A multiscalar and comparative analysis of warehousing development patterns and logistics sprawl in four metropolitan areas: Dallas, Houston (Texas Triangle) New York and Philadelphia (Northeast corridor)

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Chaire LOGISTICS CITY | Université Gustave Eiffel | sogaris La logistique urbaine du Grand Paris | Région îledeFrance | Métropole du Grand Paris

Urban studies, urban planning, geography

- Macro spatial analyses to micro level studies on warehouses
- E-commerce, innovations, new trends in consumption and impacts on city logistics
- Policy analysis, environmental policy, new data collection methods

https://www.lvmt.fr/en/chaires/logistics-city/

Results available online eg

- E-book on warehouse geography in the US
- Database on logistics sprawl (78 world cities)
- Observatory of ecommerce mobilities
- Relationships between logistics real estate, logistics market prices and urban forms

Context. Logistics landscape in large US cities

Changes in the location of logistics facilities reflect the broader transformation of warehousing and logistics as an economic sector

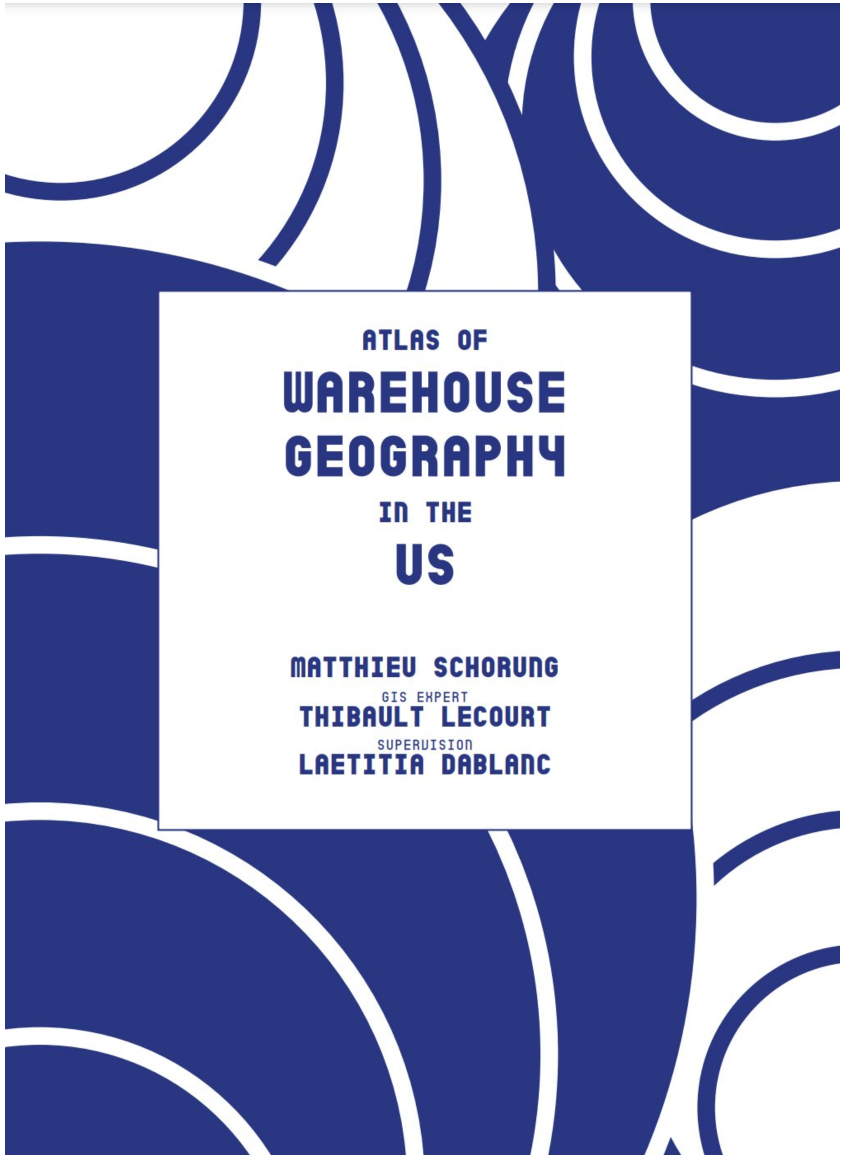
- XXL distribution centers and mega-fulfillment centers (over 50,000 sq m) → historical trend of logistics clusters moving away from urban centers

- Emerging real estate market : the search for space in dense areas to meet demand from e-commerce and parcel distribution

State of the art

- Recent studies have looked at the **location of warehouses** in metropolitan areas and how this has changed over time
- We have identified 78 case studies in the literature by 2022 (Bowen, 2008, Cidell, 2010, Heitz and Dablanc, 2015, Giuliano et al., 2016, Kang, 2020)
- Including numerous North American **case studies** in Atlanta, Los Angeles, Seattle, Toronto, all US (Kang, 2020), Chicago and Phoenix (Dubic et al., 2020)
- 86% of these studies have demonstrated a **shift in the location of warehouses and logistics facilities to suburban areas**
- The location of logistics warehouses is based on **several criteria and a complex supply chain cost structure** (transportation, accessibility, structure of the regional economy, land and real estate, workforce, last mile)

E-book on warehouse geography in the United States (Schorung, Lecourt, 2022)



- Mapping effort including the 2012 & 2019 County Business Patterns database
- Overview at the national level + 45 US metropolitan areas (MSA / CSA) and 8 US megaregions
- Diachronic comparison (from 2012 to 2019)
- Multiple indicators (barycenters, ellipses, warehouse density)
- Different methods of map representation (grid, heatmaps)
- Available online : https://drive.google.com/file/d/18pLAegEpFKSf5SkXpIzdpPXelwAa0JQU/view

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An uneven spatial distribution of logistics warehouses

- In 2019, only nine states had more than 500 logistics facilities (CBP 493): NY (589), Pennsylvania (706), NJ (736), Georgia (752), Ohio (781), Illinois (791), Florida (795), TX (1616) and Cal (2238)
- Eight metro areas had more than 300 logistics facilities in 2019
- The trend is for the main logistics clusters to become even bigger ('metropolization of logistics')

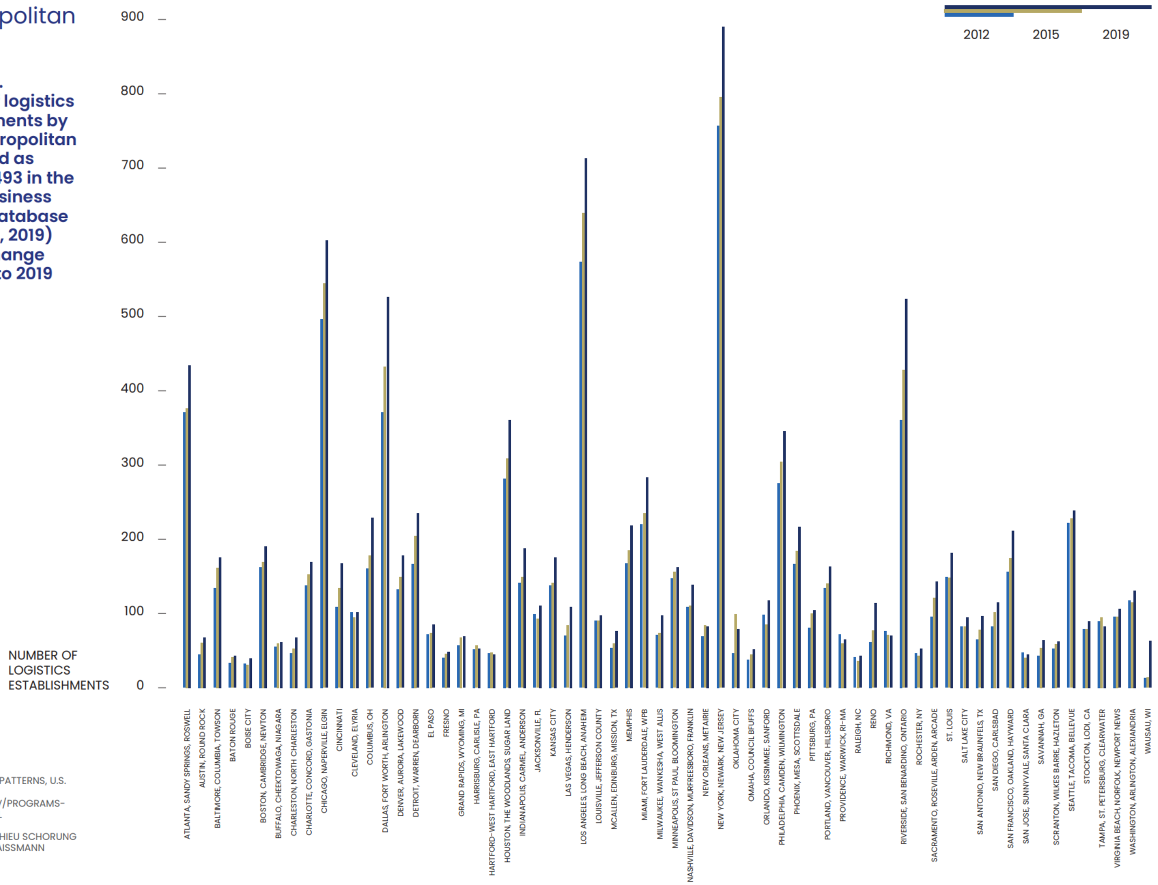
Tab. 1. Number of logistics establishments per major metropolitan areas listed as category 493 in the County Business Pattern database (2012, 2015, 2018, 2019) and the change between 2012 and 2019.

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)

B. Metropolitan scale

Diagram 2. Number of logistics establishments by major metropolitan areas listed as category 493 in the County Business Patterns database (2012, 2015, 2019) and the change from 2012 to 2019



SOURCE
COUNTY BUSINESS PATTERNS, U.S. CENSUS BUREAU: WWW.CENSUS.GOV/PROGRAMS-SURVEYS/CBP.HTML

REALISATION: MATTHIEU SCHORUNG
DESIGN: OLIVIER WAISSMANN

Cluster 0:

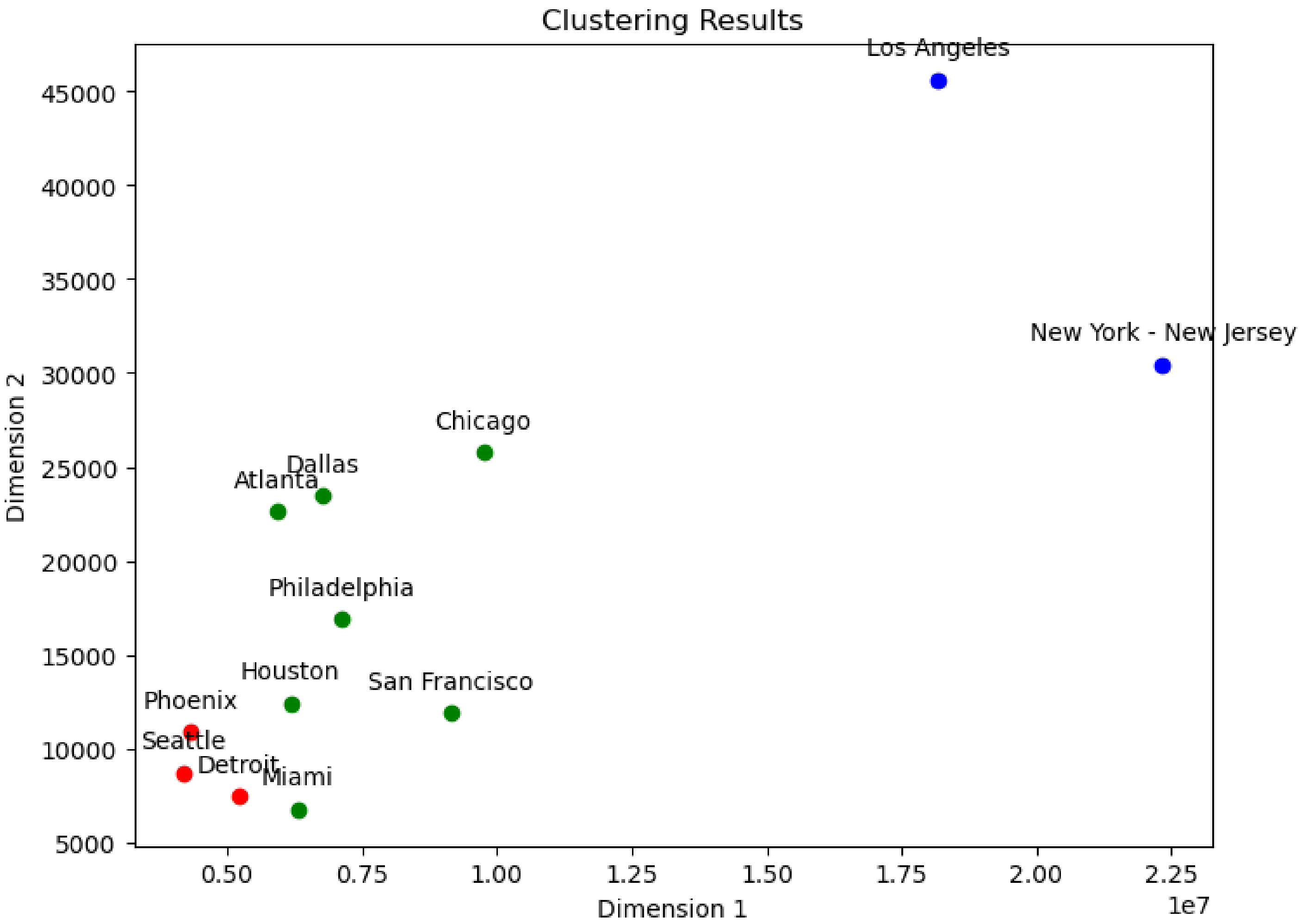
- Higher population size in both 2012 and 2019 compared to other clusters.
- Higher number of employees and establishments in 2012 and 2019.
- Relatively higher average number of employees per establishment in both years.
- Moderately high number of establishments per 10,000 inhabitants in both years.
- Larger standard deviational ellipse area in both years.

Cluster 1:

- Smaller population size in both 2012 and 2019 compared to other clusters.
- Lower number of employees and establishments in 2012 and 2019.
- Relatively lower average number of employees per establishment in both years.
- Lower number of establishments per 10,000 inhabitants in both years.
- Smaller standard deviational ellipse area in both years.

Cluster 2:

- Moderate population size in both 2012 and 2019.
- Moderate number of employees and establishments in 2012 and 2019.
- Moderate average number of employees per establishment in both years.
- Moderate number of establishments per 10,000 inhabitants in both years.
- Moderate standard deviational ellipse area in both years.



Selected features for clustering: pop., employ., nb of warehouses, average employee per establishment, number of establishments per 10 000 inhabitants, and standard deviational ellipse areas for both 2012 and 2019.

Cluster 0: Blue
Cluster 1: Red
Cluster 2: Green

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An analysis of warehousing development patterns in four metropolitan areas and their megaregions

Texas Triangle megaregion

- Dallas-Fort Worth-Arlington CSA
- Houston-The Woodlands-Sugar Lands CSA

Northeast megaregion

- New York-Newark-New Jersey CSA
- Philadelphia-Camden-Wilmington CSA

Objectives of the research

- To examine the question of logistics sprawl and the overall evolution of warehousing location patterns in four main logistics hubs in the United States (Dallas CSA, Houston CSA, New York CSA, Philadelphia CSA) during the last decade, between 2012 and 2019.

- To complete and to compare to the results of previous studies on Atlanta, Los Angeles, Seattle, Phoenix and Chicago (Kang, 2020; Dablanc and Ross, 2012; Dablanc et al., 2014; Woudsma et al., 2016; Dubic, Kuo, Giron-Valderrama, Goodchild, 2020), using a similar spatial and cartographic method.

- We contribute to two of the major aspects of the geography of the logistics sector.
  - The first is logistics sprawl, i.e. the spatial deconcentration of logistics facilities and distribution centers in metropolitan areas (Dablanc and Rakotonarivo, 2010).
  - The second aspect we examine is the polarization of logistics activities, i.e. the concentration of logistics facilities in large metropolitan areas.

- Going a step further than the existing literature, we examine the sprawl patterns of freight facilities at a local level (zip-code) in four metropolitan areas not treated before in the literature. Then we conduct this analysis at the "megaregional" level, only a few scientific papers have examined it (such as Piedmont Atlantic megaregion (Dablanc and Ross, 2012)).

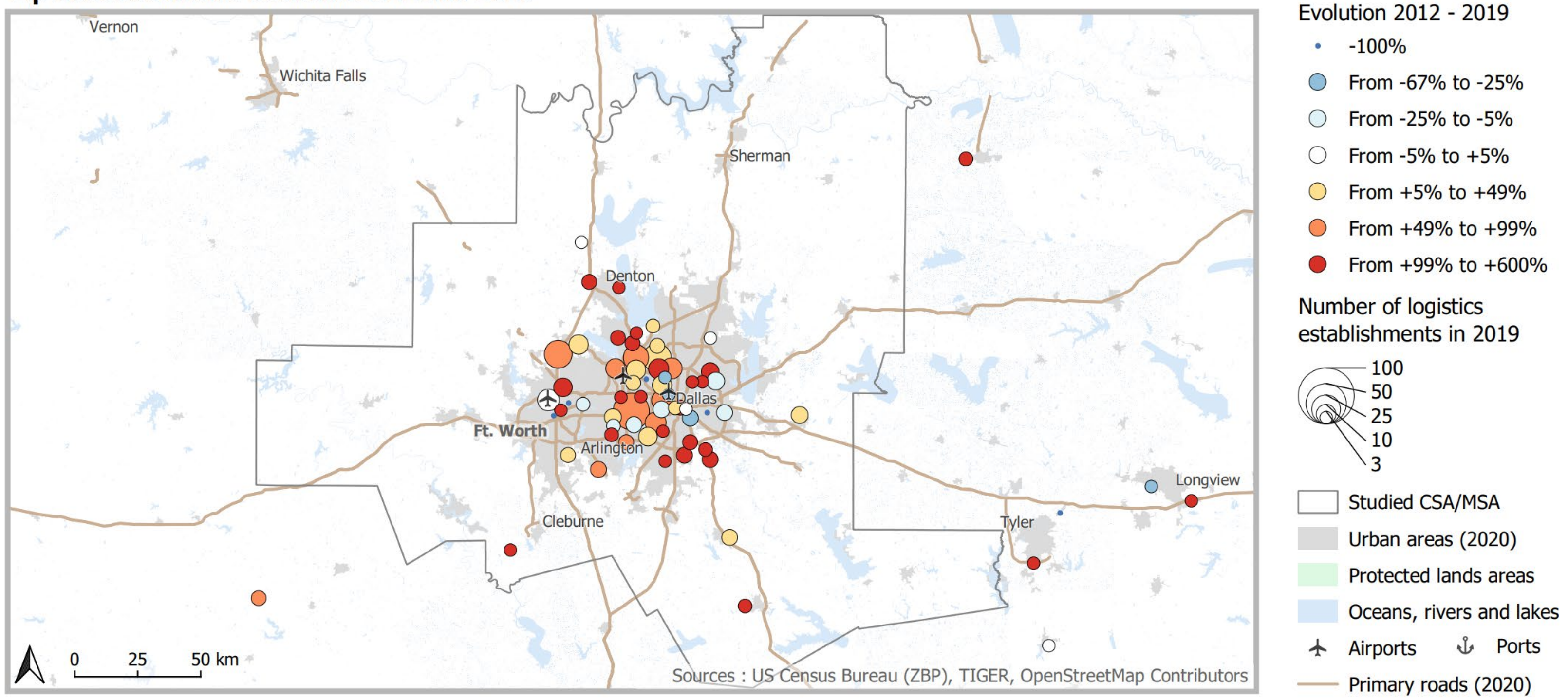
Methodology

- Warehousing development patterns in four U.S. metropolitan areas based on the **County Business Patterns database** (U.S. Census Bureau) for 2012 and 2019 data at zip codes granularity
- The same data period (2012-2019) was defined to ensure consistency in the analysis
  - Warehouse = establishment classified in subsector **493** ("Warehousing and Storage") of the North American Industry Classification System
  - '**Establishments engaged in operating merchandise warehousing and storage facilities**'
- This research used R to compile, aggregate the data and the QGIS software was used to map establishments and provide spatial analysis and barycenters

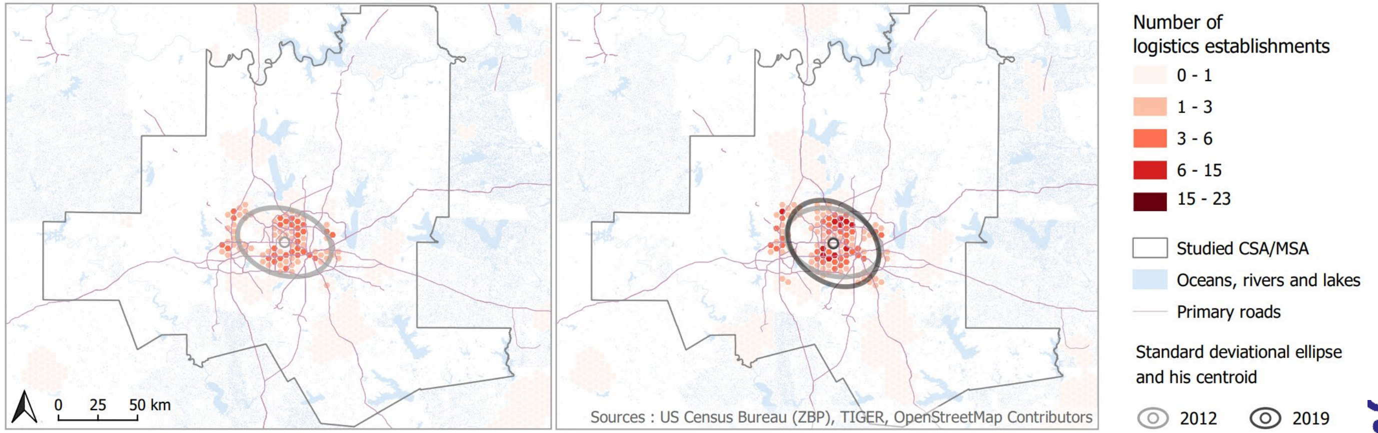
DALLAS-FORT WORTH-ARLINGTON CSA

- 376 warehouses in 2012 and 533 in 2019 (+42%)
- Northeast, southeast, and the southwest near Arlington
- Dual pattern of development: more logistics facilities in the first ring around Dallas and at the same time rapid development on the edges of the metro area
- The standard deviational ellipse area from the barycenter increased by 20% (2324 km² in 2019)

Zip Codes centroids between 2012 and 2019



Grid 5x5km



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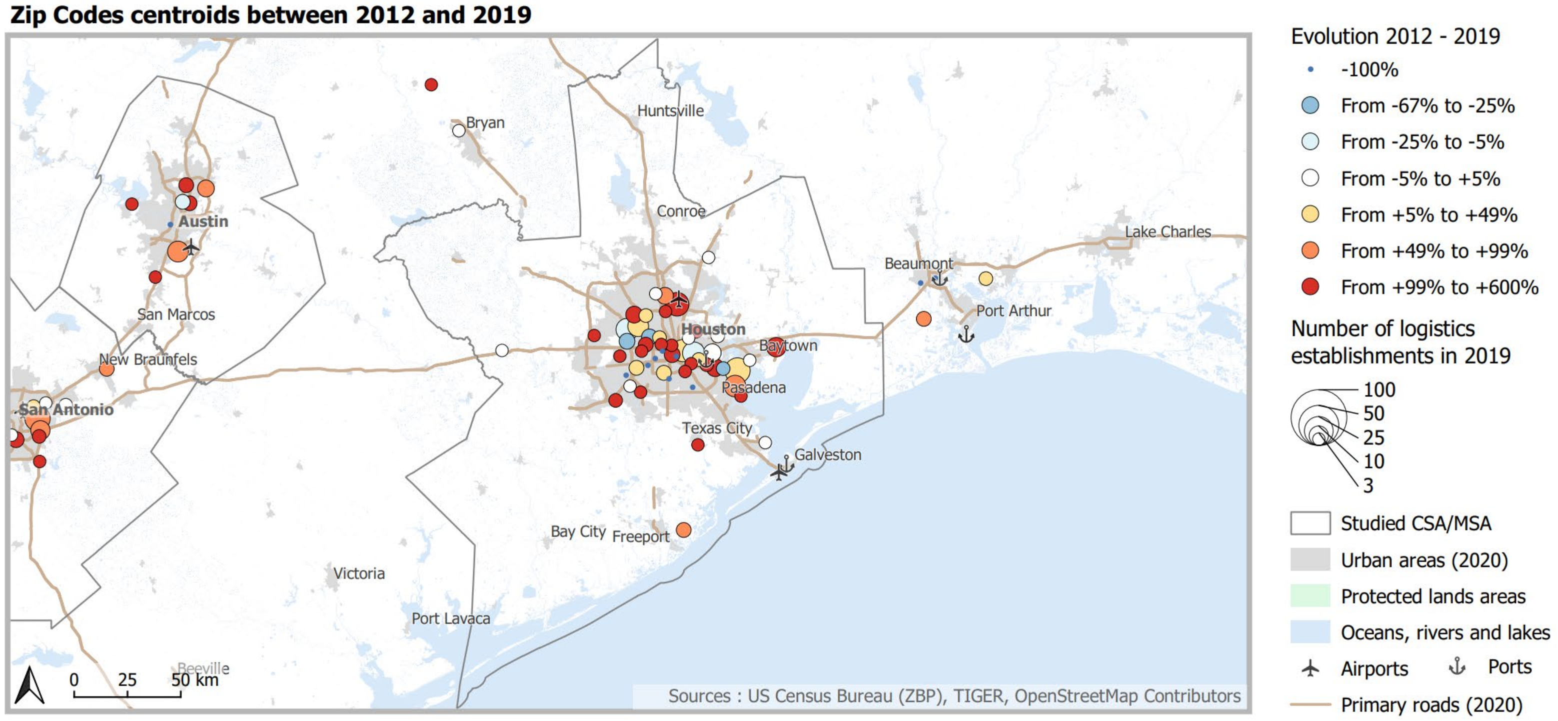
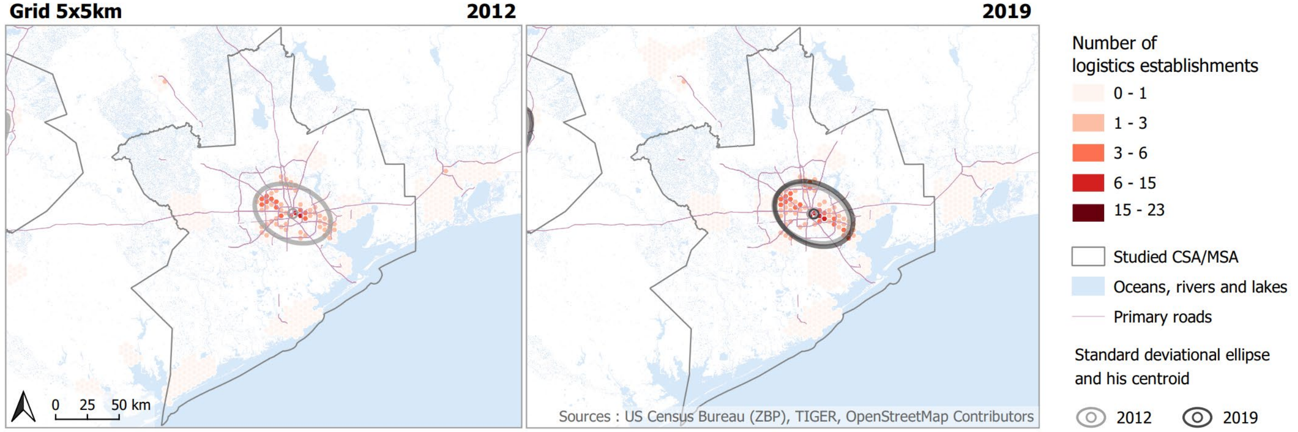
HOUSTON-THE WOODLANDS-SUGAR LANDS CSA

- A fast-growing logistics hub: increase of 29% from 281 to 363 warehouses
- Sunbelt cities: strong demographic and economic growth, urban sprawl
- Three main logistics clusters: around the Port of Houston to the southeast; around the airport to the north; and a west/northwest axis from downtown (I10, Washington Avenue, I610, Hempstead Road)
- The standard deviational ellipse area from the barycenter increased by 14% (2328 km² in 2019)





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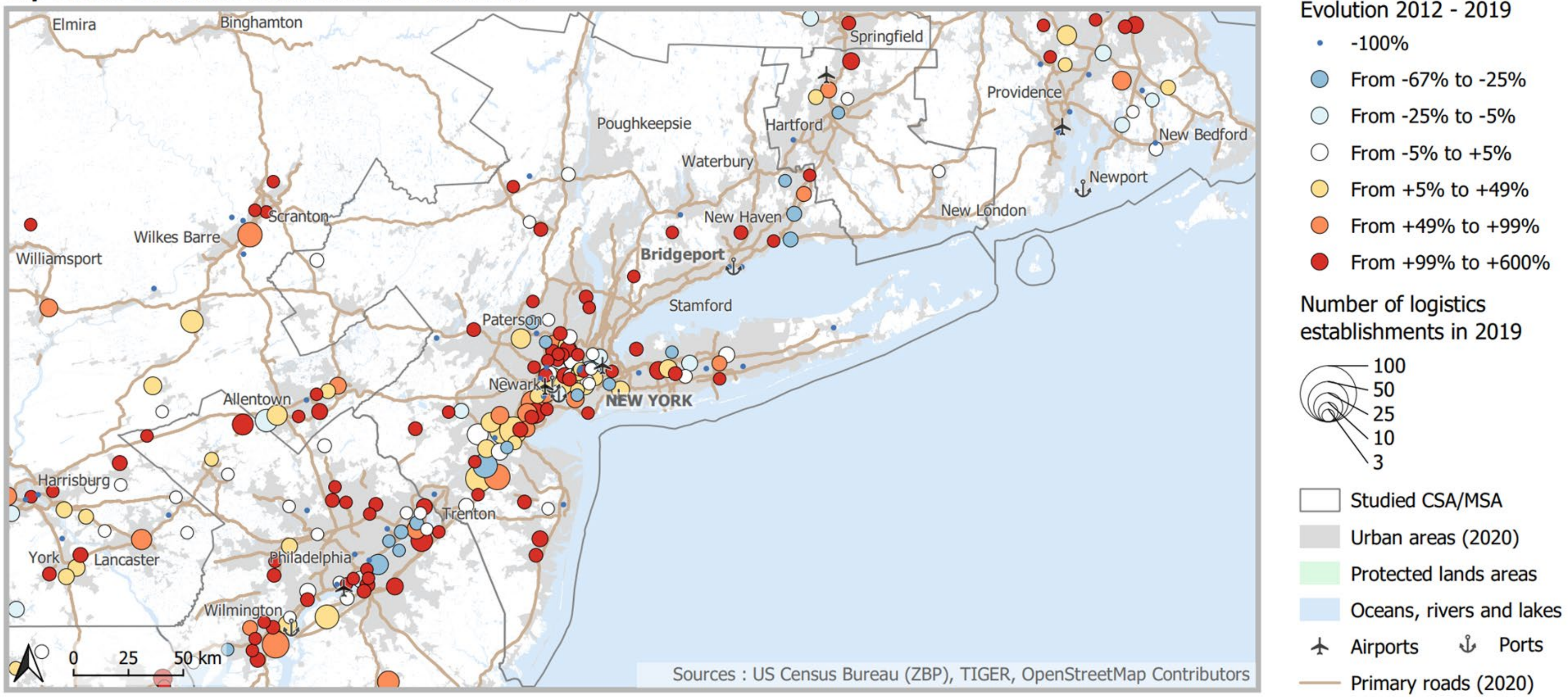
New York-Newark-New Jersey CSA

- Major warehousing hub in the US: from 844 to 993 warehouses (+18%)
- Continues to grow, confirming the metro area's role as an international and domestic gateway
- A distinctive form, essentially confined to the megacity's urban corridor
- Why? Major transportation infrastructures (Port of New York-New Jersey, Interstates, Newark? JFK and La Guardia airports) & the limited number of available land parcels in a highly urbanized region
- The standard deviational ellipse area (from the barycenter) was 4907 km² in 2019 (a decrease of 7% between 2012 and 2019)

Zip Codes centroids between 2012 and 2019



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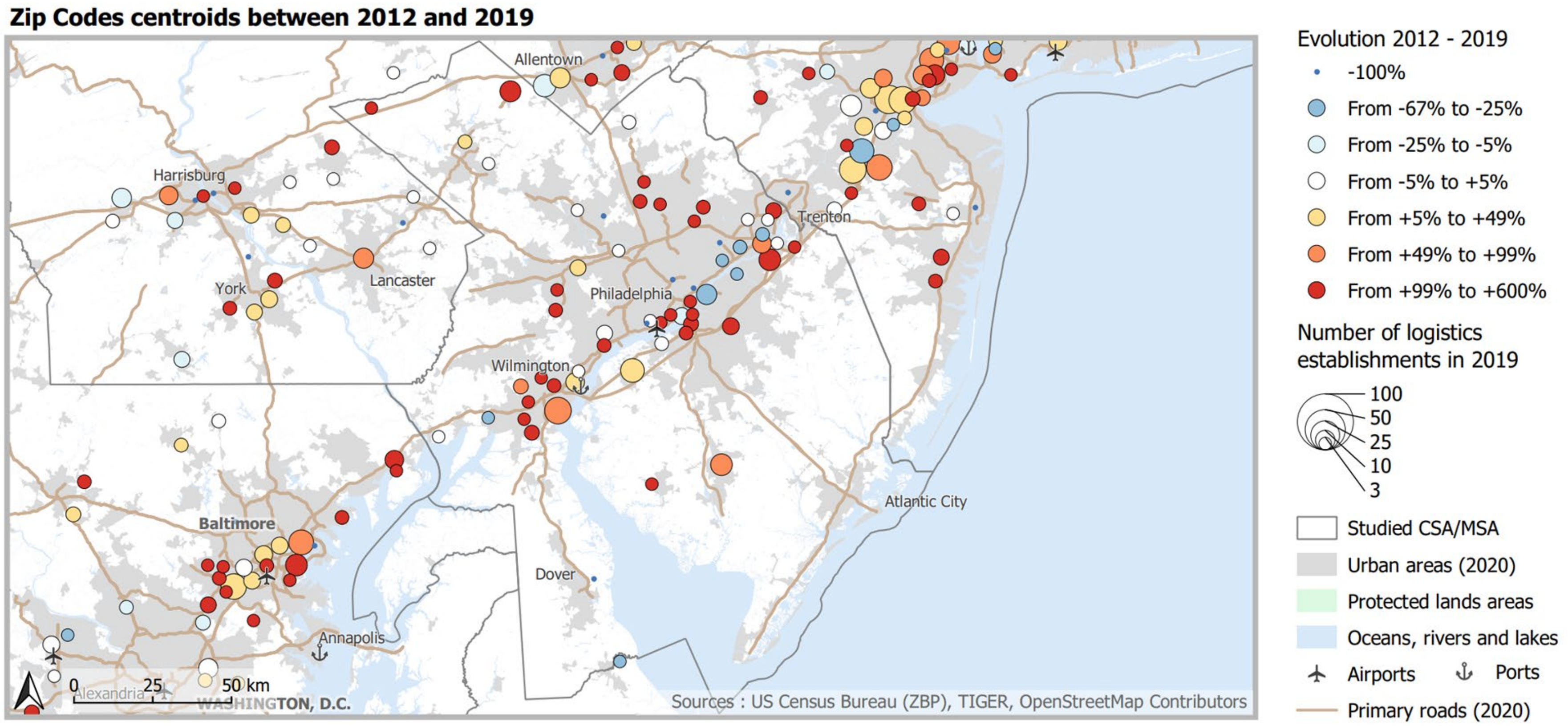
PHILADELPHIA-CAMDEN-WILMINGTON CSA

- The number of warehouses grew significantly from 324 in 2012 to 395 in 2019 (+22%)
- Most warehouses follow the metropolitan corridor along a longitudinal northeast/southeast axis that concentrate major highway and rail transportation infrastructure as well as major ports and airports
- Confirms the major trends in the logistics real estate market (periphery and center)
- Standard deviational ellipse area (from the barycenter) increased by 17% from 2012 to 2019



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The megaregional level: the emergence of metropolitan clusters

A few research focuses on the megaregional scale, due to the complexity of freight flows at multiple scales and the complementarity of logistics facilities networks. Ross and Woo (2009, 2010), Ross et al. (2009) identify a very strong relationship between road freight transport and megaregions.

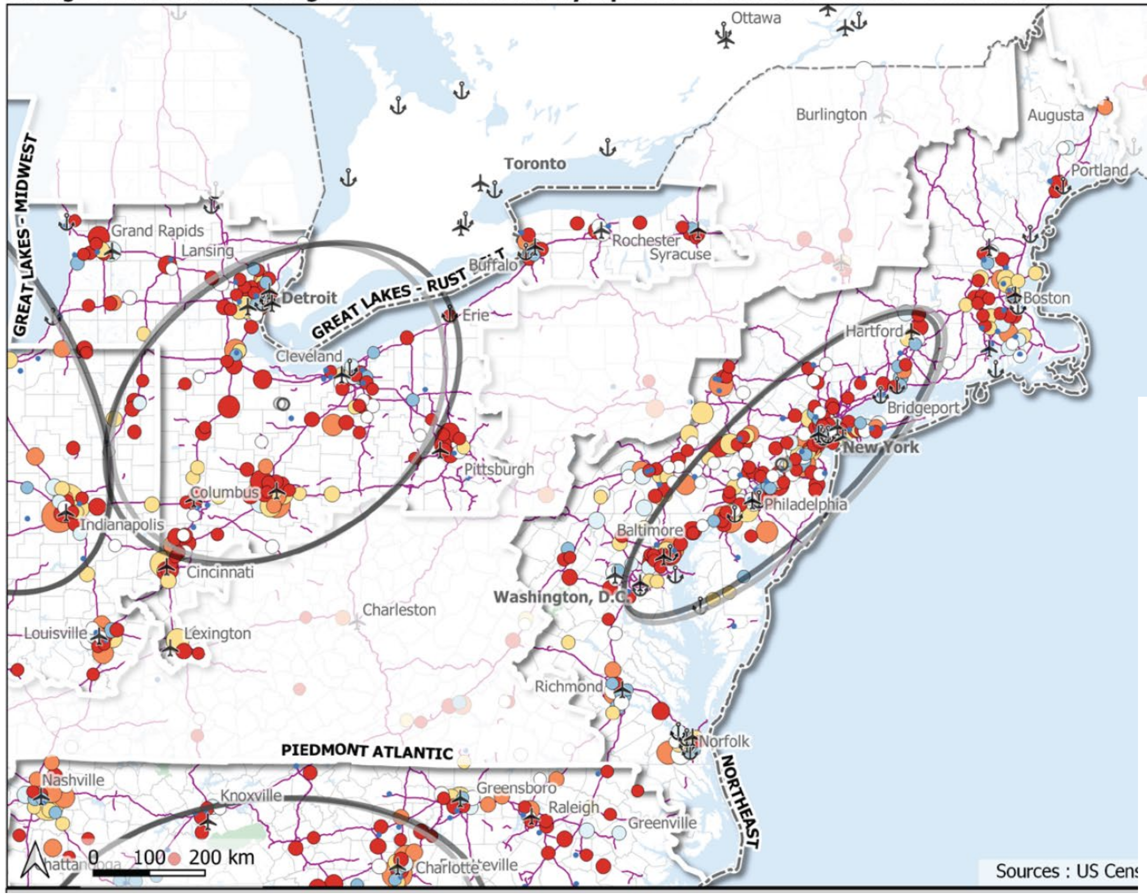
The polarization of logistics activities (Gilli, 2009) is the concentration of logistics activities in the major metropolitan areas and the most prominent transport hubs.

Gifford et al., (2011) explore the relationships between freight movements and the megaregion scale using the Commodity Flow Survey (CFS). Dablanc and Ross (2012) confirms the existence of logistics polarization at a megaregional scale, in the case of the Piedmont Atlantic Megaregion, confirming the polarization pattern of freight facilities (Gilli, 2009).

Ross (2009) define megaregions as « networks of metropolitan centers and their areas of influence that have existing social, environmental, economic, and infrastructure relationships, are geographic areas that will contain two thirds of the nation’s population by the mid-twenty-first century ».

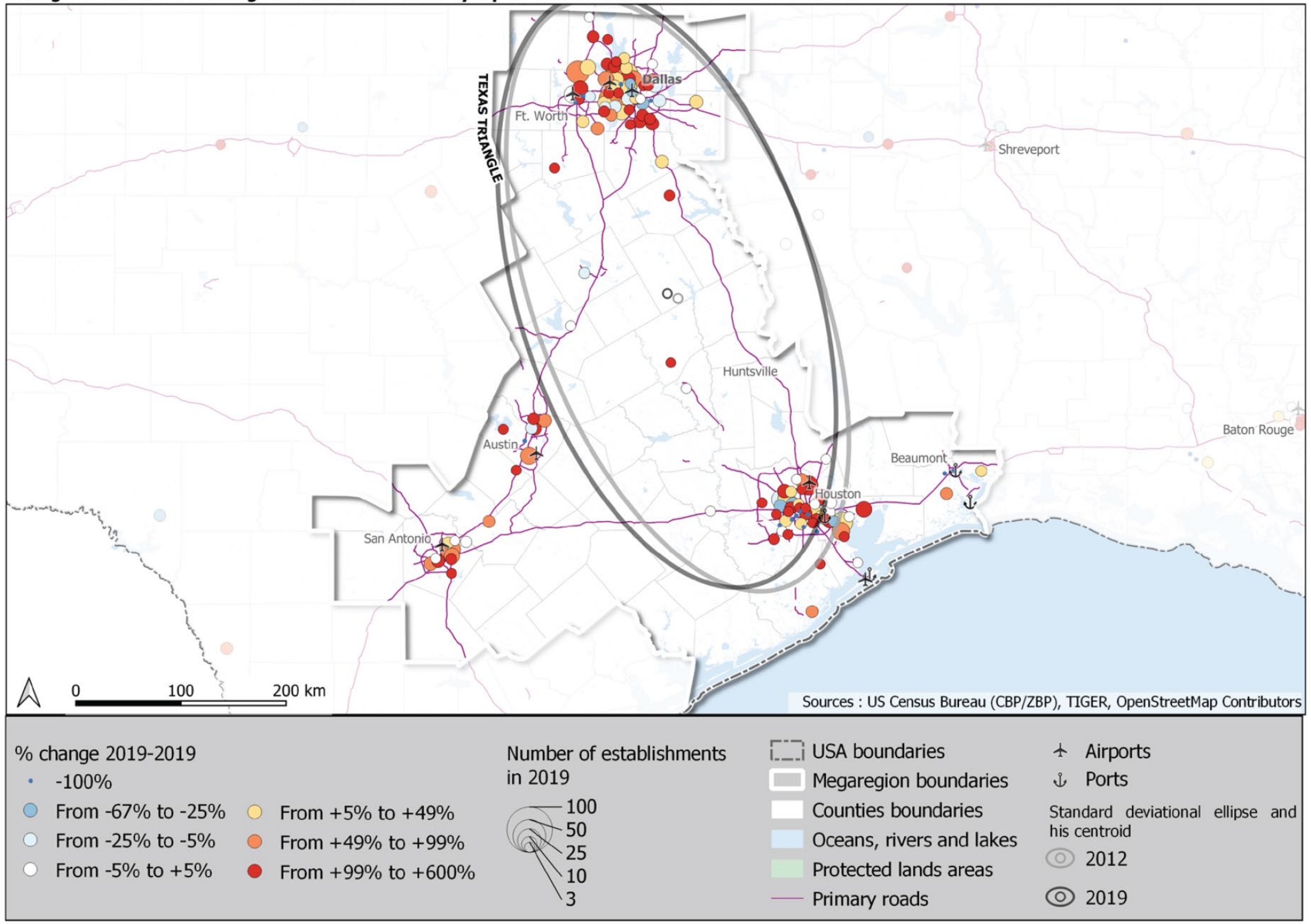
The megaregion is the result of a continuous process of polarization and accumulation of population, wealth and activities, which goes beyond the existing administrative units as well as the traditional scales of analysis – inner city, urban area, metropolitan area. Each megaregion forms a large but coherent territory, marked by environmental, economic, and infrastructural interactions, creating a new transactional and traffic space.

Change in the number of logistics establishments by Zip Codes centroids between 2012 and 2019



*(a) Evolution (2012-2019) of the spatial distribution of logistics facilities in the Texas Triangle megaregion; *(b) Evolution (2012-2019) of the spatial distribution of logistics facilities in the Northeast megaregion. (Schorung, Lecourt, 2022)

Change in the number of logistics establishments by Zip Codes centroids between 2012 and 2019



→ This analysis confirms the existence of logistics polarization at a megaregional scale, in the case of the Texas Triangle megaregion and the Northeast megaregion.

→ These maps show that the number of warehousing establishments has increased in many zip codes in or close to the core metropolitan areas. In relative as well as absolute terms, these zip codes have attracted more logistics facilities than most other urban, semi-urban, or rural zip codes in the region.

Conclusions, discussions and next steps

- The number of warehouses in the four metropolitan areas grew rapidly between 2012 and 2019
- The Dallas area is archetypical of a booming warehousing cluster (+42% between 2012 and 2019) and sprawling metropolitan area
- Houston has also experienced strong growth in numbers of warehouses (+29%) but with less urban sprawl overall than Dallas
- Warehouses cluster along major infrastructures (Port of Houston, Houston International Airport) and interstates
- The two other case studies (Philadelphia and New York) have different trajectories
- Especially, the New York-Newark-New Jersey area has experienced moderate growth in the number of logistics establishments (+18%) as this growth occurred in an already mature and well-developed logistics market
- The New York case shows an increase in urban/first ring locations for logistics facilities

- This present research adds new metropolitan areas to these having been analyzed for the phenomenon of logistics sprawl. 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 in one metropolitan area (Seattle) (Dablanc et al., 2014).

- Two important aspects of the geography of the logistics industry are mostly confirmed by this research: "logistics sprawl" - the spatial deconcentration of logistics facilities and distribution centers in the Houston, Dallas and Philadelphia metropolitan areas; and the polarization of logistics activities - the concentration of logistics activities in the urban areas of Texas Triangle and Northeast Corridor.

→ Next research steps (2023-2024) :

→ Including in our research the latest CBP data available (2021 – available since May 2023)

→ Deepen the analysis of logistics sprawl regarding the type and the size (Kang, 2020) of warehouses

→ Explore through a comparative analysis the cases of "reverse logistics sprawl"

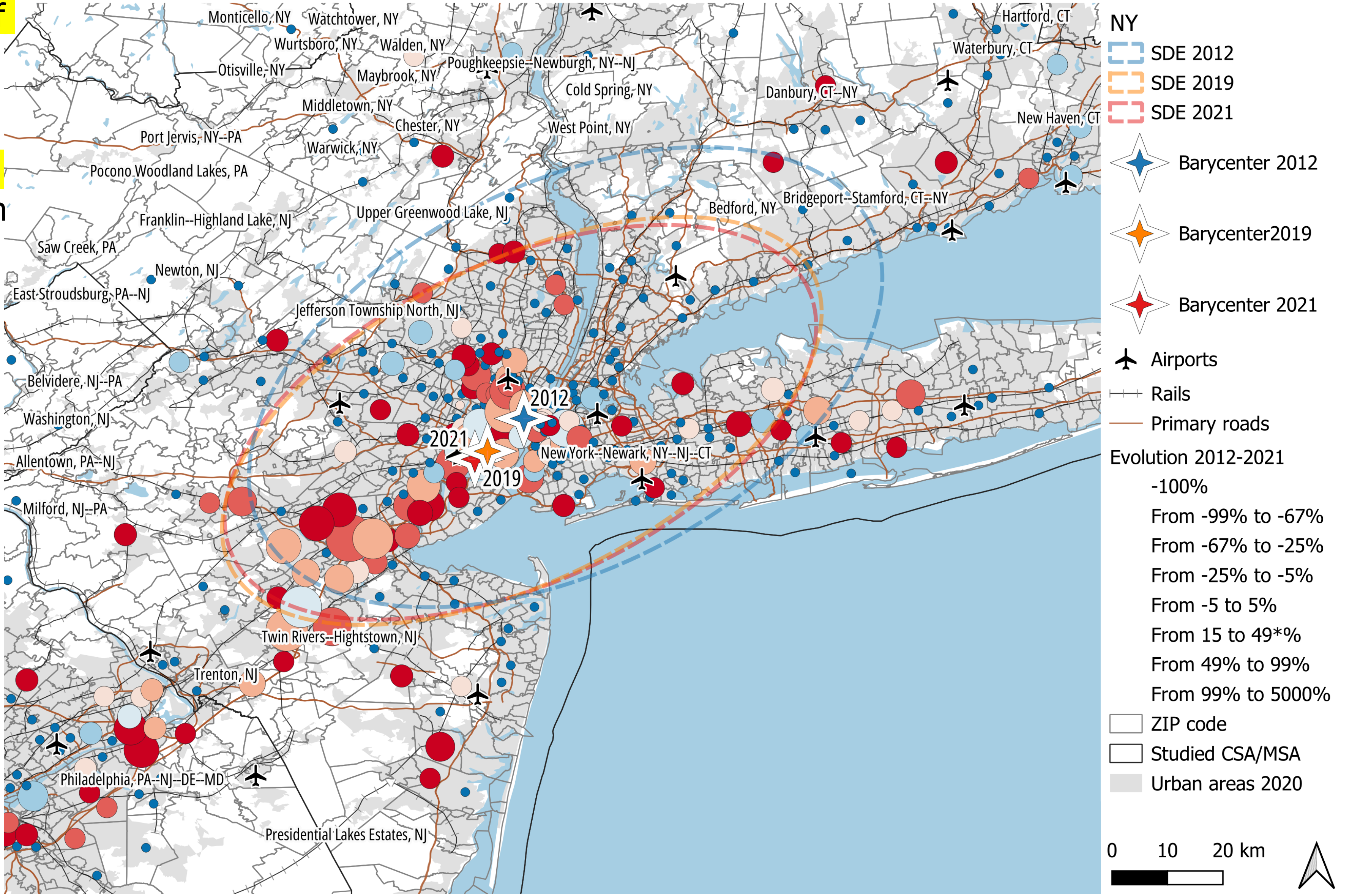
- First insights from the 2021 CBP data :
  - An impressive increase of nb of warehouses in many cases (Covid-19 effect?) → 60 more warehouses in the Atlanta CSA between 2019-2021 ; 92 more in the NY-Newark CSA → which raises the question of urban planning/land use and the scarcity of land available
  - A reactivation of logistics sprawl despite the recent development of 'proximity logistics' (Buldeo Rai et al., 2021) facilities ?

Average distance to the barycenter

Metropolitan area	2012	2019	2021
Boston	32740,37	32342,3	32190,07
CHICAGO	35727,31	33035,4	33276,28
INDIANAPOLIS	24282,56	18457,82	21201,74
MIAMI	29878,33	26832,21	29390,66
PORTLAND	17850,55	12304,12	11819,88
SEATTLE	28475,26	18605,27	20691,46
ST. LOUIS	28571,99	18886,24	19251,77
ORLANDO	41043,83	34352,07	34378,98
DENVER	20170,11	16855,98	17712,93
COLUMBUS	32461,8	24965,42	22390,76
NEW YORK	34760,75	31099,07	32168,65

- More research to come!

New York - Newark, NY-NJ-CT-PA



(Schorung, Yaghi, 2023)

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