (O'Connor, 2010; Hall y Hesse, 2013; van den Hauvel et al, 2013). So new expressions appeared such as: *logistic suburbanization* (Dablanc and Rakotonarivo, 2010), *logistic decentralization* (Dablanc y Ross, 2012 o Woudsma, Jakubicek, and Dablanc, 2016), *deconcentrating logistics* (Hall and Hesse, 2013) or *logistic sprawl* (Dablanc et al, 2017). In this debate, Heitz, Dablanc and Tavasszy (2017) distinguish between logistic sprawl and logistic suburbanization to explore the limits beyond the urban region itself and analyse the spatial patterns within them, forming spatial clusters that take advantage from infrastructures and proximity (Rivera, Sheffi, y Welsch, 2014).

Our target is to assess the effects of the logistic activity in the framework of the extended metropolitan processes and the transformation of rural areas in the context of Madrid's urban region, which extension comprehends the bordering provinces of Avila and Segovia in Castilla y Leon, and Ciudad Real, Cuenca, Guadalajara and Toledo in Castilla-La Mancha (Solís, Ureña y Ruíz-Apilánez, 2012), to which we have added Albacete to have a complete picture of this latter region.

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## 2. METHODOLOGY

Analysing logistic function and its related areas is not an easy task, the sector is within a framework of economic and spatial relationships where different flows and companies are integrated and coordinated (Ballou, 1987; Alijohani, and Thompson, 2016). To analyse logistics spatial patterns and its changes we propose a twofold approach: a functional perspective, based on statistical data from companies and workers, and other spatial, exploring information related with land use.

For the first analysis we use the social welfare system regarding companies and related workers, grouped according the national coding system for economic activities (CNAE). For the second analysis we use data from the Spanish Observatory for Transport and Logistics (OTLE), which adds interesting statistical information, released by some logistic associations, but introduce some bias because of this reason. Finally, we propose the use of cartography on land use from the Corine Land Cover project (CLC) of the National Centre of Geographic Information (CNIG), for the years 2000 and 2012. With this georeferred source we will approach the logistic distribution at a local scale using different GIS tools.

## 3. RESULTS

The logistic and transport sectors are a strategic area for the rest of the Spanish economy, representing a 5,5% of the GDP and more than 800.000 of direct workers according to the INE. In accordance with the OTLE they hold a land surface nearly 30 million of square metres.
The data brought by the Employment offices from the autonomous regions adjoining Madrid set that the logistic sector represented the 3,5% of the companies and 5% of employment in the study area in the 2012-2017 period. Madrid concentrates the 74,1% of the companies in the sector and 78,7% of employment, followed by Toledo in companies (6,6%) and Guadalajara in employment (5,6%) (see full results in Table 1).

### 3.1. EVOLUTION OF COMPANIES AND WORKERS IN THE LOGISTIC SECTOR (2012-2017)

Despite the dominant concentration of the logistic activity in Madrid, the recent evolution allows to foresee a tendency towards diffusion in the adjoining provinces. Avila is the province with the most growth in both companies and employment between 2012 and 2017 at an annual rate of 3,94% and 9,26% respectively. Guadalajara and Cuenca have a remarkable growth in employment with rates of 12,28% and 8,42% in this same period (Table 1).

### 3.2. EVOLUTION OF LOGISTIC LAND USE (2014-2017)

In terms of land use, Madrid reduces its dominance with a 56,8% of the logistic land use in the urban region, while is presenting a growth of 121,07% in respect to a 116,76% of the adjoining provinces between 2014 and 2017 (Table 2). However, the behaviour by type of the logistic activity shows significant differences: the specialized facilities decreased in Madrid by nearly 5 points while they grow by 140,85% in 2017 in respect to 2014 in the rest of the provinces with a special figure for Cuenca (1.082,35%). These specialized facilities include refrigeration services, pharmacist warehouses, logistic platforms for dangerous goods, textile or motor vehicles; that is, activities with legal regulations that require lower land price. On the other hand, provinces such as Avila, Albacete and Toledo grew above Madrid in warehouses (customs, parcels,

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Table 1. Evolution of companies and employment in the logistic sector (2012-2017).

| Madrid Urban Region | Companies Total (2012) | Companies Total (2017) | Employment Total (2012) | Employment Total (2017) | Companies evolution (2012-2017) | Employment evolution (2012-2017) | Annual growth rate of companies (2012-2017) | Annual growth rate of employment (2012-2017) |
|---|---|---|---|---|---|---|---|---|
| Madrid | 314.811 | 337.400 | 2.685.404 | 3.020.922 | 22.589 | 335.518 | 1,44 | 2,50 |
| Ávila | 7.173 | 7.828 | 34.071 | 40.575 | 655 | 6.504 | 1,83 | 3,82 |
| Segovia | 8.050 | 8.043 | 39.964 | 44.119 | -7 | 4.155 | -0,02 | 2,08 |
| Albacete | 15.764 | 16.650 | 116.780 | 129.691 | 886 | 12.911 | 1,12 | 2,21 |
| Ciudad Real | 19.767 | 21.685 | 144.489 | 161.237 | 1.918 | 16.748 | 1,94 | 2,32 |
| Cuenca | 9.252 | 9.818 | 64.276 | 71.155 | 566 | 6.879 | 1,22 | 2,14 |
| Guadalajara | 8.955 | 9.062 | 73.152 | 87.766 | 107 | 14.614 | 0,24 | 4,00 |
| Toledo | 24.357 | 25.593 | 191.007 | 212.524 | 1.236 | 21.517 | 1,01 | 2,25 |
| | 408.129 | 436.079 | 3.349.143 | 3.767.989 | 27.950 | 418.846 | 1,37 | 2,50 |
| | Logistic companies Total (2012) | Logistic companies Total (2017) | Logistic workers Total (2012) | Logistic workers Total (2017) | Logistic companies Evolution (2012-2017) | Logistic workers Evolution (2012-2017) | Annual growth rate of logistic companies (2012-2017) | Annual growth rate of logistic workers (2012-2017) |
| Madrid | 10.325 | 11.263 | 134.978 | 148.686 | 938 | 13.708 | 1,82 | 2,03 |
| Ávila | 203 | 243 | 875 | 1.280 | 40 | 405 | 3,94 | 9,26 |
| Segovia | 315 | 313 | 1.498 | 1.711 | -2 | 213 | -0,13 | 2,84 |
| Albacete | 682 | 698 | 5.357 | 5.724 | 16 | 367 | 0,47 | 1,37 |
| Ciudad Real | 759 | 802 | 5.482 | 6.404 | 43 | 922 | 1,13 | 3,36 |
| Cuenca | 436 | 470 | 3.568 | 5.071 | 34 | 1.503 | 1,56 | 8,42 |
| Guadalajara | 393 | 395 | 6.514 | 10.514 | 2 | 4.000 | 0,10 | 12,28 |
| Toledo | 991 | 1.007 | 7.939 | 9.544 | 16 | 1.605 | 0,32 | 4,04 |
| | 14.104 | 15.191 | 166.211 | 188.934 | 1.087 | 22.723 | 1,54 | 2,73 |

Source: Consejería de Economía de Castilla-La Mancha, Castilla y León y Comunidad de Madrid. According to the CNAE (codes 49, 50, 51 y 52). Own elaboration.

transport), and Guadalajara made it in distribution logistics (warehouse and management) and industrial logistics (Table 2).

### 3.3. LOGISTICS IN THE MADRID URBAN REGION, A CARTOGRAPHIC APPROACH

The Corine Land Cover cartography confirms the spatial expansion of the logistics despite the bias introduced both by the cartographic scale and the photointerpretation methods (including the labelling used in this source). The evolution of the land corresponding to the level three category "Industrial and commercial units" (Code CLC121) between the years 200 and 2012 points out a growth in this land use in the municipalities nearest to Madrid, in the province's capitals, in the mid-sized cities and in specific locations specially well connected by highways like Tarancon in Cuenca (Figure 1).

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Table 2. Logistic land use by province (sq$^2$, 2014-2017).

| Year | Province | Transport warehouses Subtotal | Distribution hub Subtotal | Industrial platform Subtotal | Mixed platform Subtotal | Specialized Subtotal | TOTAL |
|---|---|---|---|---|---|---|---|
| 2014 | Madrid | 767.073 | 899.074 | 1.516.038 | 5.000 | 253.727 | 3.440.912 |
| | Ávila | 6.000 | 2.300 | | | | 8.300 |
| | Segovia | 11.610 | 2.050 | | | | 13.660 |
| | Albacete | 43.043 | 43.200 | 141.020 | | 2.700 | 229.963 |
| | Ciudad Real | 55.626 | 16.160 | 43.880 | | 14.092 | 129.758 |
| | Cuenca | 41.900 | 13.200 | 60.100 | | 2.600 | 117.800 |
| | Guadalajara | 131.400 | 179.490 | 1.099.135 | | 111.560 | 1.521.585 |
| | Toledo | 70.538 | 174.667 | 412.647 | | 29.500 | 687.352 |
| | Provinces | 360.117 | 431.067 | 1.756.782 | 0 | 160.452 | 2.708.418 |
| | Madrid Urban Region | 1.127.190 | 1.330.141 | 3.272.820 | 5.000 | 414.179 | 6.149.330 |
| | SPAIN | 6.048.409 | 7.106.669 | 11.185.924 | 76.995 | 1.519.975 | 25.937.972 |
| 2017 | Madrid | 817.383 | 1.535.762 | 1.550.175 | 22.200 | 240.541 | 4.166.061 |
| | Ávila | 16.000 | 2.300 | 2.000 | | | 20.300 |
| | Segovia | 12.031 | 2.050 | 2.000 | | | 16.081 |
| | Albacete | 46.643 | 43.200 | 187.520 | | 2.700 | 280.063 |
| | Ciudad Real | 55.626 | 16.320 | 43.880 | | 14.092 | 129.918 |
| | Cuenca | 42.700 | 13.823 | 66.900 | | 28.141 | 151.564 |
| | Guadalajara | 120.800 | 350.285 | 1.188.545 | | 151.560 | 1.811.190 |
| | Toledo | 89.538 | 203.678 | 430.462 | | 29.500 | 753.178 |
| | Provinces | 383.338 | 631.656 | 1.921.307 | 0 | 225.993 | 3.162.294 |
| | Madrid Urban Region | 1.200.721 | 2.167.418 | 3.471.482 | 22.200 | 466.534 | 7.328.355 |
| | SPAIN | 6.457.417 | 9.233.562 | 11.728.462 | 159.803 | 1.900.035 | 29.479.279 |
| Years | Province | Transport warehouses Subtotal | Distribution hub Subtotal | Industrial platform Subtotal | Mixed platform Subtotal | Specialized Subtotal | TOTAL |
| Evolution (2014 = 100) | Madrid | 106,56 | 170,82 | 102,25 | 444,00 | 94,80 | 121,07 |
| | Ávila | 266,67 | 100,00 | | | | 244,58 |
| | Segovia | 103,63 | 100,00 | | | | 117,72 |
| | Albacete | 108,36 | | | | | |
| | Ciudad Real | 100,00 | | | | | |
| | Cuenca | 101,91 | 104,72 | 111,31 | | 1.082,35 | 128,66 |
| | Guadalajara | 91,93 | 195,16 | 108,13 | | 135,86 | 119,03 |
| | Toledo | 126,94 | 116,61 | 104,32 | | 100,00 | 109,58 |
| | Provinces | 106,45 | 146,53 | 109,37 | | 140,85 | 116,76 |
| | RUM | 106,52 | 162,95 | 106,07 | 444,00 | 112,64 | 119,17 |
| | España | 106,76 | 129,93 | 104,85 | 207,55 | 125,00 | 113,65 |

Source: Spanish observatory for logistics. Own Elaboration.

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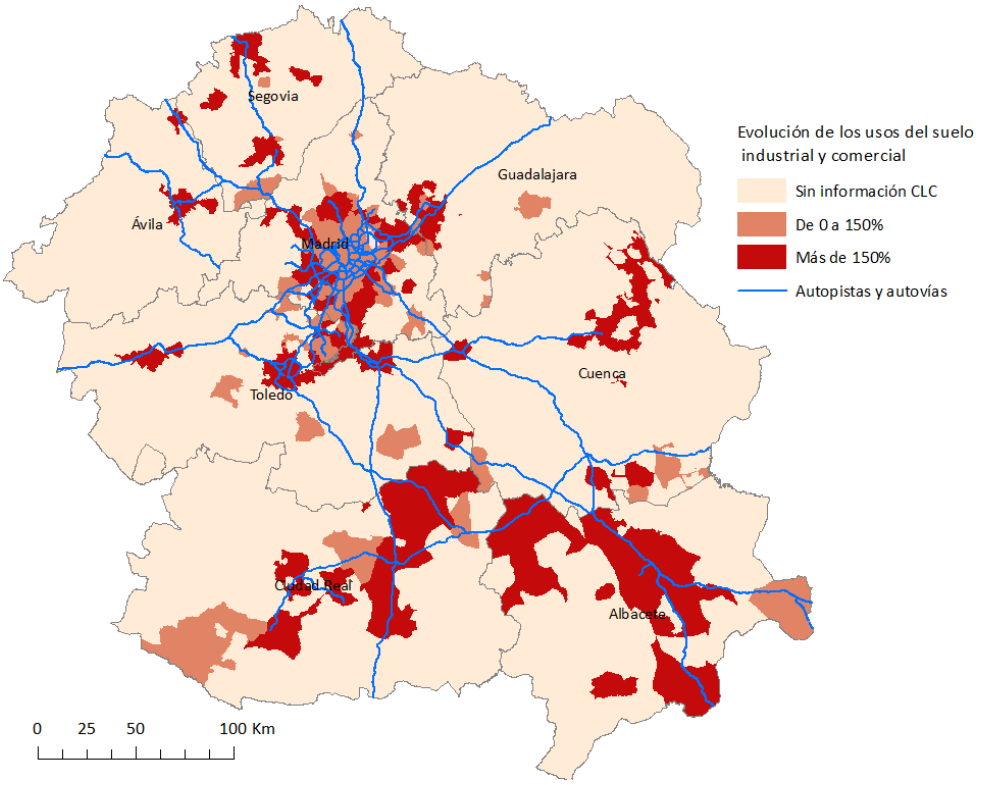
Figure 1. Evolution of land use type: "Industrial and commercial uses", Corine Land Cover (CLC) by municipality in the Madrid Urban Region between 2000 and 2012 (2000=100).




Source: CNIG. Corine Land Cover (CLC) 2000 y 2012. Own elaboration.

## 4. CONCLUSIONS

The logistic activity has become a strategic sector in the economy because its influence in the labour and spatial structures. This forces us to analyse its progression from a geographical perspective. However, it is a complex activity to explore since it is closely integrated with the rest of the sectors, especially the industry where the companies use logistics with considerable flexibility.

The analysis of the data sources stands out the continuous development of the logistic sector in the Madrid urban region, beyond the traditional spaces close to the main city. Despite that the Autonomous Region of Madrid leads the concentration of companies and employment, the land use is distributed more evenly among the peripheral provinces, which is confirming the processes of logistic dispersion towards areas farther from the metropolitan area, while the control of the activity is laid down in the core areas. On the other hand, using the land use cartography we detected processes of logistic suburbanization, with significant growths in areas near to the capital and in the main cities of the regional urban system, where the presence of new corridors of transport entails the appearance of clusters or logistic hubs. All these confirm the positive response of the logistic activity to the demand of a progressive more opened and interconnected economy.

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