# An analysis of warehousing development patterns and logistics sprawl in four metropolitan areas: Dallas, Houston, New York, and Philadelphia

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# 1. INTRODUCTION

# INTRODUCTION

The warehousing industry is one the fastest growing sectors in the United States. Employment in warehousing increased by 577% from 1998 to 2015, representing an average annual growth rate of 11.9% and the number of warehouse establishments grew by 114% over the same period (Dubie et al., 2020).

- In 2019, only nine states had more than 500 logistics facilities listed under the County Business Pattern survey code 493: New York (589), Pennsylvania (706), New Jersey (736), Georgia (752), Ohio (781), Illinois (791), Florida (795), Texas (1616) and California (2238).

- Only 8 metropolitan areas had more than 300 logistics establishments in 2019. In addition, the trend is for the main logistics hubs to grow in size, in a process that could be likened to a metropolization of logistics

Tab. 1. Number of logistics establishments per major metropolitan areas listed as category 493 in the County Business Pattern database (2012, 2015, 2018, 2019) and the change between 2012 and 2019.

| MSA | 2012 | 2015 | 2018 | 2019 | Evolution 2012-2018 (%) |
|---|---|---|---|---|---|
| Atlanta, Sandy Springs, Roswell | 371 | 376 | 419 | 434 | 16.9 |
| Chicago, Naperville, Elgin | 496 | 544 | 580 | 602 | 21.3 |
| Dallas, Fort Worth, Arlington | 371 | 432 | 505 | 526 | 41.7 |
| Houston, The Woodlands, Sugar Land | 281 | 308 | 362 | 360 | 28.1 |
| Los Angeles, Long Beach, Anaheim | 573 | 639 | 707 | 713 | 24.4 |
| New York, Newark, New Jersey | 757 | 795 | 861 | 890 | 17.5 |
| Philadelphia, Camden, Wilmington | 275 | 304 | 339 | 345 | 25.4 |
| Riverside, San Bernardino, Ontario | 360 | 428 | 496 | 523 | 45.2 |

(Source : U.S. Census Bureau, 2012, 2015, 2018, 2019)

# INTRODUCTION

Given these high levels of growth, it is crucial to understand the factors that drive the location of logistics facilities in metropolitan areas and the inherent changes over time, particularly the phenomenon of logistics sprawl or the gradual return of small logistics facilities to the central zones of MSAs.

The term “logistics sprawl” refers to growth in the number of warehouses on the outskirts of large cities, particularly in peri-urban areas where densities are low, land is available and cheap, and plots are large (Giuliano et al., 2013; Dablanc et al., 2018).

The lack of regulation in metropolitan margins has encouraged the construction of warehouses in peri-urban areas, fuelling a process of logistics sprawl (Dablanc et al., 2014) in which warehouses become concentrated in sparsely populated peri-urban areas (Bowen, 2008; Cidell, 2010). The intensity of logistics sprawl varies with the type of warehouse (greater for distribution centers, lower for courier terminals) and according to the type of strategy pursued by logistics actors.

# INTRODUCTION

The changes in the location of logistics facilities reflect the broader transformation of warehousing and logistics as an economic sector. The geographical impact of e-commerce is reflected in two distinct developments in logistics real estate (Dablanc, 2018). On the one hand, the creation of so-called "XXL" distribution centers or mega-fulfillment centers (over 50,000 square meters), which follow the historical trend of logistics zones moving away from urban centers, and on the other hand the search for space in dense areas to meet demand arising from e-commerce.

In order to meet consumer expectations, among which ever faster deliveries emerge as a priority in most surveys, goods must be located close to the end customer.

Urban warehouses have been introduced by big e-commerce players like Amazon, which has, for example, installed them in several central locations in Los Angeles (several dozen urban warehouses, from 5 to 20,000 m²), New York, or Chicago (Schorung, 2021).

# INTRODUCTION

This study examines the question of logistics sprawl and overall trends in warehousing location patterns in four main logistics hubs in the United States (Dallas MSA, Houston MSA, New York MSA, Philadelphia MSA) over the last decade, between 2012 and 2019, including the latest survey survey data from the U.S. Census Bureau's County Business Pattern, released in May and June 2021.

This study completes and compares the results of previous studies on Atlanta, Los Angeles, Seattle, Phoenix and Chicago, using a similar method of spatial and cartographic analysis (described below).

# LITERATURE REVIEW

Several recent studies have analyzed the location of warehouses in metropolitan areas and how this has changed over time. These studies have demonstrated a shift in the location of warehouses and logistics facilities to peri-urban areas (Bowen, 2008; Allen and Browne, 2010; Cidell, 2010; Heitz and Dablanc, 2015; Giuliano et al., 2016; Heitz, Dablanc, and Tavasszy, 2017).

The location dynamics of logistics warehouses are based on several criteria and a complex supply chain cost structure (transportation, accessibility, distribution activities, structure of the regional economy, warehouse equipment, land and real estate, organization of logistics flows and the last mile, etc.) (Dablanc and Rakotonarivo, 2010).

This progression has been described as “logistics sprawl”, a phenomenon that can be defined as “the tendency for warehouses to move from urban to suburban and exurban areas” (Dablanc and Ross, 2012, p. 434), which has been identified by research in all the case studies considered (Cidell, 2010; Dablanc and Ross, 2012; Dablanc et al., 2014; Heitz and Dablanc, 2015).

In the case of North America, there have been several analyses of case studies in Atlanta, Los Angeles and Seattle, Toronto (Dablanc and Ross, 2012; Dablanc et al., 2014; Woudsma et al., 2016), and recently a comparative study on Chicago and Phoenix (Dubic, Kuo, Giron-Valderrama, Goodchild, 2020).

# METHODOLOGY

The aim of this research is to analyze logistics sprawl and warehousing development patterns in five U.S. metropolitan areas, based on the County Business Pattern database (U.S. Census Bureau) for 2012 and 2019 data at Zip Codes granularity.

The same data period (2012-2019) was defined for the five metropolitan areas to ensure consistency in the analysis. Warehousing is defined in this study as establishments classified in subsector 493 ("Warehousing and Storage") of the North American Industry Classification System (NAICS). This classification covers establishments engaged in operating merchandise warehousing and storage facilities.

This research used R, a language for statistical computing, to compile, aggregate the data and the QGIS software wase used to map the warehouse establishments and to provide the spatial analysis, especially the barycenters.

*3 study areas*

1. *Dallas-Fort Worth-Arlington MSA*
2. *Houston-The Woodlands-Sugar Lands MSA*
3. *South of the BosWash Megalopolis: New York-Newark-New Jersey MSA and Philadelphia-Camden-Wilmington MSA*

# 2. CASE STUDIES AND RESULTS

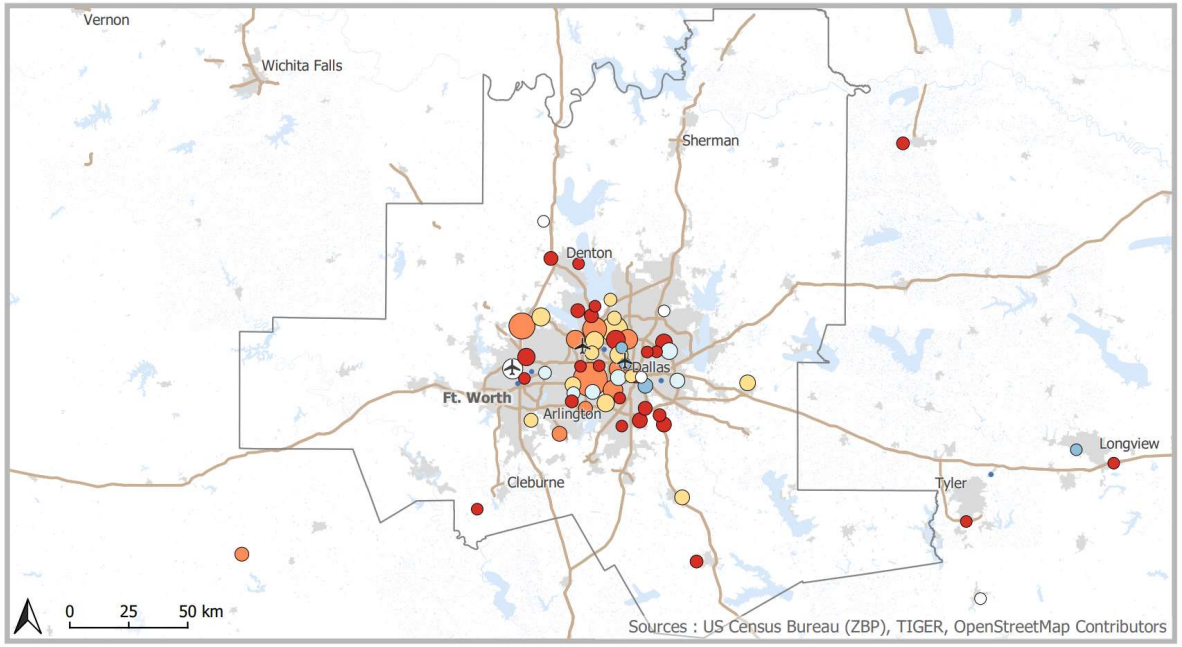
# 2.1. DALLAS-FORT WORTH-ARLINGTON MSA

When we look at the change in the number of logistics establishments between 2012 and 2019 in the Dallas-Fort Worth CSA, we see a sharp and relatively even rise in the number of warehouses across the metro area. The CSA contained 376 warehouses in 2012, compared with 533 in 2019, a 41.7 percent increase.
Numbers of logistics warehouses have increased significantly in the northeast part of the metropolitan area, the southeast, and the southwest near Arlington. These are the areas that saw the largest changes between 2012 and 2019. In addition, a twofold process is underway: on the one hand, an increase in the size of existing logistics clusters (which contain between 25 and 100 logistics warehouses); on the other hand, the rapid emergence over the period studied (2012-2019) of new logistics concentrations where the highest rate of change is recorded. Figure shows a dual pattern of warehousing development: the reinforcement of logistics establishments in the first peri-urban ring around Dallas and at the same time the rapid development of a second ring on the edges of the Dallas metropolitan area.

In addition, logistics facilities are being established near highway networks and airports.

- To measure changes in the locations of warehouse establishments, the standard deviational ellipse area (from the barycenter) was calculated for all warehousing establishments for both years:
- - the standard deviational ellipse area from the barycenter in 2012 was 1942.65 km²;
- - this area from the barycenter increased by 19.6%.
- The ellipse area moved mainly in a southeastern direction, but also in a northwestern direction.

**Zip Codes centroids between 2012 and 2019**

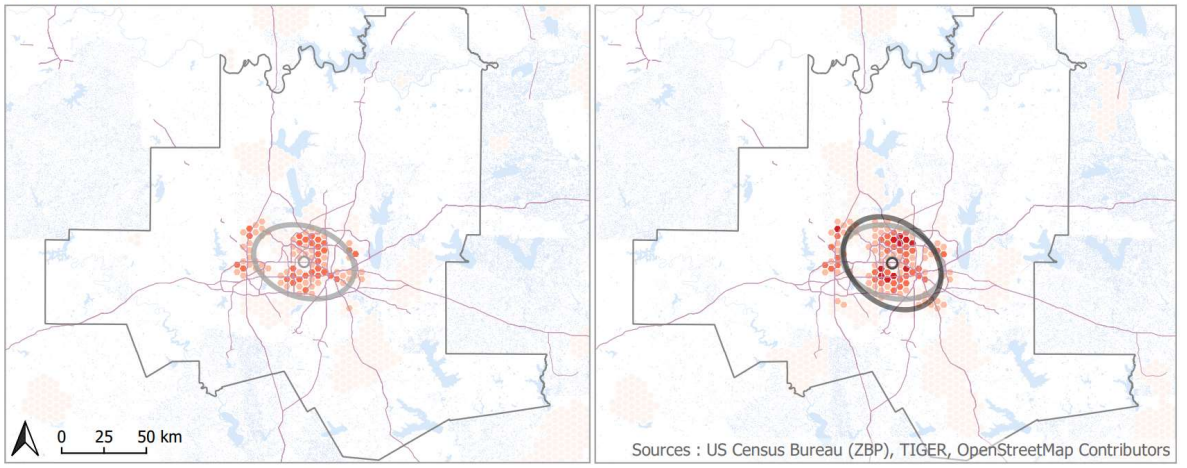



Evolution 2012 - 2019
- -100%
- From -67% to -25%
- From -25% to -5%
- From -5% to +5%
- From +5% to +49%
- From +49% to +99%
- From +99% to +600%

Number of logistics establishments in 2019
- 100
- 50
- 25
- 10
- 3

- Studied CSA/MSA
- Urban areas (2020)
- Protected lands areas
- Oceans, rivers and lakes
- Airports
- Ports
- Primary roads (2020)

**Grid 5x5km** **2012** **2019**




Number of logistics establishments
- 0 - 1
- 1 - 3
- 3 - 6
- 6 - 15
- 15 - 23

- Studied CSA/MSA
- Oceans, rivers and lakes
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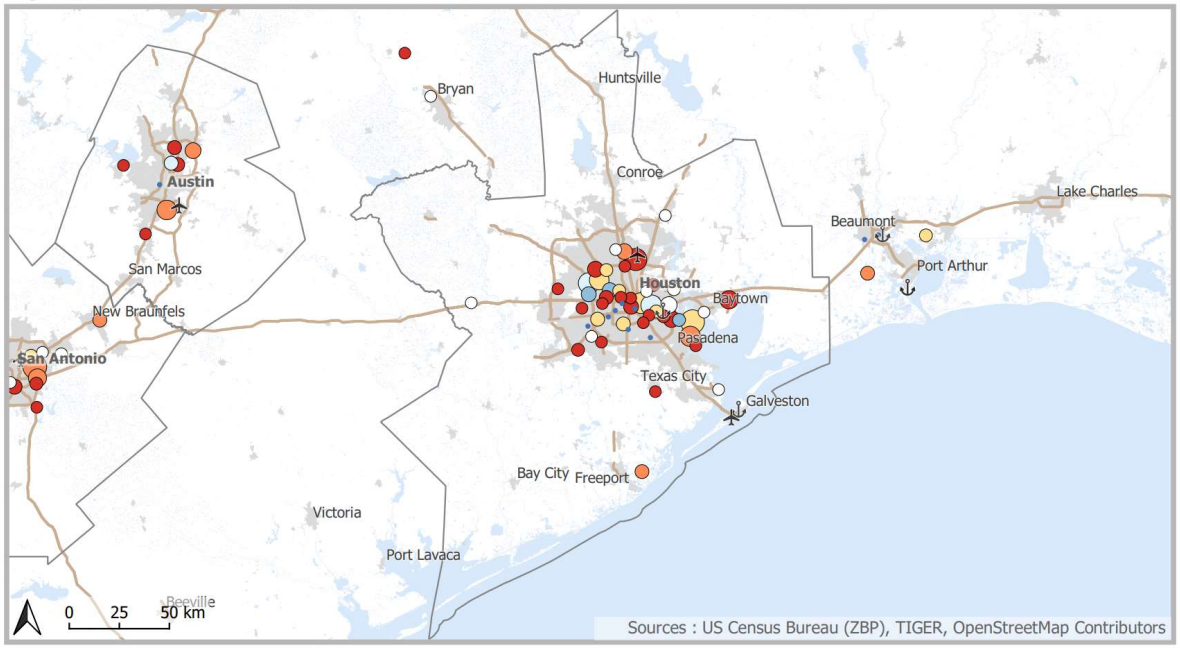
Standard deviational ellipse and his centroid
- 2012
- 2019

# 2.1. HOUSTON-THE WOODLANDS-SUGAR LANDS MSA

The Houston-The Woodlands-Sugar Lands metropolitan area is a fast-growing logistics hub, which increased from 281 logistics facilities in 2012 to 363 in 2019. The number of warehouses grew by 29.1%, confirming the rapid growth of logistics activities in Texas metro areas.
The Houston metropolitan area is typical of large Sunbelt cities that have experienced strong demographic and economic growth and have been transformed by very significant levels of urban sprawl. Houston's urban landscape is characteristic of the American suburban city, with sprawling monofunctional zones connected by a dense highway network. The CSA's logistics facilities are concentrated in three main clusters: a cluster around the Port of Houston to the southeast; a cluster around the international airport to the north; and a west/northwest axis from downtown (Interstate 10, Washington Avenue, Interstate 610, Hempstead Road
Finally, the location of logistics establishments seems to match the classic patterns of logistics sprawl: a preferred location near major transportation infrastructures and the development of a double logistics ring (pericentral and peripheral).

The standard deviational ellipse area (from the barycenter) for this CSA was calculated for both years:
- the standard deviational ellipse area from the barycenter in 2012 was 2047.51 km²;
- in 2019 this area was 2328.13 km².
The standard deviational ellipse area thus increased by 13.7% between 2012 and 2019, and moved (Fig. XX) in both the southeastern and northeastern directions.

**Zip Codes centroids between 2012 and 2019**

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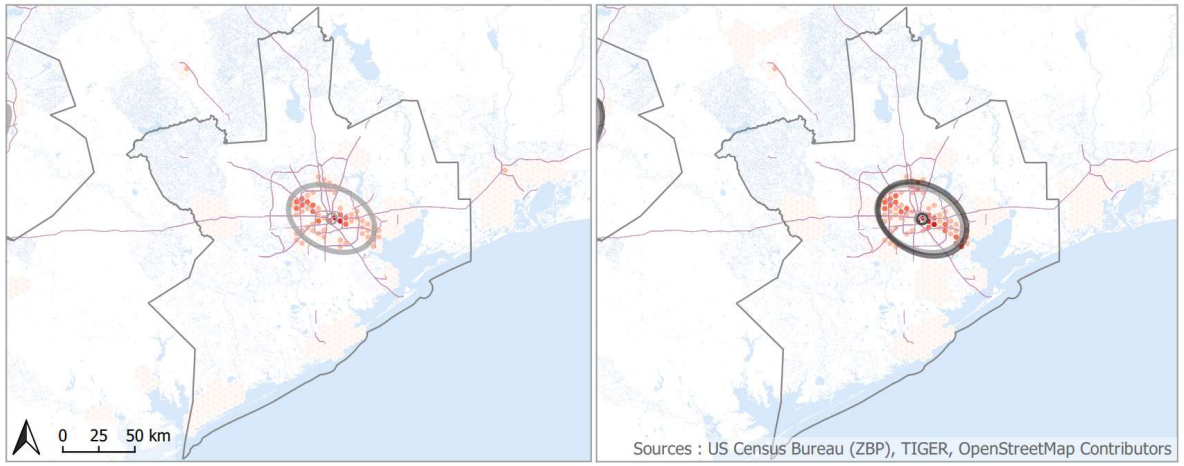


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# 2.1. South MEGALOPOLIS (New York-Newark-New Jersey & Philadelphia-Camden-Wilmington MSAs)

The New York-Newark-New Jersey CSA has the largest number of logistics facilities of any metropolitan area in the United States. There were 844 warehouses in 2012 and 993 in 2019, a 17.6% increase over the seven years. New York's major logistics hub continues to grow, confirming the metropolitan area's role as an international and domestic gateway. As a result, the number of logistics establishments per 10,000 inhabitants rose moderately from 0.38/10000 inhabitants in 2012 to 0.44/10000 inhabitants in 2019 (a 17.2% rise over the seven years). The map (Fig. XX) shows a high concentration of logistics establishments that makes the map harder to read than in the other case studies. A few areas saw a fall in the number of logistics establishments, in the extreme south of the metropolitan area north of Trenton, in northwestern New York, and on Long Island.

This logistics sprawl nevertheless takes a distinctive form, essentially confined to the megacity's urban corridor. Several factors need to be taken into account: the importance of major transportation infrastructures (Port of New York-New Jersey, Interstates, Newark and La Guardia airports), the limited number of available parcels of land in a highly urbanized region, and New York's role as a global gateway that serves as a trade node to the entire region and to the country as a whole, as well as huge and dynamic consumer markets. The standard deviational ellipse area (from the barycenter) for this CSA was calculated for both years:

- in 2012, the standard deviational ellipse area from the barycenter was 5290.22 km²;
- in 2019, this area was 4906.91 km².

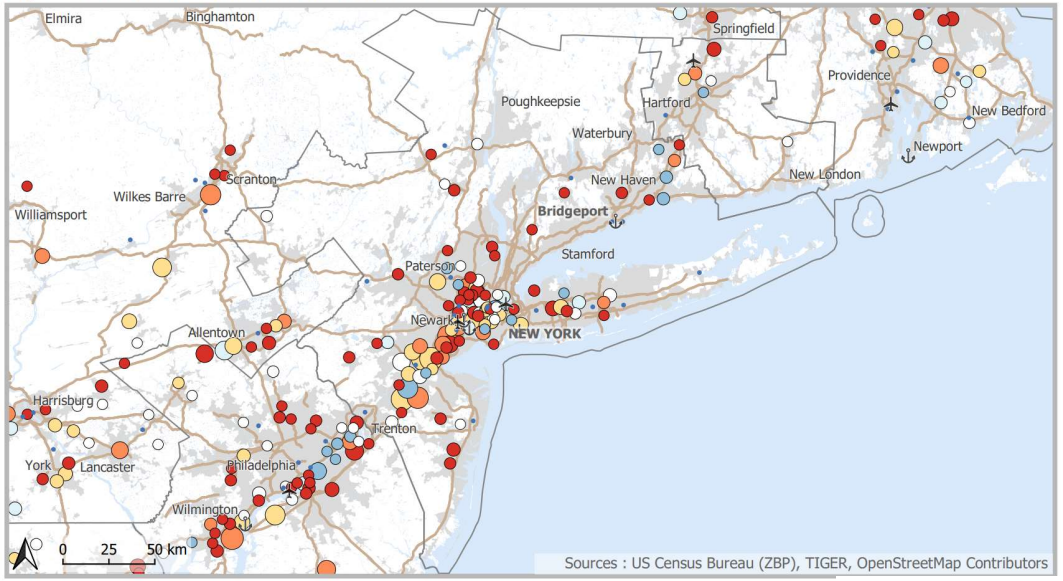
The standard deviational ellipse area thus shrunk by 7.25% between 2012 and 2019.

# 2.1. South MEGALOPOLIS (New York-Newark-New Jersey & Philadelphia-Camden-Wilmington MSAs)

The number of warehouses in the Philadelphia-Camden-Wilmington CSA grew significantly between 2012 and 2019, from 324 logistics facilities in 2012 to 395 in 2019, an increase of 21.9 percent. As a result, the number of warehouses per 10,000 residents increased by 20.4% from 2012 (0.45/10,000 residents) to 2019 (0.55/10,000 residents). The location patterns of the logistics warehouses differ significantly (Fig. XX) from those in the Dallas-Fort Worth CSA. Most warehouses follow the Megalopolis urban corridor along a longitudinal northeast/southeast axis. It is within this urban corridor that major highway and rail transportation infrastructure, as well as major ports and airports, are concentrated.

The case of the Philadelphia-Camden-Wilmington CSA seems to confirm the major trends in the logistics real estate market, in particular a division in this market between warehouses located on the periphery (where owners are looking for large and inexpensive parcels) and warehouses located near the center of the metropolitan area to meet the needs of intra-urban logistics and e-commerce. To measure the changes in the locations of warehouse establishments, the standard deviational ellipse area (from the barycenter) was calculated for both years:
- in 2012 the standard deviational ellipse area from the barycenter was 4763.58 km²;
- in 2019, this area was 5567.76 km².
The standard deviational ellipse area increased by 16.8% between 2012 and 2019.

**Zip Codes centroids between 2012 and 2019**

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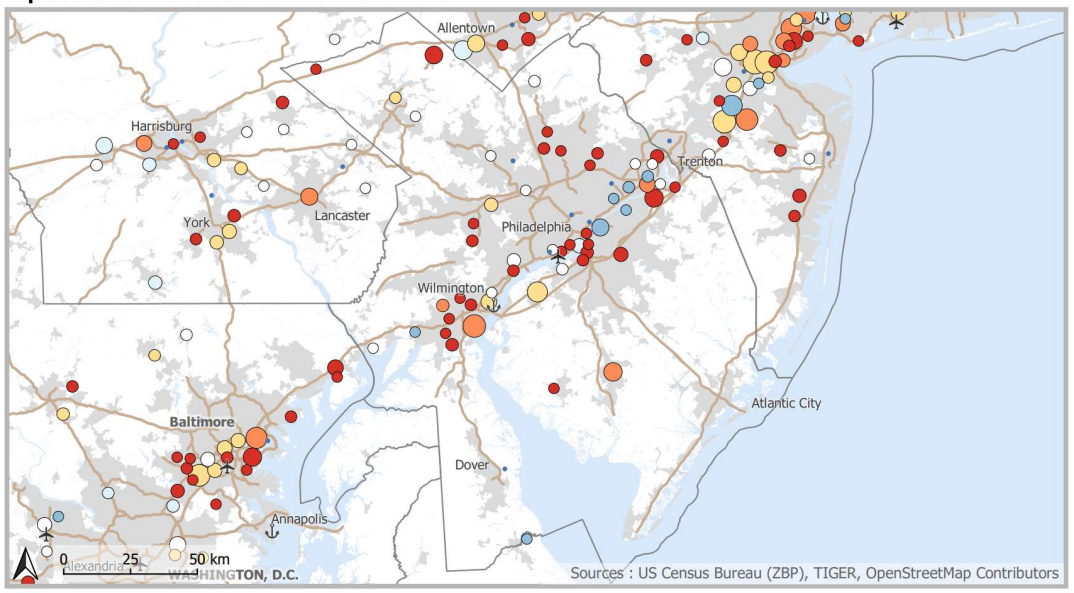


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# 3. DISCUSSIONS AND CONCLUSIONS

# CONCLUSION / PROSPECTS

The number of warehouse establishments in the four metropolitan areas analyzed in this study grew rapidly between 2012 and 2019.

Conclusions can be drawn from the similarities between the two Texas CSAs (Dallas and Houston) and between the two CSAs in the Northeast region (New York and Philadelphia).

There was an increase in warehousing in the Houston and the Dallas areas, which have experienced steady logistics sprawl. The Dallas-Fort Worth CSA is increasingly becoming a warehousing hub (surpassing Atlanta in the number of logistics establishments) because of its booming demographics and economy. It is now a major inland gateway for national freight flows. The very robust growth of the warehousing sector has led to significant dispersion in warehouse location, especially in peripheral Zip Codes (northwest, southwest, and more recently southeast of the Dallas area). Suburban and exurban areas are where land is available for development and is less expensive. These areas can provide access to a more complex system of regional and national infrastructures and flows.
The Dallas area is a typical case of a booming warehousing hub (+41.7% between 2012 and 2019) and of a sprawling metropolitan area.
The Houston-The Woodlands-Sugar Lands CSA appears to be following the same path. This area has also experienced strong growth in numbers of logistics establishments (+29.1% between 2012 and 2019) but has undergone less sprawl than the Dallas area.
The warehouses are less scattered, and their locations are polarized in more well-defined zones (west, north and southeast of the Houston area). The significant clustering of warehouses in theses areas, near the weighted geographic center, is caused mainly by the proximity of major infrastructures (Port of Houston, Houston International Airport) and interstate highways.

# CONCLUSION / PROSPECTS

The two other case studies (Philadelphia-Camden-Wilmington CSA and New York-Newark-New Jersey CSA) reveal quite different trajectories.

The Philadelphia-Camden-Wilmington CSA has seen growth in the number of warehousing establishments (+21.9% between 2012 and 2019) but less extensive logistics sprawl than the two Texas case studies. The analysis of logistics establishments between 2012 and 2019 shows changes in location patterns: less dispersal within the core corridor between Philadelphia and Trenton, with some Zip Codes having seen a fall in warehouse numbers; a reinforced logistics hub south of Wilmington; new warehousing establishments moving outwards from the City of Philadelphia (north and west of the CSA).

The development patterns of the warehousing sector in the Philadelphia area appear to be organized primarily by the urban and transportation corridor of the Megalopolis (following a northeast/southwest axis). For its part, the New York-Newark-New Jersey metropolitan area has experienced moderate growth in the number of logistics establishments (+17.6% between 2012 and 2019) but this growth occurred in an already mature and well-developed logistics market (993 warehouses in 2019). This is the only one of the four case studies to show shrinkage in its standard deviational ellipse area and reduced sprawl in its warehousing sector.

# CONCLUSION / PROSPECTS

This study expands on research into the trend for warehousing and logistics facilities to move away from central areas toward suburban and exurban zones. In four studies (see below), researchers found that logistics sprawl was experienced in all the cases studied.

This present research adds new metropolitan areas to those where the phenomenon of logistics sprawl has been analyzed. Logistics sprawl has been confirmed for six metropolitan areas in North America and Europe (Atlanta, Los Angeles, Phoenix, Chicago, Toronto, and Paris) (Dablanc et al., 2014; Heitz and Dablanc, 2015; Woudsma et al., 2016; Dubie et al., 2020) and has not been confirmed for one metropolitan area (Seattle) (Dablanc et al., 2014).

The contribution of this paper to the existing literature is to document the presence or absence of logistics sprawl in the New York, Philadelphia, Dallas, and Houston metropolitan areas, offering a comparative view of two pairs of cities (two in the Northeast region, two in the Texas Triangle).

This paper confirms the crucial role of accessibility, connection to regional and national flows, and proximity to highway networks, ports, and airports in determining the location and development patterns of the warehousing sector (Bowen, 2008; Dablanc and Ross, 2012).

Future research could consider additional cities, probably intermediate and medium-sized conurbations, and megaregions.

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# THANK YOU FOR YOUR ATTENTION !

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